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SCIENCE, TECHNOLOGY AND GLOBAL SECURITY WORKING GROUP
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Iran as a Pioneer Case for Multilateral Nuclear Arrangements

by

Geoffrey Forden and John Thomson

September 5, 2006

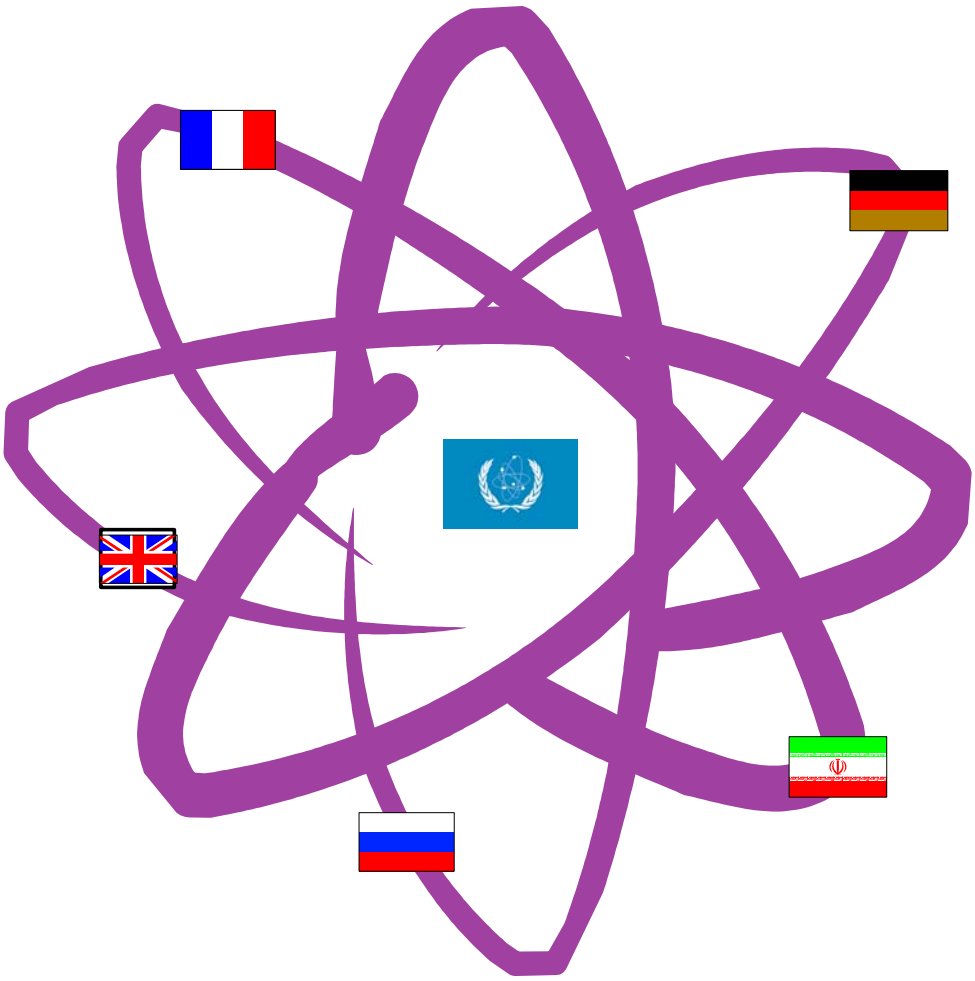

Table of Contents

SUMMARY

This paper is a considerable expansion of pieces we published in February and April 2006 focusing on the Iran crisis.

It makes two recommendations for general nonproliferation policy, both particularly relevant in the event of a global expansion in nuclear energy. The first advocates multilateral facilities ranging over the fuel cycle from conversion to ultimate disposal. Building on this, the second proposes a virtual fuel bank organized through the IAEA. Both are necessary to persuade countries to forgo permanently national enrichment and reprocessing facilities.

The bulk of the paper details the Forden-Thomson plan for dealing with the Iran crisis, essentially a multilateral enrichment facility on Iranian soil with the capacity to provide material for a virtual fuel bank. Given that the escalating dispute has carried the parties well beyond an ideal agreed solution, the plan is put forward as the best option in a bad situation.

A treaty between Iran and the EU-3, Britain, France, and Germany, 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.

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 partnership would also lease URENCO centrifuges and install them in batches, the first in a few months, the last (making a total of, say, 50,000) seven or more years later. Until the first batch comes in to operation, the partnership would use Iranian P1 centrifuges; all of which would be phased out as soon as the URENCO centrifuges begin to operate. (We estimate that in this period the existing P1s could not produce enough HEU for a weapon.) To preserve secrecy, the sensitive parts of the P1's would be “black boxed” 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.

If the Iranians accept our plan, they are unlikely to expropriate the internationally owned facilities. To do so would be a seizure of the property of powerful governments well placed to retaliate by various means. It would signal an 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. 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 diversion of material and against the establishment of a clandestine facility.

The LEU produced would be sold commercially on the global market and profits distributed according to shareholding. The Iranians would be customers like all others. Whereas the P1's will never produce enough LEU for more than one reactor, the URENCO machines can easily satisfy the needs of the full Iranian program (20 reactors by 2035) and still have approximately half the output to contribute to a virtual fuel bank.

We consider the pros and cons of certain variants (e.g. Russian instead of URENCO centrifuges) and also possible add-ons (e.g. a regional nonaggression treaty.) We conclude with the pros and cons of the whole proposal.

We claim that (1) our proposal meets the bottom line of both sides, enrichment on Iranian soil and no nuclear weapons in Iranian hands, (2) that the built-in safeguards are robust and effective and more likely to deter and prevent clandestine operations than any proposed alternatives, (3) while risks exist, our plan is the best option in bad circumstances. In addition, it points the way to strengthening the global non-proliferation regime.

Iran as a Pioneer Case for Multilateral Nuclear Arrangements

This paper is at one and the same time intended to serve three purposes:

- it is an exploration through the illustration of one particular case of how a policy of multilateralism might work to strengthen the global nonproliferation regime;

- it describes a possible resolution of the current Iranian nuclear problem;

- it suggests a means to meet the non-proliferation goal of a guaranteed fuel supply without political strings.

While each objective can be considered as a separate issue, a synergy exists which we exploit in our proposal. Our principal overall objective is to strengthen the non-proliferation regime. This being so we have to deal with the Iranian crisis for, if that goes badly, the regime will be sorely damaged. Conversely, if the Iranian crisis receives a constructive solution, that may point to wider applications of the idea involved and hence to strengthening the regime.

Following this line of thought, we begin with general comments on each of the three purposes mentioned above. Next, constituting the bulk of the paper, comes our plan for a multilateral enrichment plant in Iran. We continue with some other ideas which might be packaged around the multilateral plant proposal and end with a discussion of the pros and cons of the whole proposal in relation to proposed alternatives.

At the outset we stress that our plan for Iran is not the ideal outcome, only that it is the best available option in a difficult and dangerous set of circumstances.

Multilateralism

Multilateral control of the means to make nuclear weapons is an idea almost as old as the nuclear age itself but hitherto it has had little success. The Acheson-Lilienthal Report of 1946 recommended an "Atomic Development Authority" with a global monopoly of control over all the processes that could lead to a nuclear weapon. Under the title of the Baruch Plan it became official U.S. policy but was soon suffocated by mutual Cold War suspicions.

