The Science, Technology, and Global Security Working Group
Massachusetts Institute of Technology

Iran as a Pioneer Case for Multilateral Nuclear Arrangements

by
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Fourth Edition
May 2009

About the Authors

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Table of Contents

Preface

In preparing this, the fourth edition of the Forden-Thomson Plan, we were disappointed to re-read the section in the third edition dated 24 May 2007 entitled "The Urgent and Critical Nature of the Iran Crisis", (reproduced in Appendix IV below). Our disappointment was not because of what we wrote two years ago – events have borne it out – but because the predictable results of western policy continue to be spurned by western policy makers. None of them, we suppose, would dispute that the situation in 2009 is worse than it was in 2007. And yet wishful thinking leads them to persist with failure.

A new US administration with a better grasp of realities than its predecessor offers a unique opportunity to change tack. The choice for western policy makers is essentially to stay the course or to change to our plan or something like it. If they choose the former we are likely to find in 2010 that once again the risks have increased while the opportunities for keeping Iran from nuclear weapons have declined. The latter offers a realistic prospect of an accommodation with Iran in which the west secures its main object, no nuclear weapons in Iranian hands. "Urgent" and "critical" apply today even more than two years ago.

We acknowledge gratefully that in revising our plan we have profited from observations or comments, some supportive, some critical from a variety of sources. These include notably Frank von Hippel and Hal Fieveson, Peter Friend, Mark Fitzpatrick, Gary Samore, Gary Sick, Matthew Bunn, Julian Whichello, and above all our colleague Marvin Miller. In addition we owe a good deal to several people in governments and agencies who would probably prefer not to be named. We absolve them all from responsibility for our mistakes and our conclusions.

GF
JT
May 2009, Cambridge MA

Main Points of the Argument Summarized

Indisputably, the western position in the Iran crisis has deteriorated since May 2007 when we published the third edition of the Forden-Thomson Plan. And 2007 was notably worse than 2005 when Iran had not yet enriched uranium. Now, we know from IAEA reports, Iran has around 6000 operational centrifuges that have produced so far over 1100 kgs of LEU. Work on cascades for a further 9000 centrifuges continues and since early 2006 the Additional Protocol inspections have been suspended.

In addition, Iran has flouted repeated Security Council resolutions, survived concerted sanctions, seen off military threats from Israel and the US and resisted pressures from the Permanent Five plus Germany (5+1). In doing so, Iran has gained sympathy in the developing world, particularly with ordinary Muslims. All of this is bad for the non-proliferation regime.

The change in US administration and Obama's readiness to negotiate without preconditions creates conditions for a change of course from the failed policies of the last four years. Those threatening policies had the counter-productive effect of making even moderate Iranians suppose that a nuclear deterrent would make them stronger and safer. On this issue, the population rallied behind the government. But fortunately, it is probably not too late to persuade Iran to stick to its repeated claim that it does not want nuclear weapons. The US National Intelligence Estimate (NIE) made public in December 2007 is probably right in assessing that Iran used to have a weapons program, stopped it and may or may not resume it.

At this critical juncture, the 5+1 need to abandon old thinking and failed policies in favor of a plan that stands a reasonable chance of getting Iranian agreement while simultaneously ensuring that Iran does not make nuclear weapons. The Forden-Thomson Plan does that better than any alternative and is clearly less risky than the old policy or the modifications of it now under discussion. The NIE assesses – and independent experts agree – that if Iran decides to go for a weapon the most probable route would be a new secret program. Despite this, existing policy has tolerated for more than three years the suspension of Additional Protocol inspections thereby making it impossible for the IAEA to discover whether or not there is a secret complex with an enrichment and conversion plant. The Iranians would have no serious difficulty in creating such a complex given that the chief of Israeli Intelligence has testified that Iran has crossed the "technical threshold". Curiously, those governments which most loudly proclaim that Iran is making a weapon seem convinced that Tehran has not yet embarked on a new secret program – a logical inconsistency which throws doubt on either their motives or their understanding.

The essence of the Forden-Thomson Plan is an agreement between a small number of governments to set up a large, high-quality enrichment plant in Iran under multilateral ownership and control and subject to stringent safeguards, including by the IAEA. While the details are tailored to the Iranian case, the basic idea of a multilateral facility has become standard in discussions of how to promote the use of nuclear power for electricity globally without allowing it for military purposes. It has for the last several years been recommended by the Director-General of the IAEA.

The simplest model is a treaty between Iran, France, Germany, the UK and the Netherlands (the last three being the owners of URENCO, the makers of the most advanced centrifuges) to establish the multilaterally owned enterprise, to agree that its Board of Directors should hire a competent management company to run the day to day business on commercial lines, that the costs and profits should be divided in proportion to shareholding, that the enterprise should lease all enrichment-related facilities and machinery in Iran and begin operations with existing Iranian centrifuges, that these should be replaced as soon as possible by far more cost-effective advanced centrifuges of which three types are potentially available, the URENCO TC-12 and TC-21 and the Russian model which the Chinese bought and are operating. In our opinion, each type would do the job. Possibly the best course would be to start with the TC-12 because it is extremely reliable and there is a pool of potential staff thoroughly experienced in its operations and in due course as the enterprise expanded to meet demand to phase in the more cost-effective TC-21.

In the treaty Iran would undertake not to reprocess – the facility at Arak would be included in the lease – and not to enrich except through the multilateral consortium. Thus instead of an Iranian national enrichment industry there would be a multilateral enterprise with facilities capable – as the national industry is not – of meeting the fuel needs of the ambitious Iranian civil reactor program. Iran would thereby gain a state of the art industry on its soil with robust foreign financing. Into the bargain, it would acquire the prestige of pioneering an international model agreement designed to help climate control and non-proliferation.

Critics of the Forden-Thomson Plan concede that the basic idea would be acceptable so long as the facilities were sited outside Iran and preferably without sophisticated centrifuges. But they are wrong on three counts.

First, acceptability. The Iranian president and foreign minister have repeatedly said in public that they would accept a multilateral consortium for enrichment. But they insist that it must be on Iranian soil. It is unlikely they will change their minds.