In the following quarter century, some agreements, for example, the Test Ban Treaty (1963), the Latin America Nuclear Free Zone treaty (1967) and SALT I (1972), sought to control weapons while others, mainly Eisenhower's well meaning but naïve Atoms for Peace (1955) promoted the spread of nuclear knowledge and materials for beneficial purposes. These two types of agreement, each admirable in its way, are essentially inconsistent, one limiting weapons, the other in effect promoting the means to make them. This inconsistency is at the heart of our present predicament and in the first place, of the Iranian crisis.

From the beginning it was well known that the material that gives us electricity and medical treatment will do just as well, after some extra work, for weapons and that the equipment necessary to produce Low Enriched Uranium (LEU) for civil purposes need only operate a bit longer to produce Highly Enriched Uranium (HEU) for bombs. Political leaders at the time understood that they could not rid themselves completely of weapons nor hold back humanity's drive for electricity. Accordingly, they crafted a political framework intended to keep the military and civilian uses of nuclear energy safely in balance; no spread of weapons combined with widespread civilian use of nuclear energy. The resulting framework was called the Non-Proliferation Treaty (NPT), signed in 1968 and entered into force two years later. So important was and is the NPT that, remarkably, every country in the world adhered to it save three, India, Israel and Pakistan. Later, North Korea resigned. These four hold-outs all ran clandestine programs and made nuclear weapons, thereby seriously complicating efforts to control weapons globally.

The NPT, now often described as "flawed", was the best bargain that could then be made to prevent proliferation of weapons while encouraging the spread of civil uses of nuclear energy.

It did not do away with the potential inconsistency between the two objectives but it created a regime that encouraged governments to choose to avoid nuclear weapons. If the rules were observed, all would be safer and all members who sought civil nuclear power would be helped. Eventually, however, governments began to make choices that had the opposite effect putting the non-proliferation regime in jeopardy. This is not the place to analyze the bad choices and the unfortunate effects. It is important to realize that the blame is widely shared: some is due to the "hold-outs" undermining the bargain made by the rest of the international community, some to governments turning a blind eye to dangerous illegal activities (above all Pakistan and the A.Q. Khan black market) some to cheating by non-nuclear weapon states (NNWS) of which Iran and North Korea are currently the main examples, some to the nuclear weapon states (NWS), especially Russia and the U.S. who have fallen dismally short of carrying out their obligations under the NPT to reduce (ultimately to nothing) their dangerously huge nuclear arsenals and some to all the states, which irrespective of their rhetoric, have failed to give top priority to the cause of non-proliferation.

For the sake of the future, it is important also to understand why the non-proliferation regime was so much more effective for a quarter century or so than many experts expected. First, the treaty was a negotiated bargain by which all parties derived benefits and assumed responsibilities with both being spotlighted in the five-yearly conference of the NPT. Second, an effective international expert body, the International Atomic Energy Agency (IAEA), monitored both sides of the bargain. Third, another inter-governmental body created in the mid 1970's, the Nuclear Suppliers Group (NSG), operated agreed guidelines which bound commercial competitors to adhere to NPT and IAEA rules. These three institutions together formed the core of a regime that worked well so long as governments behaved as they had undertaken to do.

This regime is damaged but not broken. Since no realistic prospect exists of starting afresh with a better one, there is no sensible alternative to repairing the damage and where possible introducing improvements. Such repairs cannot be done by the institutions themselves; only the governments can amend their own behavior and thus re-create a fair balance. Multilateralism, we contend, can make a significant contribution to helping governments do this. Mohammed ElBaradei, Director General of the IAEA has commended the multilateral concept

for the last several years and an expert group appointed by him in which twenty-five countries were represented produced a useful report on Multilateral Nuclear Arrangements (MNAs) in February 2005[1]. Unfortunately, the report has attracted little attention and the conspicuous lack of enthusiasm by major governments seems designed to bury the concept.

Interment without examination is unjustified and shortsighted. We would like a serious open discussion of the issues raised by this important report. If, as seems possible, the production of electricity through nuclear energy returns to the expansionist path of the early 1970's, fresh risks of proliferation will quickly arise. Conceivably they could be handled solely through the mechanisms of the existing global market but that is doubtful. Much of the world does not regard the status quo as fair, a point that in itself calls for fresh thinking and this burden of unfairness may cause the already damaged non-proliferation regime to perform inadequately or worse.

Given this prospect we should consider whether the balance of fairness can be redressed through multilateralization of critical facilities, especially enrichment and reprocessing plants. They are the two most critical facilities. Enrichment creates fuel for electricity-producing reactors but unfortunately if further enriched produces weapons grade uranium for a bomb. Reprocessing of spent fuel from a reactor can extract plutonium usable in a nuclear bomb. We argue that multilateralization can greatly reduce the risk that civil facilities will be used for military purposes.

We show also how multilateralization can support non-proliferation by providing a secure long-term source of reactor fuel irrespective of political quarrels, thus removing the apparent need for <u>national</u> enrichment or reprocessing facilities.

<u>Iran</u>

The present dispute between Iran and the West is going from bad to worse. In the process, it is becoming increasingly bad-tempered and on each side the room for maneuver is being narrowed.

[1] Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report submitted to the Director General of the International Atomic Energy Agency, INFCIRC / 640 of 22 February 2005

There is a case for moving before it is too late from entrenched positions and frequently repeated arguments to a fresh approach, such as the one we present below. Again, we want to stress that we do not put forward our proposal as the best of all possible outcomes. We support, for example, the current Six Power negotiating position if it can be agreed. We prefer that enrichment should take place outside Iran. But if there is likely to be no agreement with the result that unconstrained enrichment takes place in Iran that would be so bad for the entire non-proliferation regime that our proposal would be much preferable. Consideration of it, therefore, should not be postponed until everything else has been exhausted. By that time, the negotiations may be so ill tempered and distressful that one or both sides will be unwilling to enter into any compromise agreement with the other.

The compromise we propose comes after three years of failed negotiations. During this period, the potential common ground between the two sides has been whittled away to such an extent that we have been obliged to take our stand on what seems to be the irreducible minimum for each.

The West is seeking to prevent Iran from achieving three things: mastering the technology of industrial scale enrichment, possessing an effective industrial-scale enrichment facility and making nuclear weapons. These three steps are progressive; the first is essential to the second and the second to the third. Thus, Iran might have the technology without an actual effective enrichment facility and the latter without going on to nuclear weapons. But if it takes the first and second steps (which would make it "weapons capable"), there is a general presumption that it will take the third. However this is not necessarily true. For example, neither Japan nor Brazil, both "weapons capable", have taken the third step. The West aims to prevent Iran from becoming "weapons capable" but if it fails it will still strenuously seek to prevent Iran from making a weapon. So we believe the Western bottom line is no nuclear weapons in Iranian hands.

Iran, for its part, declares that under the NPT it has an inalienable right to steps one and two and that its voluntary decision to renounce step three was and remains linked to that right.

Therefore, its bottom line is step two and this does not conflict with the Western bottom line. Awkwardly, though Iran does not put it this way, it is asserting a right to posses a nuclear weapons capability while renouncing weapons. The West believes the first point but not the second whereas the Iranians do not believe Western reaffirmations of Iran's right to nuclear energy for peaceful purposes. On both sides, there is a shortage of credibility and this makes a negotiated settlement very difficult.

Our proposal is designed to meet both bottom lines - industrial scale enrichment on Iranian soil but no nuclear weapons. Another way of looking at our proposal is to say that it comes down the middle: Iranians acquire civil nuclear technology but are prevented from having a bomb, they have an industrial scale enrichment facility on their soil but only share in its ownership and control.

Guaranteed Fuel Supplies

Many other countries besides Iran consider that under the NPT they have rights that are threatened by Western policies, including the relatively recent policy of preventing any more countries from acquiring enrichment or reprocessing facilities. For this policy to become acceptable, countries must be satisfied they have a credible guarantee of buying at market rates as much fuel as they want, free of all political considerations. The only condition should be that the purchasers must be members of the NPT in good standing and accepting full scope safeguards and the Additional Protocol.

Recent experience of the way countries neglect or deny their obligations mean that few are content to accept merely verbal assurances from existing suppliers. They want a well-funded and well-founded scheme run by a multilateral organization, probably the IAEA. Our proposal provides that.

The Forden – Thomson Plan

We turn now to a plan specifically designed to deal with Iran's nuclear program. It is based on multilateralism and includes provisions for a guaranteed fuel supply to countries in good

standing with the NPT. We believe therefore that, in addition to dealing with the current crisis in Iran, it contributes to strengthening the whole non-proliferation regime.

We begin by setting out the details of a complete plan so far as access to data permits. Further research may suggest modifications and in any case we want to preserve a good deal of flexibility. But that said, clarity will be served by showing the reader, as we do, a single complete model. At the same time we include variables or alternatives on two or three important points. On these, we set out our ideas in separate sections immediately following the model plan.

The Essence of Our Plan

We propose an agreement between a small number of governments to set up in stages a large, high-quality enrichment plant in Iran under multilateral ownership and control and subject to stringent safeguards, including by the IAEA.

The Formal Structure

A treaty is the preferred form of agreement. It binds all parties in a solemn and formal way. None will lightly break their obligations, penalties can be specified, means of arbitration provided and arrangements for winding up the operation by mutual agreement may be laid out. In addition, the principles upon which the operation is to be run should be broadly stated. The agreement should aim (a) to avoid unwelcome surprises down the road, (b) to endow the parties with the ability to adjust the agreed structure to changing circumstances and with the flexibility needed to make the business a commercial success.

The treaty would specify that no enrichment-related activities or equipment other than those conducted by the multilateral organization would lawfully take place in Iran. The treaty would also ban reprocessing in Iran.

The original parties should be Iran and the EU-3 (France, Germany and the UK). The Netherlands as the partner of Germany and the UK in owning and operating URENCO should be

offered the opportunity to join. Because of Russia's existing commitments to the Iranian program, a similar invitation might be extended to her. Given the high cost involved, the original parties might consider inviting one or two states flush with oil money to join the enterprise. The UAE and Norway come to mind. Others could be added later at the unanimous invitation of the original parties. The proposal meets the declared wish of the Director of the Iranian Atomic Energy Organization, Gholamreza Aghazadeh, to enroll foreign partners in the financing of Iran's enrichment program.

The treaty would create a holding company owned by the participating governments as the sole shareholders. The simplest arrangement would assign them equal numbers of shares but this could be a matter for negotiation. In any event, two provisions not subject to amendment would be incorporated in the treaty. One would provide a mechanism so that no one country irrespective of the size of its shareholding could override the others. The second would allow Iran after giving appropriate notice (? three years) to require the removal from Iranian soil of all the moveable equipment belonging to the holding company with the costs borne by Iran.

The costs of operations authorized by the holding company would be met by the shareholders on a proportionate basis and profits would be distributed likewise. The holding company would determine policy and would operate as much as possible by consensus. However, subject to the non-proliferation commitment of the shareholding governments, it would operate as a commercial company and its Board would be guided by commercial considerations.

The Iranian government would make available for lease by the Board all enrichment related equipment and facilities in Iran, a matter to be closely defined in the treaty. All conversion and fuel fabrication facilities as well as enrichment and storage would be included. The URENCO governments would make available for lease by the Board centrifuges of the latest fully functioning model, probably TC-21s. In the event that the holding company was wound up, the leased equipment and facilities would return automatically to their original owners.

The Board would hire an international management company to conduct the day-to-day operations. That company would follow the guidance of the Board and report to it. The fee paid to the company would have some relation to its commercial success. The company must be highly qualified technically and it must employ nationals of all the original shareholders though not necessarily in proportion to their shares. Probably a new company will have to be formed especially for this purpose. The jobs must be assigned so that neither commercial nor proliferation secrets are breached. The CEO of the management company would be a national of one of the three URENCO countries.

All the enrichment related operations of the holding company and the management company would be subject to full scope IAEA safeguards, the Additional Protocol and other transparency procedures to be agreed between the Board and the IAEA. Both the Board and the CEO of the management company would keep in close touch with the IAEA and would be sensitive to their suggestions. IAEA representatives could be invited to take part in meetings when appropriate.

The Means of Production

When the operation is in full swing it will consist of a 50,000 centrifuge facility at Natanz together with facilities designed to support enrichment (or reprocessing) operations. Several of these will be at Esfahan. The facilities at Arak would also be included. The Iranian authorities would own and operate the facilities for the production of electricity such as the Bushehr reactor and any subsequent power reactors. The Iranian-owned facilities like the multilateral ones would be under full scope IAEA safeguards plus the inspections available under the Additional Protocol and any other transparency measures that may be agreed.

The Supply of Uranium

Under guidance from the Board of the holding company the management company will determine according to commercial considerations where to purchase uranium, either indigenously from Iran or from abroad and in what form. At the existing Iranian conversion facilities leased by the holding company, the yellowcake would be converted into UF6 and transported to the enrichment facility at Natanz. But again, commercial considerations would be

critical. If the Iranian-produced UF6 is of an inferior quality (as suggested by recent media reports) the Board would have to decide whether to improve the equipment and technology and perhaps the skills of the operators or to close the Iranian conversion plant and buy from abroad. Obviously, the issue would have a political dimension but this would not be decisive if it was contrary to an overwhelming commercial case.

The Iranian P1 and P2 Centrifuges

The Iranians have admitted acquiring from abroad designs and parts for two types of centrifuge, the P1 model and the more capable P2. They have shown the IAEA a cascade of 164 P1s. In our scheme, this cascade together with any other machines (whether or not in a cascade) plus spare parts would be leased by the holding company as would the facilities for manufacturing centrifuges.

In our understanding of the Iranian program, discussed in more detail below, the P1 machines will do the job (as they did in Pakistan) but will take a long time to fuel a single reactor with LEU. The P2 machines, which the Iranians have not yet managed to get into production despite several years work, should have a capability more than twice that of the P1s but even so they will take quite a long time to produce a significant quantity of LEU. The exact times depend upon the numbers of centrifuges and the way they are configured and run.