Second, the alleged risk of expropriation by Iran. If Iran decided to make a nuclear weapon it would do so, as noted above, via a secret program. It would not seize the property of powerful countries well able to retaliate. And it would not warn the world of its intention when it was still many months away from being able to test, let alone assemble a small arsenal to act as a deterrent. Iran does not possess the engineering industry or the skills to reverse-engineer the sophisticated URENCO machines. So there would be no improvements in the existing inefficient Iranian centrifuges.

Third, the real risk is a secret facility. As pointed out above, current policy has been tolerating this risk for three years. Modifications of that policy will only extend this period. By contrast, the Forden-Thomson Plan makes it virtually impossible for Iran to institute a secret program. Under the Plan, there would be three levels of IAEA inspection – full scope safeguards (currently in operation), Additional Protocol and further ad hoc transparency measures. More important, having the multilateral facility on Iranian soil secures the best of all safeguards, societal verification. This means no Iranian national industry and embedding Iranian scientists and engineers in an international structure. The UNSCOM and UNMOVIC experience in Iraq showed that verifiers best instrument is detailed knowledge of the competencies, characters and

whereabouts of the relevant scientists and engineers and that this can be gained by their colleagues on the shop floor and also through the operations of the departments dealing with personnel, travel, finance etc. all internationally staffed. No other plan is as effective as ours in controlling the risk of a secret facility

To conclude, the Forden-Thomson Plan is the only detailed worked-through alternative to some modification of the failed policy and is superior to the latter in do-ability and in controlling risks.

The Purpose and Scope of this Paper

This paper serves three purposes:

- It describes a possible resolution of the current Iranian nuclear problem;
- It is an exploration through the examination of one particular case of how a policy of multilateralism might work to strengthen the global nonproliferation regime;
- It suggests a means to meet the non-proliferation goal of a guaranteed fuel supply without political strings.

While our principal object is to protect and strengthen the non-proliferation regime globally, we concentrate here on the Iran crisis. Its outcome will affect for good or ill the future of the regime. That is reason enough to treat the crisis as serious and urgent. Yet there are additional reasons for doing so. The nuclear problem can no longer be regarded as a stand-alone issue. It has become intertwined with relations between the great powers and more consequentially with the politico-strategic balance of forces in the greater Middle East. Fortunately this development results from agreement between the two sides, Iran on the one hand and on the other, the five Permanent Members of the Security Council plus Germany (5+1). Both sides are conscious that embodying the nuclear issue in the context of Middle Eastern political problems adds to the complexities involved but both also recognize that this acknowledges realities and enhances the possibilities of trade-offs.

Thus the plan for Iran that we put forward has to be treated by policy makers and negotiators within the greater Middle East context. Any agreement will be a compromise requiring give and take in a wide field. Accordingly, the details of our comprehensive plan in which the parts are intended to form a logical whole must in practice be regarded as mutable. Indeed, here and there we acknowledge possible alternative arrangements. We believe that the core proposal, a multilateral consortium, is sufficiently simple and strong to support a good deal of flexibility in detail. We expect significant variations if this idea is applied, as Dr. ElBaradei has proposed, to different elements of the fuel cycle in different regions.

Neither the general non-proliferation problem nor the greater Middle East can be considered here though, both, we repeat, are relevant. Instead, in this introductory section we restrict ourselves to a few comments on the Iran crisis.

The Iran Crisis

Like all other commentators we believe the crisis can be settled peacefully to the satisfaction of both sides. However, we differ from some in our definition of satisfactory. Our meaning is a solution consistent with the Non-Proliferation Treaty. Thus Iran can have an enrichment plant on its soil and access to some technical knowledge but equally the international community is entitled to hold Iran to its commitment not to acquire nuclear weapons. Now that Iran has passed, according to the chief of Israeli intelligence, the “technical threshold”, a deal balancing a multilaterally owned and operated enrichment plant in Iran with additional provisions to ensure Iran does not make a weapon seems even more necessary than it in did when Iran had no centrifuges spinning and no Low Enriched Uranium (LEU).

Some of those who dislike this outcome are prone to exaggeration and wishful thinking. Usually they find themselves denouncing the public version of the National Intelligence Estimate (NIE) of November/December 2007. They do not explain why all sixteen US intelligence agencies are incompetent or dupes. For our part, we accept as a reasonable working hypothesis the past, present and future described by the NIE - that Iran had a weapons program, has suspended it and may or may not resume it. This account of the future surely suggests that hard liners in Tehran should not be given ammunition to overcome moderate nationalists. Sadly, the threats from Washington and Tel Aviv and the forces ringing Iran provide persuasive arguments for acquiring a deterrent. What is needed is a deal which both removes the argument for a deterrent and institutes the strongest possible safeguards against bomb-making either openly (unlikely) or covertly. Our plan does that.

As the NIE says, if the Iranians were to decide to make a weapon they would be likely to do it covertly. Most western policy makers also hold this view. Strangely, however, they have followed a policy which maximizes Iranian opportunities for a covert program. Of course, this has not been their intention but it is the practical effect of plugging on with an ineffective stick-and-carrot policy for more than three years after Iran suspended its de facto acceptance of the IAEA's Additional Protocol inspections. The result is that we do not know whether Iran has a covert enrichment plant or not. In this unhappy situation only two points can be made with some confidence. First, the Iranians have had and continue to have a fine opportunity to conduct enrichment secretly. Second, if it should emerge that they have not done so, it is a strong indication that they do not currently have a weapons program.

If such a program does not exist our plan outdoes all others in making it difficult if not impossible to start one. Apart from the IAEA inspections common to all plans, ours provides societal verification. This results from embedding Iranian scientists and technicians in an international matrix. Their competencies, habits and movements would be known to their international colleagues. Unexplained oddities or absences would be investigated. In these conditions it would be close to impossible to run a secret program. This matter is discussed more fully at pages 25-6 below.

The Iranian nuclear scientists and engineers having overcome handicaps and achieved things other nations have failed to do are in no mood to back away. They do not take kindly to being told they should cease to work on interesting problems. After all they have done they do not see why they should buy from abroad what the West allows them to have. And they hold that what they have done is in accordance with their rights under the NPT. With public opinion solidly behind them they are a force to be reckoned with. Our plan, unlike others, offers them a profitable, secure and prestigious future.