Given these figures we believe it would be politically advantageous and also acceptable in terms of the risks of misuse to start multilateral operations with one or two P1 cascades. By using existing Iranian machines, the multilateral enrichment process could begin soon after the ratification of the treaty and, provided there was no cheating, could help to build confidence. A limited number of P1 centrifuges could presumably operate in an existing building while a permanent home was being constructed for the first batch of URENCO centrifuges. Aboveground buildings are preferable to using the existing underground space secretly constructed by the Iranians. The main reason is safety for the operators but there is also a political argument. If the Iranians were (foolishly) to expropriate the enrichment facilities it would be easier to use military means to destroy an aboveground than a hardened under-ground facility. This should be counted by the Iranians as a cheap way of building confidence amongst

Western governments. Incidentally, it would help also to undercut arguments for new earth-penetrating nuclear-tipped weapons.

Probably it would be desirable to include all existing Iranian P1s in the startup program either in cascades or held in readiness to replace broken or malfunctioning centrifuges. For the sake of argument, let us take a higher figure than we believe actually exists and assume a single cascade of 656 centrifuges with an additional 164 to be held in reserve for spare parts and replacement of malfunctioning machines. This cascade is four times as large as the 164-centrifuge cascade in Iran's existing pilot plant, a cascade far too small to run efficiently because of mixing problems.

If our hypothetical 656 P1 centrifuges operated for as much as two years before the first batch of URENCO centrifuges came online, they would produce about 450 kg of LEU (at 4.3% enrichment)[2]. But, as we say below, the P1s are likely to be phased out well before two years and in any case, the probable startup number is likely to be less than 656. So there is little risk that using the existing P1s to start the multilateral operation will result in enough HEU for a bomb.

In our plan, the LEU produced by the P1s will be dedicated to providing fuel for Iranian reactors. In effect this would mean turning the LEU into fuel for Bushehr, an easily measurable operation. It would be open to the Iranian government to take credit with domestic public opinion for achieving their objective.

We assume that the first 500 URENCO centrifuges could be put into operation within one year and that the whole of the first tranche, say 7,000 centrifuges, would be working by the end of year three. As soon as a few URENCO centrifuges are operating, it will be uneconomic to continue to run the inefficient P1s. At that point, the P1s should be destroyed or put in secure storage. This being the prospect, there would be no case for making or repairing P1s after the ratification of the treaty and still less for further attempts to develop P2s.

[2] It should be noted that even if all of that LEU was diverted for making HEU in a secret enrichment facility, it would produce approximately 20 kg of HEU at 90% enrichment; not quite enough for even a single nuclear weapon.

Each shift of operators (whether for the P1s or the URENCO centrifuges) would be composed of at least three different nationalities. The sensitive parts of the P1s would be "black boxed" and thus unavailable to non-Iranians just as the "black boxed" parts of the URENCO centrifuges would be available only to URENCO nationals. When a centrifuge had to be replaced or repaired, it would be removed bodily by appropriate technicians—Iranians for P1 centrifuges, URENCO representatives for the TC-21s—and taken to its place of manufacture. In the case of the URENCO centrifuges, that would mean shipping them to Europe under safeguards.

Treatment of the LEU Produced

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 about 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.

How should the Board handle the LEU it has caused to be manufactured? As a commercial concern, it needs to sell it as soon as possible in the open market. Accordingly, it would sell to any country which is in good standing with the NPT and which accepts the appropriate IAEA safeguards.

As its reactor program expands, Iran would obviously be a likely customer but would have no lien on the LEU except as provided above for that produced by the P1s. The diversity of reactor types and the specifications and regulations of a multitude of countries mark the international market for reactor fuel: essentially every reactor requires its own unique level of enrichment. This will complicate the production and proliferation-resistant storage of fuel if it is to be done in an economically viable fashion. Given this consideration, the simplest and safest way to keep stocks which are to be turned into reactor fuel will be as yellowcake. But we cannot exclude the possibility that surplus LEU will be created. A considerable cost is associated with

bringing the centrifuges up from stationary to their operating speeds. Thus, to be cost-effective, the enrichment facility would at some level be run more or less continuously and might therefore produce more LEU than was immediately needed. Uncontracted for LEU would be enriched to a maximum of 3% and would be stored probably on site and in cylinders containing two tons of UF6: each cylinder would be placed under IAEA seals and other safeguard mechanisms such as cameras and motion sensors that the Western partners of the joint venture could require.

To meet subsequent LEU contracts, whether from ordinary commercial customers or under an IAEA virtual fuel bank (see below), the 3% (or less) LEU would have to be further enriched according to the precise specifications of the reactor concerned. The storage of LEU in any form but especially as UF6, which can be directly used in an enrichment process, represents some level of risk for theft and diversion. However we believe that risk is low and controllable given the physical properties of UF6—it is a solid below roughly 130 degrees Fahrenheit and is highly toxic and corrosive—and the safeguards mentioned above. When further enriched to meet a contract, the LEU would be quickly turned into uranium oxide—a much more proliferation resistant form—either processed into pellets and fuel rods or immediately shipped out of the country for processing elsewhere.

In addition to theft and diversion we have to take account, at least theoretically, of the possibility of expropriation by the Iranian government. We deal at greater length with this issue below (page 22), but here it is worth pointing out that the expropriation of a store of even very low enriched uranium, together with the centrifuge facility would in theory shorten the time and scale of the task facing a rogue government that aimed to make nuclear weapons. Nevertheless, it would still require a significant effort to raise the enrichment level from 3% or less to 90% or more. The time involved would depend upon various factors such as the level of enrichment sought, the extent of the "tails" accepted and the number and configuration of the centrifuges involved as well as the number of tons of stored LEU. If, as proposed above, the level of production of very low enriched LEU is determined mainly by the level of demand in the commercial market, we judge that the storage of LEU in Iran would not add significantly to the risks of expropriation. While it would probably reduce the length of time taken to produce weapons grade HEU, that time would at first still be measured in months. Later, say ten years

from now, the time would be reduced because of the increase in the number of centrifuges but in turn that increase would extend the time needed for reconfiguration of the cascades. All these calculations are predicated on a combination of worst case assumptions, which in our estimation, are unlikely or very unlikely.

Finance and Costs

Based on information about URENCO's enrichment plants built for the Louisiana Energy Services and for the George Besse II in France, we estimate in current prices that the cost of a 15,000 centrifuge facility would be about € 570 M ($700 M), while a 50,000 centrifuge facility would cost about €1.5B ($1.9B) -- €2.3B ($2.8 billion), depending on conditions in Iran. There would of course be many other costs, for instance for conversion to UF6 and for fuel fabrication.

The large costs involved emphasize the importance of planning on the basis of commercial considerations. And that in turn means that it will be important for the shareholders to exercise through the Board close control over policy and expenditure and to be ready to adjust in the light of expectations about future market conditions. It goes without saying that the management company will have to be highly professional, closely knit, properly compensated and transparently accountable to the Board. It is obvious also that there will be a special responsibility on the host government to facilitate the operations in every possible way. Some of these ways will be financial and others administrative.

The facilities and the necessary personnel must be made safe from unwarranted and harassing legal actions in-country. One possibility would be to accord them many of the same rights and privileges as IAEA personnel (Article XV of the IAEA States).

Having made these general points, we feel that it is premature to enter further into a detailed discussion of costs and profits.

Uranium Deposits in Iran

We do not think it appropriate or necessary for the mining and initial treatment of uranium ore (such as concentration) in Iran to become the responsibility of the commercial partnership.

Control over that should remain with the sovereign government of Iran. However, for political reasons, we think the Board should agree to use Iranian uranium as the input for the P1 centrifuges subject to market pricing. Since it appears that the Iranians already have in hand a considerable quantity of mined uranium relative to the needs of the P1 program, this may in any case be the cheapest solution. The P1s will soon be phased out and for the URENCO centrifuges the Board through the management company must deal in the global market as advantageously as possible.

Nevertheless, it will be interesting to have some idea of the possible contribution to that market by the Iranian mining industry. According to the IAEA, Iran's proven deposits are some 3000 tons, an amount which happens to provide the fuel for the initial loads of 20 reactors but not to sustain them past several years of operation. The IAEA estimate there may be a further 20,000 to 30,000 tons which could be mined. If this turns out to be true, that would be enough to keep 20 reactors running for around seven years. In short, the best available figures show that Iran is not rich in uranium and will in any case have to buy on the open market if it is to sustain its reactor program.

Spent Fuel and Nuclear Waste

These are issues which will have to be addressed explicitly in the treaty. Safety is paramount. Earthquake-prone Iran is not an ideal place in which to store dangerous material. The Russians have offered to take back the spent fuel from the Bushehr reactor. It would be helpful if at least for a time they would take all the dangerous unwanted products of the MNAs operations. In the longer term, we hope that another MNA explicitly for the storage of spent fuel will be established elsewhere, for example in Australia. Until that happens, the dangerous waste produced in the multilateral enrichment facility in Iran will remain legally the property -- and the responsibility -- of the shareholders.

Iran's Nuclear Program

The economic justification for a nuclear program in a country so rich in hydrocarbons as Iran is lies in the fact that it has little else to sell but oil and gas. In the most recent budget, 70% of the country's GDP is derived from its energy exports. At present, Iran consumes at home about one-

third of its oil production. It has a young population which is expected to double in less than 30 years. At that point, Iran might well consume two-thirds of its oil and possibly more. So Iran apparently feels it needs a large increase in the amount of oil for sale abroad and an efficient way to achieve this is to make savings at home through the use of nuclear energy.

Iran has announced an ambitious program to produce electricity from nuclear reactors. Their first 1000-MW reactor currently being built and fueled by the Russians is supposed to begin operations this year. But at present the Russians are withholding the necessary fuel. As already noted, Iran has announced plans for six more reactors to be in operation by 2020 building thereafter to a total of twenty by 2035.

To fuel these reactors, Iran plans a 50,000-centrifuge plant. It intends to manufacture the centrifuges itself based on the P1 machine whose design and many components Iran bought from the Pakistani A.Q. Khan. In the mid-1970's, much of the basic knowledge that went into the P1 was stolen by Khan from URENCO. It was the first machine used by Pakistan to produce HEU for its weapons.

So the Iranians start with an assurance that the P1 will enrich uranium. And apparently they have got a cascade of 164 machines to produce LEU. If they continue to have a free rein such as they have enjoyed since January 2006, they will eventually master the technique for running an industrial-sized enrichment plant. It is possible they may achieve such mastery as early as 2007. They are developing a more advanced centrifuge, the P2. This too was used in the Pakistani military program and the plans obtained in the mid 1990's from A.Q. Khan. But it appears that the Iranians have had trouble in making it and probably they are not yet able to mass-produce it.

In short, the Iranian centrifuge development program is progressing slowly. At the present rate, it will be a long time, possibly more than ten years, before they could have a 50,000 P1 centrifuge plant in operation and still longer before a similar sized P2 plant could up and running.

The P2 machine should produce a little more than twice the fuel produced by the P1 in the same period. But that is still far from enough to meet the needs of the reactor program. A plant with 50,000 P1 centrifuges will have an annual capability to produce 17 tons of LEU at 4.4% enrichment, an amount that will sustain one reactor only. The equivalent figure for the P2 maybe about 52 tons. And so it could sustain perhaps three reactors. Compared with a need to sustain 20 reactors, the Iranian centrifuge program looks like a disaster.

The whole nuclear power program, not just the centrifuge part of it, is gravely inadequate for anything but a small number of reactors, probably one. The existing UF6 production facility would be well matched with a 50,000 P1 centrifuge facility run at approximately 80% design capacity. The fuel fabrication facility with a planned output of 20 tons per year is also consistent with fueling a single reactor.

These figures taken together with Iran's meager uranium deposits make the idea of a significant (in terms of Iran's electricity needs) self-sufficient civil nuclear industry seem a distant dream. And not only distant, but also expensive. There is nothing in its program to suggest that Iran will be able technically to play in the same league as China and India, let alone Europe and Russia. On its own, it is unlikely to be able to sell nuclear services competitively in the global market.

Iran can, of course, buy all it needs for a civil program on the open market provided it does so in a fully transparent way that gives the international community confidence that a secret weapons program is not intended. The current U.S. sanctions are a hindrance but not an insuperable one to such a policy. However recent history symbolized by these sanctions understandably causes the Iranians (and others) to fear that essential supplies, principally LEU fuel, might for political reasons be cut off.

There are few suppliers and none is an ally of Iran. Energy supplies have been used in modern times as a politico-economic weapon. And energy sanctions are mentioned frequently as political threats. Certainly Iran and many other countries are well past the point at which they would have been comfortable in relying solely on assurances by Western suppliers. A more

reliable guarantee, a sort of lender of last resort, is required if countries are to be content to depend exclusively upon the market. This is important not just for Iran but also for Third World support for the whole non-proliferation regime.

Our proposal meets this requirement at the same time as solving Iran's centrifuge problem and thus rescuing its reactor program from failure. It does so by introducing the latest model of URENCO centrifuge, the TC-21. This machine is fifty times the efficiency of the P1 and approximately twenty times that of the P2. A plant with 24,000 TC-21s will sustain 20 reactors which is equivalent to the whole Iranian program in 2035. So a plant of that size will have the capacity to take care not only of the Iranian program, but also of the needs of others up to, say 2030. Governments fearful of politically caused disruption of supply will welcome the multilateral structure and IAEA involvement we propose.

The 'Black Box" Issue

URENCO's competence with centrifuges and IAEA's ability to monitor them has been well tested. For example, the French government has made an agreement with URENCO to acquire centrifuges, essential parts of which representing commercial secrets will be "black boxed" in such a way that those parts will be inspected neither by the French nor by the IAEA monitors. Yet the IAEA say they can make all the measurements necessary to be confident that no diversion of material is happening. A similar agreement exists between URENCO and the American company, Louisiana Energy Supplies, for a joint enrichment facility in New Mexico using "black boxed" centrifuges monitored by the IAEA.

The acceptance by the Americans and the French of "black boxes" means that in doing likewise the Iranians need not fear discrimination. On the contrary, it could be argued that they will have a favored position since the Americans and French are already nuclear powers with sophisticated industries whereas the Iranians still have a great deal to learn. So, even with "black boxing", the Iranians might well learn techniques currently unknown to them. But by itself this would not allow them to make a bomb. Besides such technical knowledge is permitted to all Non Nuclear Weapon States under the NPT and it would be a mistake to try to deny it to them. If we are to convince countries not possessing enrichment plants (or, as the case may be, other

elements of the full fuel cycle) to agree never to acquire them, we will have to provide a quid pro quo, including some technical knowledge. Accordingly on balance we conclude that the risks of Iranian espionage should be accepted, provided sensible counter measures are also adopted. At the same time, it should be noted (as we detail below) that using Russian centrifuges or older URENCO ones instead of TC-2ls would reduce both proliferation and commercial risks. To have options is helpful and we can imagine useful trade-offs.