The main charge leveled against our plan is that it opens up the possibility of Iran expropriating a sophisticated, working enrichment plant and using it to produce weapons grade high enriched uranium (HEU). No doubt such a dramatic step would be physically possible. Yet who can suppose that if the Iranians intend to make a weapon they would go about it this way? What would be the point of entering into a solemn agreement with powerful foreign governments only to make them more angry

than they are at present by violating the agreement and seizing their property? Far better to reject a multilateral solution and proceed with a secret program.

Besides, this criticism ignores the progress Iran has made. Already it has the technology, the machines and the low enriched uranium (LEU) needed to make HEU. If it has the will it could have a bomb. There is no need for Iran to wait for the construction of a sophisticated plant.

Most critics are so emotionally wedded to the stick-and-carrot policy that despite its failure over more than three years, they find it unpalatable to consider an alternative. In their eyes our plan is a "fallback", a description devaluing the views of those who feel our plan could and should have been the preferred option. Their negative attitude is a natural human reaction to the failure of their own preference and of course they are entitled to point out such risks as they find in our plan. No plan, including ours, is totally free of risk. But when it comes to assessing the significance of risk it has to be measured not against an abstract ideal but rather against the practical alternatives including the consequences of pursuing a failed policy. We trust that our plan together with these introductory comments will enable the reader to make his own assessment of risk and acceptability.

It may be going too far to suggest that Iran has already indicated its acceptance of our plan. But it would be wrong to overlook the several official statements by the president and the foreign minister of Iran commending the idea of a multilateral enrichment plant in Iran. Each of these statements has been brief and general. The 5+1 have studiously avoided taking notice of them, let alone asking for elucidation. So when Iran says it favors a multilateral enrichment plant we have an important statement of principle but very little detail. Yet it seems to open the door to a satisfactory outcome.

How long will the door remain open? The Iranians considering world public opinion probably will not shut it definitely. Yet the progressive development of the Iranian program may make them disinclined for compromise. According to the IAEA, Iran had on 1 February 2009 3936 centrifuges being fed with UF_6 and an additional 1476 installed and under vacuum. Work continues on three more cascades which when complete will bring the total of working centrifuges to about 15,000.

It is unlikely that Iran will consent to reduce whatever number of centrifuges they have in operation at the time of agreement. Six thousand centrifuges (approximately the number they have in operation now) gives them theoretically a "breakout capability" and fifteen thousand would do it handsomely. As they approach that number, Iran is likely to feel increasingly confident and in a stronger negotiating position. It is impossible to avoid the conclusion that time is against current western policy.

The lateness of the hour is underlined by the IAEA's revelation that on 1 February 2009 Iran had in store 1010 kgs of LEU enriched to 3.5% and that it is adding to this at the rate of rather more than 2 kgs per day, a rate which is likely to increase as more centrifuges are brought into operation. This revelation has caused expert American analysts to declare "Nuclear Weapons breakout capability achieved".[1]

[1] IAEA Report on Iran by David Albright and Jacqueline Shire, Institute for Science and International Security, February 19, 2009.

In addition, the international situation is deteriorating. The Russians, Chinese and Germans perceive that the stick-and-carrot policy has failed and are reluctant to ratchet up sanctions to no purpose. Against this, the French have become more hardline than ever and the British are not far behind. Thus the unity of the 5+1 is in question. Only a new initiative of the Obama administration seems capable of rallying them. But what initiative? More sanctions will not produce unity and in any case will not do the trick with Iran. Obama does not want to be set up for a failure and besides in the greater Middle Eastern complex (including Afghanistan) Iran could be helpful. A compromise that keeps Iran from having a weapon is an attractive option.

The failure so far of western policy has created enough grief. Israeli dismay is unbounded and counter-productive. In their maneuvers to persuade the US to attack Iran they are creating an imaginary Iranian super power. The reality is quite modest and Israel's own relatively large nuclear force cannot be left out of account. Nevertheless, Israeli fears are real, and form a significant element of the problem. Another element of concern is the damage to the authority of the Security Council resulting from Iran's flouting of several Chapter VII resolutions. And the way in which Iran has so far successfully seen off prolonged pressure by the 5+1 is yet a further undesirable lesson available to potential proliferators and others.

Altogether western policy is increasingly expensive not to say dangerous. Prudent risk assessment suggests that it is high time for a change. We believe the most effective change is indicated by our plan below.

The Forden-Thomson Plan

The Essence of Our Plan

We propose an agreement between a small number of governments to set up 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 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. It would specify that no enrichment-related activities other than those conducted by the multilateral organization would lawfully take place in Iran. The treaty would also ban reprocessing in Iran: the Iranians say they have no intention to build a reprocessing plant.

The original parties should be Iran and the EU-3, that is 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 would be incorporated in the treaty and would not be subject to amendment. 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 facilities belonging to the holding company with the costs borne by Iran.

The costs of the 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. Thus no enrichment- related facilities would remain or be allowed in exclusively Iranian national possession. All conversion and fuel fabrication facilities as well as enrichment and storage would be included.

The Board would also lease from URENCO or the Government of Russia centrifuges to produce LEU. We have in mind three models of centrifuge- the standard URENCO TC-12, the ultra-modern URENCO TC-21 and the Russian centrifuge, which the Chinese bought and are currently operating. Somewhat different considerations apply to each model and these are discussed below. 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.

Location of Facilities

When after several years the operation is in full swing it will consist of a facility at Natanz with up to 50,000 centrifuges together with facilities designed to support enrichment operations. Several of these will be at Esfahan. Because they could be used in steps towards the production of plutonium, the facilities at Arak would also be included. The Iranian authorities would separately own and operate the facilities for the production of electricity such as the Bushehr reactor and subsequent power reactors.

Uranium Deposits in Iran

We do not think it appropriate or necessary for the mining and initial treatment of uranium ore in Iran to become the responsibility of the multilateral consortium. 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 IR-1 centrifuges.

Since it appears that the Iranians already have in hand a considerable quantity of mined uranium, this may in any case be the cheapest solution. The IR-1s will soon be phased out and for the URENCO or Russian 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. All the uranium deposits identified so far are likely to be relatively costly to produce but Iran is a large country and exploration is far from complete. Only one mine (Gachin) is currently in full operation. The planned capacity of the Bandar Abbas Uranium Production Plant fed by the Gachin mine is 21 t U per year. A second mine (Saghand) has begun to produce but its production plant (Ardakan) is not likely to be complete before the end of 2009. It has a planned capacity of 50 t U per year.[2]

Leaving aside the existing Bushehr reactor for which the Russians are supplying fuel, Iran officially estimates a reactor requirement for 254 tonnes U in 2016, 995 in 2021 and 2474 in 2026. The assumptions for the dates of reactor readiness to receive fuel are unlikely to be met. This makes it fairly safe to suppose that Iran will be able to produce indigenously the initial loads and at first the annual top ups for its first few reactors. But the longer term outlook is currently poor. The IAEA credit Iran with proven deposits of some 3000 tonnes and estimate a potential of a further 20,000 to 30,000 tonnes. If the potential is realized these figures would be approximately enough to keep the 20 reactors planned running for around seven years. Unless large new deposits at competitive prices are found, Iran's reactor program will require buying on the international market.

[2] This paragraph and the subsequent one are largely based on: Uranium 2007: Resources, Production and Demand (otherwise known as the "Red Book", 22nd edition), Nuclear Energy Agency, Organization for Economic Co-operation and Development, and the International Atomic Energy Agency, OECD 2008

Supply of Uranium

Customers seeking enrichment normally themselves supply the necessary uranium but when it is a question of enriching for Iranian customers or for the proposed fuel bank, the procedure might be on the following lines.

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. The yellowcake would be converted into UF_6 at the leased conversion facilities and transported to the enrichment facility at Natanz. But again, commercial considerations would be critical. If the Iranian-produced UF_6 is of an inferior quality (as suggested by some 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.

Black Boxing

Whichever type of centrifuge is chosen, it should be black boxed. This means restricting, so far as possible, access to sensitive technical information to authorized personnel. "Sensitive technical information" means in the first place proprietary information. The makers of the centrifuges obviously want to avoid effectively giving away trade secrets and so compromising their competitive position and their market opportunities. The price they charge for their machines is likely to reflect their judgment of the extent to which a sale will have this effect. But, by the same token, they are likely to assess that centrifuge technology is becoming more widely known, that the relevant skills are becoming more common and dispersed as they are applied to products other than enrichment centrifuges, that relative costs are likely to decline and, in short, that their competitive position on the machine in question is going to erode anyway.

"Sensitive technical information" also refers to information that enhances the risk of weapons proliferation. This does not apply, of course, to transactions with any of the five NPT nuclear weapons states. However, it does apply to all others. In principle, this consideration is of great importance but in practice, it does not add much to restrictions imposed to protect proprietary information: the two categories of sensitive information largely overlap.

It would be different if possession of centrifuges was strictly and effectively limited to the five nuclear weapon states. But such a restriction would be contrary to the NPT and in any case has long been breached in practice. At least twelve states (including the five nuclear weapon states) operate centrifuges in enrichment plants. Politically, it is now virtually impossible to prevent some dissemination of what has hitherto been regarded as "sensitive". However, "some dissemination" does not mean everything is disclosed. On the contrary, it means protecting so far as is possible (given what has been said above about widening knowledge of the relevant technology) all sensitive information. Some dissemination is unavoidable and it is likely to grow with the passage of time. The mere observation of the working documents of a successful enrichment plant would convey some sensitive information to a technically competent person. Observation of the actual operations would convey more, examining

the exterior of a centrifuge cascade still more and studying the interior of a centrifuge most of all. But in most countries it would be hard to turn this knowledge to practical use. As thing stand now, few countries have the range of industries, skills and expert manpower to replicate advanced centrifuges and the more sophisticated the machines the harder it would be. Iran is, as yet, not one of those countries.

The degree to which sensitive information becomes disseminated is a product of political, commercial, financial and practical considerations and is likely to increase with time. In other words, it is not a simple matter. In the case of Iran, we suggest applying the principle of black boxing. That is protecting, so far as possible, intimate knowledge of the centrifuge machines. In practice, this would mean that the installation and handling of Iranian IR-1 machines was restricted to Iranians while similar activities with URENCO centrifuges were handled only by URENCO nationals and Russian centrifuges only by Russians. This restriction would apply even to access to the centrifuge hall. All other procedures and access to them would be restricted to authorized personnel but these people would be drawn from all the share-owning nationalities. Thus Iranians would not have access to the centrifuges themselves but their participation in all the other procedures would show them how a modern enrichment facility works and would enable them to make educated guesses about some of the centrifuge parameters. In due course they might learn more about the centrifuges themselves but for the reasons mentioned above it would be hard if not impossible for them to make such machines by reverse engineering. The difference between advanced centrifuges and the Iranian machines is so great that knowledge of the former would not help them to improve the latter.

In short, while black boxing is not certain to prevent Iranians or other participants of non-URENCO or non-Russian nationality from learning more than they ought, it would impede their access and increase the difficulty of applying anything that they might learn illicitly.

As a further precaution, it would be established that each shift of operators working in the facility would be composed of at least three separate nationalities.

Iranian Centrifuges

The latest IAEA report (19 February 2009) shows the Iranians with nearly 6000 IR-1 centrifuges operational and proceeding with preparations for the installation of a further 9000 centrifuges. It is not yet clear that all of the 9000 will also be IR-1s but that seems likely. In addition, Iran is feeding UF_6 into a twenty machine cascade of IR-1s, a ten-machine cascade of IR-2s and also to single IR-1, IR-2 and IR-3 machines.[3]

The IR-1 is an Iranian modification of the P-1, the centrifuge with which the Pakistanis began their nuclear weapons program. The Iranian improvements probably mean that the machine has a capability of about 2 SWU per year. The IR-2 is derived from the P-2, the design for which was bought by Iran together with the P-1 from A.Q. Khan. This machine, still apparently in the early stages of testing, probably will have a capacity of 4.5 or 5 SWU per year.