Strengthening the Non-Proliferation Regime

Non-proliferation ultimately fails or succeeds according to the decisions of individual governments. It will fail if governments, perhaps only one or two, decide that they can get away with going nuclear and that the benefits outweigh the costs. In this decision, they will be greatly influenced by what others do and don't do. That is why the example of only one or two governments may ensure failure. Success is harder because it requires all governments always to decide not to go nuclear. This will happen only if all governments accept a fair and workable set of rules and if there is a climate of opinion in favor of abiding by them. Then governments are likely to conclude that each time they ask themselves whether to go nuclear that the balance of considerations is against it.

Both points -- the rules and the climate -- are achievable and indeed were achieved, not quite perfectly but nearly so, for thirty years up to 1998. If they are not re-established soon, non-proliferation will fail. The NPT provides the bedrock bargain and the essential rules and so it needs to be reaffirmed and strengthened, notably by the great powers providing impeccable examples.

The treaty setting up the enrichment facility should recognize explicitly that:

- France, the UK and Russia (if an original shareholder) base their actions on Article I of the NPT in which Nuclear Weapon States (NWS) undertake "not in any way to assist, encourage, or induce any Non-Nuclear Weapon State (NNWS) to manufacture or otherwise acquire nuclear weapons … or control over such weapons…";

- Iran reconfirms its undertaking in accordance with Article II of the NPT "not to manufacture or otherwise acquire nuclear weapons … and not to seek or receive any assistance in the manufacture of nuclear weapons…";

- in accordance with Article III of the NPT, all Parties have obligations in respect of safeguards which they will respect individually and as partners in the joint venture;

- "the inalienable right of all the Parties [to the NPT] to develop research, production and use of nuclear energy for peaceful purposes…" (Article IV, paragraph 1) is reconfirmed;

- the MNA is established in line with Article IV, paragraph 2 ("Parties to the Treaty in a position to do so shall also cooperate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of Non-Nuclear Weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world.");

- the same paragraph provides the basis for the arrangements being made for secure fuel supplies to NNWS members of the NPT in good-standing and accepting appropriate safeguards;

- all Parties undertake in accordance with Article VI to take fresh steps towards "cessation of the nuclear arms race" and towards "nuclear disarmament";

- all Parties undertake to seek to amend the NPT by dropping Article X, paragraph 1 which provides for withdrawal if supreme interests are jeopardized.

Basing action on the NPT and employing its language makes use of Iran's repeated declaration of loyalty to this Treaty and helps to stress the equality of the Parties to the deal.

The Risks of a "Break Out"

Two kinds of "break out" towards the creation of a nuclear arsenal are logically possible. One is the North Korean route, an open break with the non-proliferation regime, whether or not it involves formal withdrawal from the NPT and the production of nuclear weapons. The Iranians have occasionally threatened withdrawal but wisely have reaffirmed their commitment to the NPT. The second kind would be the "nationalization," in fact expropriation, of multilateral enrichment facilities in Iran.

Both kinds would be huge political statements with an almost undeniable presumption that they were intended to lead to a military program. Both would involve the withdrawal of IAEA inspection and leave Iran (or any other country) in an "outlaw" position. If anything, the second kind would be seen as the more heinous because it would be making use in bad faith of other countries capital to forward the acquisition of forbidden nuclear weapons. Both kinds would flout the NPT and the IAEA. But the second would also challenge the powerful governments whose property was expropriated and would lead at once to Security Council action. A provision to this effect could be included in the treaty. Military action would be likely to follow.

Nevertheless, it would be wise to build in physical safeguards against expropriation. We have two types in mind. A smart tag could be incorporated in or attached to each piece of equipment. The tag would give notice of any unauthorized tampering with or movement of the equipment. In addition, devices could be incorporated into the black boxed parts of the URENCO centrifuges and if activated, would alter the magnetic fields within the centrifuge and thus cause it to "crash" with something like the force of dynamite. The result would be wholesale destruction of the cascades. Between them, these devices would probably deter expropriation. For further discussion see Appendix II.

A government set on making bombs would be unlikely to accept our proposal in the first place. It would be more politically and commercially advantageous to accept suspension of enrichment and then follow the route blazed by others of clandestine facilities. To accept our proposal and then expropriate would more or less guarantee a very bad outcome. In addition to

the points already made, the expropriating government would put itself in a position of maximum danger until it could convince the world that it actually controlled a useable, if small, arsenal. Seizing centrifuges and stocks of LEU would be a declaration of intent to make HEU but that alone would leave the expropriator well short of a weapon. Machining the parts, miniaturization to fit a pre-determined design, testing the product, producing a credible delivery system and fitting the warhead to it would take precious time whereas both the centrifuges and the LEU stores even if they survived self-destruction, would probably be destroyed by military action within days if not hours. Why run these risks and antagonize the whole world when a clandestine operation on the Israeli or Pakistani model would be safer and easier?

The Risk of a Clandestine Weapons Facility

In theory, the Iranians could enter into a multilateral enrichment facility in Iran, as we propose, and then build secret enrichment-related plants elsewhere in the country. They could do this, of course, with or without a MNA in Iran. In other words it is an option under any scheme. For example, they could build a secret facility despite a promise to the West to suspend their program for a limited period or even to forgo it altogether. Or they could build a secret facility while pretending to ship all their UF6 to Russia for enrichment there. And if they were allowed to have a pilot or experimental plant under national control, this would further facilitate a secret installation.

In comparison with these possibilities, the risks of a clandestine facility under our scheme appear minimal. This is where there is a positive advantage in having an enrichment plant sited in Iran. To enter into an agreement providing for intense control and inspection within Iran at the same time as trying to build clandestine facilities in the country would be both difficult and stupid. Our proposal has inherent mechanisms for aiding the West to detect such covert facilities that would be hard, if not impossible, for other regimes to match. As UNSCOM and UNMOVIC found in Iraq, familiarity with key scientific personnel can contribute substantially to understanding all the relevant activities in a country's program. Western technicians would work with their Iranian counterparts 24-hours per day, seven days a week and would not only understand their skills and competences but would be aware of their comings and goings. This familiarity could be a major source not only of reassurance that Iran was not misbehaving at the

multilateral facilities but also for detecting any clandestine enrichment plants in Iran. (See Appendix I for additional discussion of this point.)

Not only would IAEA inspectors be stationed permanently in Iran with full rights under the Additional Protocol and also under additional agreed transparency measures but as well all parts of an enrichment program from conversion onwards would be run by the proposed international management company. Western technicians would be working alongside Iranians at every level and so would be ideally placed to detect evasions. A stronger deterrent is hard to imagine.

To evade its effects, the Iranians would almost certainly need a duplicate set of scientists and technicians, one set for the overt facilities at Esfahan and Natanz and a second set to build and operate more or less identical facilities elsewhere. And this would have to be done despite all enrichment related facilities including the plants for the manufacture of centrifuges having been put under the control of the multilateral organization.

Cleaning the Slate

While our scheme is at least as effective a guarantee against the establishment of new clandestine facilities as any we know of, it does not totally assure the international community that such facilities are not already in existence. After all, the Iranians ran a clandestine operation for eighteen years and several other countries have done so as well. It is, however, unlikely that the Iranians were running two clandestine operations simultaneously or that they would have risked starting a new one while they were negotiating with the EU-3 (from September 2003 to December 2005 inclusive) and observing the IAEA Additional Protocol. Nevertheless, their history of evasion leaves the burden of proof on the Iranians.

Even more to the point the Iranian history of lies and evasions, compounded when they were found out by further lies and evasions, has more or less destroyed their credibility in the West. Not only their word but also their intentions are doubted. The IAEA has repeatedly sought explanations from the Iranians on some relatively simple questions and again and again has been ignored or fobbed off. This is all the more pointed in that similar questions have been satisfactorily answered by Tehran. After some three years of failure to respond to the IAEA on

some of their questions, it is evident that the Iranians find full disclosure embarrassing. The international community can only suppose that it is a case of no smoke without fire. And it is upsetting that the Iranians seem to take lightly the fact that they continue to be non-compliant with the IAEA regulations. This destroys international respect for Iran and makes it hard to take their negotiators seriously. Whatever the cause of the embarrassment, it is in Iranian interests to come clean.

A clean slate will encourage the international community to begin again to trust Iran and will remove a serious burden from the Iranian negotiators. Obviously the best course would be simply to tell the IAEA the truth. If, however, the Iranians cannot bring themselves to do this, there is another way in which the truth can be conveyed to the international community. This is what might be called the "Swedish Buddhist" method. It is modeled on the agreement between the British Government and the Irish Republican Army (IRA) whereby a French Canadian general trusted by both sides, dealt separately with each and assured the British that what the IRA said about the disposal of its weapons was true.

In the present case, the Iranians might find a neutral trusted personality—the Swedish Buddhist—show him the missing material and convince him of the true answers to the IAEA questions. He would then try to get the West to agree (but without showing them the evidence) that if the Iranians presented those answers to the IAEA, the West would encourage the Board of Governors to note the situation, reprimand the Iranians, recall the file from the Security Council and announce that the slate had been wiped clean.

Russian involvement/Russian centrifuges

Russia played a prominent part in the negotiations over the Iranian crisis and made an important proposal backed by the EU3 with US support. Essentially this was for a joint Russian-Iranian venture to produce LEU at an existing Russian enrichment facility at Angarsk in Siberia. In exchange, the Iranians would suspend their enrichment program indefinitely. The uranium for the joint venture would be provided by the Iranians possibly in the form of UF4 rather than UF6 and the LEU would be fabricated into fuel rods in Russia before returning to Bushehr or subsequent reactors. Iranian technicians would not be permitted in the critical parts of the

Angarsk facility. Other details of the financing and operations of the joint venture remain to be worked out.

The Iranians had objections but did not dismiss the proposal entirely. Their acceptance (though this is not expected) would presumably resolve the crisis and render our proposal unnecessary. But if this does not happen, there is a case for involving Russia in our proposal. This could take one of two forms. In both arrangements, Russia could join the board of the holding company, meet an appropriate share of the capital costs, and draw a similar share of the profits. In the first case URENCO centrifuges would be leased, as described above, while in the second case Russian centrifuges would be leased. The latter would result in a net in-flow of cash for Russia (from the leasing fees) and might have an additional non-proliferation benefit. What the Iranians could learn from observing the operations of the "sub-critical" Russian centrifuges would be of doubtful value in their attempt to master the "supercritical" P1 technology. Of their various models of centrifuge, the Russians have already sold one to China and would presumably see little difficulty in selling or leasing the same model to the multilateral facility in Iran.

Against these considerations is the probable reluctance of Iranians that the multilateral facility should depend solely on Russian equipment and on Russia for its repair and maintenance. Russian centrifuges would require Russian technicians for many years ahead. In addition, if the Russians insist on the security provisions of their original proposal, Iranian personnel would be entirely excluded from the operation—a requirement we consider unnecessary given the inherent proliferation resistance of the joint facility we propose.

In our readiness to take seriously the idea of using Russian centrifuges instead of TC-21s, we are assuming that both the capital costs and the running costs would be similar. The Russian centrifuges concerned are much smaller and a good deal simpler than the TC-21s but to produce the same amount of LEU a very large number with proportionately larger buildings would be required.

<u>Older URENCO centrifuges.</u>

Instead of TC-21s, the centrifuges used might be the older TC-12s. Like the Russian centrifuges, these might have non-proliferation advantages in using less advanced technology. They might also be available quickly and thus allow the P1s to be retired sooner. They would probably be more expensive to run than TC-21s in order to produce a like quality and quantity of LEU. They could be black boxed and monitored like the TC-21s. In the longer run, however, more TC12s than TC21s would be needed in order to provide material for the virtual fuel bank.

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. 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 the following table:

Table 1 Comparison of Capital Costs

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	$66M - $82M
20	2,400,000	60,000	$1.1B - $1.7B	24,000	$0.9B – $1.3B	960,000	$1.3B - $1.6B
42	5,000,000	125,000	$2.3B - $3.5B	50,000	$1.9B - $2.8B	2,000,000	$2.7B - $3.4B

The P1/P2 problem

Our plan involves taking over all the Iranian centrifuges – P1, P2 and any other – and the facilities for making them. It also provides that no enrichment equipment or facilities would be made or operated in Iran except those in the possession of the multilateral body. These provisions, if observed, would mean no national enrichment in Iran. That is the crucial point.

However, the West not satisfied with that, has hitherto sought to prevent the Iranians from acquiring enrichment technology. In this endeavor the West is failing. Already it is generally acknowledged that the Iranians have succeeded in producing a tiny amount of LEU and the longer they have a free run, as at present, in conducting their own R&D and pilot plants, the nearer they will come to mastering the technology. They are capable of doing so and it is only a matter of time before they achieve it. No one can make a reliable estimate of how successful their experiments will be but the time to mastery is probably to be measured in months rather than years. Therefore the date on which the Iranian centrifuges are no longer available for R&D determines their degree of mastery, unless, of course, they get there first.

On present form, the West will continue demanding immediate suspension of centrifuge activities while the Iranians will continue to press forward and at the best, either delay suspension or permit it for a short period only. They may, however, desist from industrial scale development while continuing with a pilot plant.

Obviously our plan could be modified to insist on suspension as a pre-condition but we do not recommend that course. Our plan is based on the concept of continued enrichment in Iran but under multilateral, not national control. The question of suspension would arise only if the Iranians indicated acceptance in principal but then sought to prolong the negotiation of details. There would be little excuse for their doing so since the first step in our plan is the continuation of the P1 operation under multilateral control.

Since our plan has been in the public domain for some months without attracting the support of Western governments, we are reluctantly compelled to suppose that the Iranians will have mastered the technology before the West adopts the plan. In that event, a large part of the point in calling for immediate suspension will have disappeared. Not only will the Iranians have mastered the technology but the plan will be urgently required in order to prevent them from gathering in their own hands significant quantities of LEU. At that point, it will be sensible to make a virtue of necessity and offer those Iranian leaders who are ready to accept our plan – not all of them will be keen to do so- a public posture and arguments, which can defeat their critics. Hence, the proposal that there should be a short period of operations with PIs before they are phased out on the introduction of URENCO centrifuges. A possible attraction of using TC-12s rather than TC-21s is that this might shorten the period.