[3] IAEA GOV/2009/8, 19 February 2009

The IAEA report credits Iran with a store of over one thousand kgs of LEU at 3.5% enrichment. All this apparently is the product of IR-1 cascades.

It is thus clear that Iran has "mastered" centrifuge technology albeit with an inefficient, low capacity machine, that nevertheless it has produced a significant quantity of LEU and is daily increasing its store, that it has the ability (if it chooses) to turn the LEU into HEU, that it is likely before long to introduce a more efficient centrifuge, the IR-2 and that, as a result, it has an increasing potentiality to produce the fissile material for a small arsenal of weapons. But it is also clear that this potentiality which the Iranians insist is not for weapons is woefully inadequate as a supplier of fuel for the ambitious Iranian civil reactor program. To illustrate, 50,000 IR-1 centrifuges would provide enough fuel for only one 1000 megawatt reactor whereas the Iranian plan calls for twenty such reactors.

These quantities set up a potential deal. In the treaty establishing the international consortium Iran re-confirms its non-nuclear weapon status and undertakes not to enrich (or re-process) except through the consortium. In the same document, the other partners in the consortium undertake to implement a policy based on the use of modern technology and commercial considerations which secures for Iran the option of buying all the fuel needed for 20 reactors from indigenously produced LEU.

Initially, the LEU produced by the consortium would be derived from Iranian-mined uranium enriched by Iranian centrifuges. Thus the Iranian government could claim that they had achieved their object and that none of the capital sunk in the program was wasted. They would point out that national interests required participation in international trade – for example, to import uranium and later to sell LEU – and international help in the introduction of modern machinery and management techniques. Doing all of this, they would say, through participation in a high quality international consortium was advantageous technically and financially.

In addition to these political, presentational attractions, beginning the operations of the consortium with the existing Iranian centrifuges has practical advantages. It would mean that the enrichment continued seamlessly and that the consortium acquired in practice as well as in law control over all enrichment-related activities in Iran. This could be important in ensuring no diversion of equipment to a covert site. Also it would give the new management company time to enter into contracts whether with URENCO or with Rosatom for the supply of modern centrifuges. Otherwise, a gap of a year or more in the production of LEU while waiting for the new machines could be politically and financially damaging.

The Iranian centrifuges would be black-boxed and so the practical consequences within the enrichment plant would have been practiced and understood before similar black-boxing procedures were applied to the modern non-Iranian centrifuges ordered by the management company. Similarly, the smooth continuing of the existing Iranian operations would facilitate the piecemeal introduction of international management and operations. Of course, the LEU produced before or after the agreement came into force would be the property of the consortium. And so also with the Iranian centrifuges and their means of manufacture. When the modern machines were securely in operation the Iranian

centrifuges would be phased out and would be rendered inoperable. Similarly with the means of manufacture. This would be an important safeguard against a secret Iranian centrifuge operation.

Such is the current level of mutual distrust that points like this need to be made clearly. However once a balanced clear agreement has been negotiated, every effort should be made to create a harmonious atmosphere and cooperative relationships in the interests of making a success of the consortium and its commercial operations.

Modern non-Iranian centrifuges

While there are distinct advantages in avoiding a hiatus between phasing out Iranian centrifuges and beginning commercial operations with modern machines, it is nevertheless important that the latter should be introduced as soon as is consistent with technical excellence. Commercial good sense demands it and non-proliferation arguments support it. But which modern centrifuge?

The choice at present is limited to three, two of which would have to be obtained from URENCO and one from Rosatom. They are respectively the TC-12, TC-21 and a sixth generation machine sold by the Russians to the Chinese. Each has pluses and minuses, summed up in Table 1. Cost-effectiveness is a high priority but reliability is obviously also important and political considerations could play a part. For example, there could be Iranian resistance to increasing Russian involvement in the nuclear industry in Iran.

For our part, it seems that each of the three machines is suitable and none imposes itself. Perhaps the TC-12 would be the safest choice because it has already proven itself and is still in production. But our plan does not depend upon the choice. The following paragraphs briefly draw attention to some relevant considerations. They do not purport to settle the issue.

The URENCO TC-12

This centrifuge has shown itself to be both efficient and extremely reliable. So reliable, in fact, that it requires no maintenance and will spin for years on end without problems. When very occasionally one fails, it does not need to be removed from the cascade; instead it can be left in place and by-passed.

These characteristics are hugely attractive to a commercial operator and also to those concerned to prevent espionage. It means that once assembled (an operation done on site) and put to work the centrifuges need not be moved. Thus the opportunities for an unauthorized inspection which regular maintenance or the need for repair or removal can afford do not arise.

The TC-12 is the most effective machine currently in commercial operation and probably also has a cost advantage, especially in the costs of operations vis-à-vis the Russian machine. In due course it will be supplanted by the more cost-effective TC-21. Nevertheless it may be the best machine for a new enterprise: its reliability speaks strongly in its favor. Equally important, it should be much easier than with the TC-21 to gather an international staff trained in operating this machine.

The machines would be leased from URENCO, a deal which would require the agreement of the Dutch, German and British governments. The agreement of the three governments could presumably be relied upon if, as proposed above, they were

partners in the consortium. In addition, the new arrangements between URENCO and Areva bring in France, also proposed as a founding partner.

The TC-12 is not available "off the shelf". The machines required would have to be made specifically for the consortium. They would be installed in a new above-ground building at Natanz. Meanwhile, the IR-1s would operate in their below-ground site until the TC-12s were operational.

Since the consortium's business will expand in response to demand there may well come a time at which it is decided that any new centrifuges required will be TC-21s. There should be no difficulty in phasing in these ultra-modern machines with the continued use of the existing TC-12s.

The URENCO TC-21

The advantages of this machine are obvious; though still in development it is state-of-the-art and is clearly superior to the other two candidates in cost-effectiveness. Nevertheless, for the reasons given above it may not be the best choice for at least the initial operations of the consortium. Assuming that it performs well at George Besse II, the pioneer site in France and provided the relevant governments are in agreement it could be leased to the consortium as the latter expands its operations.