General Security Issues

We turn now to three ideas which though frequently mentioned in the debate over policy towards Iran, seem to us to be non-essentials. They are to be welcomed as "add-ons" if they help both sides to reach agreement but if not, they may add unnecessary complications. This judgement is in no way intended to suggest that other big issues such as the security of Iran, the security of Israel, the Israel-Palestine conflict, Israeli nuclear weapons and the possibility that other Middle-Eastern states may acquire them are not crucially important. But the idea of multilateralizing the nuclear fuel cycle does not depend on them. So, our inclusion of the following paragraph on Security Guarantees, a Nuclear Weapon Free Zone and a Non-Aggression Pact should be regarded in that light: they are not integral to our plan.

Nevertheless, if contrary to its repeated assertions, Iran was ever to seek to justify a military program, a prime argument would likely be its need for a deterrent. Bearing this in mind, the EU-3 have alluded to their readiness to incorporate a security dimension in a deal. Probably they think mainly of credible assurances by the US of respect for the Iranian sovereignty, but the level of distrust is such that mere words might not cut much ice. A Nuclear Weapon Free Zone including Israel could do more but is unlikely at present. A Non-Aggression Pact looks a better bet. Rather than reinforcing Iranian security, its main point would be to assure Arab countries that Iran does not threaten them.

The Pros and Cons

The great majority of governments and their advisors will be in favor of almost any agreement that resolves the nuclear quarrel between Iran and the West without damaging the non-proliferation regime. However, there will be a small minority who see advantage in the quarrel continuing and some of them may hope that it will lead to military operations against Iran.

Some Arab states are concerned that a nuclear Iran might be over-mighty and bullying but probably none would welcome U.S. (and still less Israeli) military action. Some Arab dissidents including al-Qaeda would welcome military action against Iran for one of two reasons or for both. All of them would see it as leading to an intensified jihad against the U.S. in particular and the West in general in which most Arabs and all Islamists could unite. Some, in addition, would be pleased that a "heretical" Shia country was being punished. In Washington, neo-cons hope to use the quarrel as an instrument to produce regime change in Iran. And some would welcome military action supposedly as a means of protecting Israel and inducing wholesale reform in the Middle East.

Apart from such general considerations, there will be specific reactions to our proposals in each of three communities: Iran, the West, the international community as a whole.

Iran

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 "break out" via expropriation or a clandestine program would be both high and virtually certain. And the latter would be operationally difficult. They would prefer no scheme at all, in other words liberty to pursue their existing program, perhaps with a clandestine program on the side. If there has to be an agreement, the best, they feel, would be a renewal for a specified short period of the former suspension of some or maybe all enrichment related activities with minimum inspection.

The Russian proposal for a jointly owned enrichment facility at Angarsk in Siberia to which Iran would contribute financially but without access for Iranian technicians is not, as it

stands, acceptable to Iran. In an attempt to meet Iranian objections, the Russians seem to have contemplated allowing a pilot plant enrichment operation to continue in Iran but did not proceed when the Americans expressed strong opposition. That the Russian proposal was vague in some respects as, for example, on what would happen to existing enrichment-related facilities in Iran may not matter since the proposal seems lifeless or at least in the deep freeze. It appears that the Russians have recognized that a proposal which provides no work for Iranian nuclear technicians, no realistic prospect that the Iranians would ever be allowed to enrich on their soil and which locks Iran into dependence on its old enemy, Russia, is not viable. The Russians seem also to have recognized (as the Europeans and Americans have not) that their proposal provides the Iranians with the motive and probably the means to embark on a clandestine program. It is not a proposal that moderates in Iran would be able to support.

For those in Tehran who are not fixated on weapons and still more for those who have no intention of pursuing weapons, our scheme has considerable attractions. Apart from resolving a crisis and avoiding sanctions it would:

- provide a full fuel cycle operation on Iranian soil thus meeting public expectations while also ensuring that Iran's civil program could not be held to ransom;

- bring large scale foreign investment to Iran's nuclear program;

- rescue Iran's declared reactor program from obvious failure and validate Iran's repeated claim to be interested solely in civil nuclear power;

- provide responsible jobs for Iran's nuclear professionals;

- probably, in the long run, earn a profit and meanwhile permit Iran to export more oil and gas to earn hard currency;

- confir the prestige of pioneering a new type of international institution.

Against these advantages, our scheme would keep critical secrets of the URENCO enrichment process from the Iranians. They would gain, no doubt, from performing sophisticated tasks alongside Western technicians, but it would not automatically or quickly lead to nuclear sophistication. Nor would it necessarily remove U.S. sanctions against Iran. For some Iranians, a multilateral project would be a poor second-best 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.

The International Community

Some countries may feel mildly jealous that the Iranians obtain advantages not offered to them, and may therefore be encouraged to make demands. But those seriously interested in nuclear power will welcome a guarantee of fuel supply that does not depend upon the word of certain great powers. Many countries will be glad that the West has found a way without sanctions or military force to prevent Iran from making nuclear weapons. At the same time, many will be pleased that the West has veered from unilateral dictates to a multilateral solution. They will hope that this signals more attention by the Nuclear Weapons States to their obligations under Articles IV and VI of the NPT. Several will see advantage in giving substance to the concept of Multilateral Nuclear Arrangements.

TheWest

The West has retreated from its unrealistic starting positions. We no longer ask Iran to give up its rights under the NPT permanently, nor to dismantle its conversion facility, nor do we insist on the Russian proposal. Unfortunately, these retreats may have encouraged the Iranians to suppose we will retreat further while simultaneously making Western negotiators unwilling to consider further compromises. On top of this our scheme involves considerable financial outlay and offers Iranians opportunities for learning to operate a modern enrichment facility.

These criticisms, however, are subordinate to the fact that the multilateral enrichment facility is to be on Iranian soil. Is this not exactly what we are trying to prevent, critics ask? In

saying so, they overlook the distinction between a national plant and a multilaterally owned and operated facility. What we are trying to prevent is not enrichment per se, but Iran's possession of nuclear weapons and this will be achieved by our multilateral proposal unless the Iranians cheat.

Many Westerners assume that they will cheat either by expropriation or by running a clandestine program. We have dealt above with both issues but they are so insistently repeated that it may be worth restating a few basic points.

We do not argue that our scheme is ideal, merely that it is likely to be the best available 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.

In this debate, much depends upon difficult-to-predict internal developments in Iran. Where there is a choice, the Six 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.

The core argument for our scheme rests on two points: it prevents the Iranians from making nuclear weapons, and it is better than the available alternatives. But it has other advantages as well:

- it supports the NPT bargain at a time when the non-proliferation regime may be unraveling;

- it provides a credible guarantee of security of supply of LEU to all countries in good standing with the NPT and accepting full scope safeguards and the Additional Protocol;

- it is a step towards persuading other countries not to go in for national enrichment or reprocessing plants;

- it pioneers in a practical way Multilateral Nuclear Arrangements that may have important applications in other parts of the nuclear fuel cycle, and other parts of the world;

- it is cheap at the price.

Appendix I

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 pick up 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

[3] International Atomic Energy Agency, IAEA Use of Wide Area Environmental Sampling in the Detection of Undeclared Nuclear Activities, STR-321, August 27, 1999, p. 7.

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.

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[4] Garry Dillon, "Wide Area Environmental Sampling in Iran", The Nonproliferation Policy Education Center. p. 5

Appendix II
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 nearby 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.