Its superior sophistication makes it even more difficult than the TC-12 to reverse engineer. Even if the Iranians were to purloin a TC-12 or –21, it would not advance their centrifuge capability in a practical way: the gap between the Iranian technology and the URENCO machines is formidable.

The Russian centrifuge

The Russians have produced several generations of centrifuges. Typically they are serviceable sturdy machines, much shorter than the URENCO models and therefore stacked on top of each other. To do the same work as the URENCO machines a much larger number of Russian centrifuges is required and consequently a truly big building. Of the three models considered here it is almost certainly the most expensive to run.

The Chinese have bought a Russian centrifuge (though not the latest model) and are running it with apparent success on a commercial scale. It seems therefore that if available that model would be a credible candidate for the consortium's enrichment facility. Since the Russians have sold it to a potential competitor, it is reasonable to suppose that they would consider doing likewise for an international consortium and on similar terms including black boxing.

It is not known whether a purloined Russian machine would be of practical assistance or not to the Iranian centrifuge program. Nor do we know how much maintenance, if any, the Russian machines require. If they needed repair from time to time or regular maintenance this would add to the complexities of safeguarding them. There might also be difficulties about recruiting expert operators.

Self-destruct and disabling mechanisms

As explained above, we do not believe the Iranians would expropriate the property of the international consortium. It would provoke a vast and dangerous crisis. The world would assume that Iran acted in order to drive as quickly as possible to a nuclear weapon. But if the Iranians were

determined to get weapons it would be far more sensible to pursue a secret program. In that way, they would surprise the world instead of giving several months warning. And when the moment came to reveal that they had all along been acting in ill-faith, they would have already a small arsenal of weapons to act as a deterrent.

Accordingly, it seems unnecessary to introduce self-destruct or disabling mechanisms in order to frustrate an attempt at expropriation. Besides, inevitably there are risks that such mechanisms could be set off accidentally or as a result of a misunderstanding. So we do not recommend them. But since some critics insist that the risk of expropriation is significant, we offer optional methods to make it a futile or at least a dangerously lengthy proceeding.

Centrifuges, by the very nature of having a rapidly rotating core, contain enough energy to destroy or permanently disable them. In fact, each one contains almost the equivalent of a stick of dynamite. That energy can be harnessed to destroy either the entire centrifuge or crucial parts of it. Alternatively, it is possible to non-destructively disable them so that it would take a considerable period to restore them for operation. (Annex II goes into further detail of these mechanisms.) This period of time when the centrifuges were inoperable would allow diplomatic moves to punish Iran for expropriating the facility and/or an air strike to destroy it since it would be built above ground.

Both of these options, the self-destruction or the disabling option, could be based on embedding an encrypted electronic-key circuit inside each centrifuge's motor. This circuit, when used as a disabling mechanism, would require that the centrifuge receive a periodic message allowing it to continue operation. That message would have an encrypted authentication code associated with it that would prevent it from being forged; a technology that has been well developed by the electronic banking industry. Similarly, this same circuit could be used to destroy the centrifuge by reversing the phases of two of the three power lines. The degree of destruction this would cause depends on the details of the centrifuge but it could range from destruction of the bottom bearing—a crucial and difficult to reproduce piece of technology—to the destruction of the entire central rotor.

Table 1[4]

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	$26M - $93M	1,200	$50M - $74M	48,000	$73M - $91M
20	2,400,000	60,000	$1.2B - $1.9B	24,000	$1.0B – $1.4B	960,000	$1.4B - $1.8B
42	5,000,000	125,000	$2.6B - $3.9B	50,000	$2.1B - $3.1B	2,000,000	$3.0B - $3.8B

[4] The calculations in Table 1 are based on an exchange rate of €1=$1.3.

Treatment of LEU

The amount of LEU produced depends upon a variety of factors, including which model of non-Iranian centrifuge is chosen, the number employed, whether run on high or low "tails", the level of demand and the policy of the holding company.

To illustrate, let us assume what is probably the most cost-efficient set of circumstances, namely a multilateral enrichment facility that will eventually (probably ten or more years from the start) be operating with 50,000 URENCO TC-21 centrifuges. On that assumption, 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 that country would be a regular customer. In other words, roughly half the production of the facility once it has eventually reached full capacity might go to Iranian customers. If so, this would provide relatively secure economic underpinnings. The other half would be available for other customers including the proposed fuel bank. Such customers would need to be in good standing with the NPT and accept the appropriate IAEA safeguards.

The international market for reactor fuel is complicated by the diversity of reactor types and the specifications and regulations of a multitude of countries; essentially, every reactor requires its own unique levels of enrichment. In fulfilling precise contracts for Iranian or any other reactors, the UF_6 would be enriched to the specified level and then turned into fuel rods at a fabrication plant, possibly that belonging to the Board at Esfahan. However, 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 be run more or less continuously and, might well produce more LEU than was immediately needed.

Non-contracted for LEU would be enriched only to 3% and would be stored, on site, in cylinders containing two tons of UF_6; 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. The storage of LEU on site, in any form but especially as UF_6 which can be directly used in an enrichment process, represents some level of risk for theft and diversion. However, we believe that the risk is low and controllable given the physical properties of UF_6—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—and either processed into pellets and fuel rods or immediately shipped out of the country for processing elsewhere.

We emphasize that from a proliferation point of view the foregoing paragraphs in this section represent a worst case. In practice, there would be several mitigating factors. The most important is one of the basic premises of our plan, namely that the consortium would be run on commercial lines. This means among other things that the Board would not install centrifuges until the contracts they entered into required them. It also means that they might decide in favor not of the TC-21 but rather of the TC-12 or the Russian centrifuge. A contract with the fuel bank to be run by the IAEA might allow some flexibility in the timing of

the provision of LEU. If so, the consortium could use relatively slack times (in terms of customer orders) to make fuel for the bank at a concessionary rate. Furthermore, it would be open to the Board to keep the centrifuges spinning without feeding UF_6 into them. Since Iran is earthquake prone the Board, especially the Iranian members, would have a significant reason for wanting to keep the amount of spare LEU stored in Iran to the minimum.

The production of LEU anywhere in the world poses a potential proliferation risk. But granted that, the risks specifically associated with the production in Iran of LEU by an international consortium are small and can be guarded against.

Spent Fuel and Nuclear Waste

These are issues that will have to be addressed explicitly in the treaty. Safety is paramount. As we have said, 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 on a commercial basis all the dangerous unwanted products of the multilateral operations. In the longer term, we hope that another multilateral organization explicitly for the storage of spent fuel will be established elsewhere, for example in Australia. Meanwhile, the dangerous waste produced in the enrichment facility in Iran will remain legally the property -- and the responsibility -- of the shareholders. IAEA safeguards will apply.

Commercial Demand for Enrichment

The recent "meteoric" increases in the price of uranium will for cost efficiency reasons affect the demand for enrichment. For many years the relatively low price of uranium has discouraged investment in enrichment facilities. With a low price, profit normally dictates high "tails", that is spending a relatively small sum to extract a relatively small amount of the available U-235 from a low cost ore. But with high cost ore, the economics reverse: that is spending more to extract more of the available U-235 i.e. low "tails", is cheaper than buying more high cost uranium. More extraction means more demand for enrichment facilities and the lead-time to provide these is measured in several years. So, purely on grounds of cost it appears that the world is going to need more efficient enrichment facilities, phasing out the old expensive gaseous diffusion plants.[5]

If, on top of this, one factors in a generally expected rise in demand because more people want more electricity and because nuclear reactors come to be preferred on environmental grounds to coal and oil-fired power stations, it is reasonable to suppose that there is room in the global market place for a new modern enrichment plant built in stages and expanded in relation to demand.

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 of TC-21s would be about € 570 M ($757 M), while a 50,000 centrifuge facility would cost about €1.5B ($2.0B) -- €2.3B ($3.7 billion), depending on conditions in Iran. There would of course be many other costs, for

[5] This paragraph draws heavily on Thomas L. Neff, "Uranium and Enrichment-Fuel for the Nuclear Renaissance" in Nuclear Energy Review, 2006.

instance for conversion to UF_6 and for fuel fabrication. Since all shareholders would be governments, there would be no carrying costs.

These figures and the others in Table 1 are put forward as broad indicators of orders of magnitude. They illustrate points but do not purport to indicate costs reliably. The costs are substantial and continuing until the enterprise becomes self-sustaining and even profitable. The large costs involved, irrespective of which non-Iranian centrifuge is chosen, 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.

Apart from noting these general points, it is premature to enter further into a detailed discussion of costs and profits.

Legal Status

In appropriate paragraphs of this paper we have drawn attention to some of the issues that will need to be covered in the treaty establishing the multilateral consortium. It may be convenient that sometimes only the appropriate principles or main points will be set out in the treaty while the details are relegated to subsidiary documents which can more easily be amended if necessary.

In this section we list a few additional issues worthy of some form of treatment in the treaty.

We suggest that the real estate in Iran controlled by the consortium should be granted a status equivalent to a diplomatic mission. Similarly, the non-Iranian personnel properly appointed by the Board of the consortium including the staff of the management company and also visitors employed by the Board should have diplomatic status. The object, of course, is to prevent the frustration of the purposes of the treaty through administrative or legal action.

Probably it will be desirable to authorize the Board and its appropriate servants to deal directly with the IAEA without having to go through national channels.

Some provisions will be required about the financing of the consortium's operations.

The mechanisms for the settlements of disputes will need to be clearly set out.

Strengthening the Non-Proliferation Regime

Non-proliferation ultimately fails or succeeds according to the decisions of individual governments. It will fail if governments decide that they can get away with going nuclear, 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 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 rules and so it needs to be reaffirmed and strengthened. This depends crucially on 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 multilateral enrichment consortium 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 a fuel bank available to members of the NPT in good-standing and accepting appropriate safeguards;

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

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 Iranian Position

On several occasions, the president and foreign minister of the Islamic Republic of Iran have spoken or written favorably about a multilateral consortium to enrich uranium in Iran for peaceful purposes. In the written Iranian package proposal to the 5+1 of May 2008 one of the agenda items which Iran

says it is ready to consider reads, "Establishing enrichment and nuclear fuel production consortiums in different parts of the world – including in Iran".

Since the 5+1 have studiously avoided taking up this offer, we do not know precisely what the Iranians have in mind. Nor can we easily judge what a balanced negotiation might lead to. But it is abundantly clear that in principle Iran accepts or even favors the multilateral consortium for enrichment in Iran that is the core of the Forden-Thomson program.

Western policy makers are reluctant to admit this. Yet it is hardly surprising for there are substantial advantages for Iran in such a multilateral consortium, not least assistance with their announced civil nuclear program.

Iran's Nuclear Program

Three and four years ago, western commentators were loudly skeptical that a country so rich in oil and natural gas as Iran is should need nuclear power. But this argument is heard no more and indeed the US Government has been promoting nuclear power in the UAE and Saudi Arabia. All these countries are in the same economic boat. A very large percentage of their export profits and also of government revenues is derived from oil and gas. They have little else to sell but this income is now threatened by the rapid growth of their own populations demanding more and more energy. It makes sense to meet this demand through nuclear power instead of robbing their exports to feed their internal markets.

Iran has announced plans for seven 1000-MW reactors to be in operation by 2020 building to a total of twenty by 2035. The first, the long delayed Russian built and fueled reactor at Bushehr seems set to begin operating in 2009.

The uranium mining described above, the conversion and fuel fabrication facilities at Esfahan and the centrifuge plant at Natanz appear aimed at creating an indigenous nuclear industry, not dependent upon imports. But as explained above they fall woefully short of meeting the needs of the Iranian reactor program. However as Table I on page 19 shows, the Forden-Thomson plan more than meets the needs of the entire Iranian reactor fleet and thus provides the material for a profitable export business and for an IAEA fuel bank. So there is a clear advantage to Iran in using modern sophisticated centrifuges. A multilateral consortium is the best and almost certainly the only way to obtain them.

Other Advantages

In addition, an international consortium brings major financial advantages. The head of the Iranian Atomic Energy Organization has said Iran would welcome foreign investment in its program. Given the large capital costs involved this is sensible. Otherwise Iranians would have to provide all the money themselves and on top of that the costs would be higher and the process longer if they had to fund their own research and development instead of tapping into a fully functioning well-tried product.

Depending upon the expansion of nuclear power globally, the consortium might make profits over a long period of years.

Political advantages also arise, less substantial but perhaps equally attractive. Partnership with some of the most advanced nuclear powers makes a statement about Iran's place in the world while

simultaneously promoting nuclear science and technology in Iran. Hosting the first (outside of Europe) multilateral plant tends to show Iran in a progressive light. And, in more ways than one, it underlines Iran's claim to be a supporter of the NPT and the non-proliferation regime.

The Risk of Western Withdrawal

As the West is concerned to protect against Iranian violations of the treaty, so Iran seeks protection against politically inspired Western violations. In effect, this means protection against procrastination or wrecking withdrawal. Both risks should be taken care of formally in the terms of the treaty.

In addition, the risk of deliberate Western delay can be guarded against by incorporating a timetable in a memorandum of understanding spelling out how the general provisions of the treaty are to be implemented in practice. For the reasons already given, the West will be keen to introduce non-Iranian centrifuges as quickly as possible in order to phase out the Iranian IR-1s. It seems likely that in the first stage of the enterprise any deliberate delay would not come from the West but from the Iranian side. In later stages, the risks are more evenly balanced and it will not be feasible to lay down a precise timetable since global demand for LEU is inherently unpredictable. It will not even be feasible to predict with confidence the extent of the Iranian demand in any given year. That will depend upon decisions of the Iranian government and upon how they go about building or contracting for their ambitious reactor program. Considering the large investments involved and its commercial basis, the Board of the holding company will no doubt act prudently. As explained above, the enrichment facilities will be built in stages related to the expansion of the opportunities. With those considerations in mind, a timetable for say the first seven years of the enterprise could specify, for example, legally binding provisions obliging the Western partners to ensure a minimum number of centrifuges working and a minimum level of investment linked to minimum Iranian commitments.

The same sort of considerations effectively precludes a risk that the Western partners will withdraw leaving the Iranian program in a shambles. A Western withdrawal other than for prolonged commercial failure would undercut the dominant political reasons which induced those countries to invest large amounts in a difficult enterprise in a foreign country. Under the terms of the scheme above, the entirety of the Iranian enrichment-related facilities (including the IR-1 and IR-2 centrifuges) leased by the holding company would automatically revert to Iranian control. In addition, the Iranians would enjoy the benefits of skills acquired during the years of the operation and of improvements made to the fixed facilities. Thus the risks to the Iranians of participating in the enterprise would be no greater and arguably smaller than those accepted by the Western partners.

The Risks of a Covert Weapons Program

In December 2007, the US published an unclassified version of a just completed National Intelligence Estimate which judged with moderate confidence that "Iran probably would use covert facilities – rather than its declared nuclear sites – for the production of highly enriched uranium for a weapon". This judgment has been

confirmed repeatedly by expert commentators.

In theory, the Iranians could enter into a multilateral enrichment facility in Natanz, as we propose, and then build secret enrichment-related plants elsewhere in the country. They could do this, of course, with or without a multilateral facility in Iran. In other words, it is an option under any scheme and any circumstances. 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 UF_6 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 covert facility under our scheme appear minimal. To enter into an agreement providing for intense control and inspection within Iran at the same time as building clandestine facilities in the country would be spectacularly risky.

Our proposal has inherent mechanisms for detecting 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 II for additional discussion of this point.) In addition, IAEA inspectors would be stationed permanently in Iran with full rights under the Additional Protocol and also under further agreed transparency measures.

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. Moreover, they would have to keep the two sets separate and refuse official positions to those in the secret set. Given the "societal verification" described above plus the IAEA inspections, the secret set might well be discovered. In short, this would be such a high-risk policy that the prospects of failure would be a deterrent to embarking on it.

Despite what we say in Appendix II about the advantages of using LEU as the feed material to produce HEU, we are inclined to suppose that if the Iranians did decide to make HEU in a covert facility their initial feed material would be natural uranium. This might well involve building a secret conversion plant to produce UF_6 which would probably be sited alongside the secret enrichment plant. In this way they would be able to operate their declared plants strictly in accordance with the rules and would presumably get IAEA certification of their adherence to rules.

If successful, this plan would avoid arousing suspicion and would permit a test to take place before anyone realized there was such a possibility. Moreover, it would allow Iran to produce say half a dozen nuclear weapons before testing one. They

would then have a deterrent against possible retaliation.

We cannot rule out the possibility that Iran is already running a covert operation on these lines. Since the Iranian withdrawal in February 2006 from the Additional Protocol there has been no effective bar to such an operation. Western policy makers who claim to be convinced that Iran is deadset on getting a weapon must, by their own logic, assume that Iran has taken advantage of the absence of Additional Protocol inspections and of western failure to institute "societal verification" to begin covert operations as the easiest and safest way to their objective. The fact that Western policy makers deliberately refrain from the steps that would have closed such an Iranian option suggests that they do not really believe that Iran is set on getting a weapon.

That may well be right, if this is indeed their unexpressed judgment. We too are inclined to guess – the facts do not allow more than that – that Iran is not (yet) running a covert operation.

The Risks of Expropriation

This section can be short because the issue has been discussed already in more than one context.

Briefly, at least three reasons explain why it is unlikely that if Iran accepted the Forden-Thomson Plan it would seize the property of the international consortium.

First, there would be no point (yet much risk) in expropriation unless Iran wanted to make HEU for a weapon. But if Iran were set on getting a weapon it would be far safer to proceed via a covert program, as explained above.

Second, expropriation would not only violate a treaty but it would also make enemies of several powerful countries well able to retaliate. Retaliation might take several forms, would probably be long lasting and to say the least, would damage Iran's economic well being.

Third, one amongst several likely forms of retaliation would be action to bring Iran's civil nuclear program to a halt. While military means might be used it might be sufficient to cut off imports of uranium.

In short, the argument that our plan is too dangerous because of the risk of expropriation is vastly overblown. One has to wonder why so unsustainable an argument is made. In some cases, the simple explanation may be right: the critic has not thought through his instinctive opposition. In other cases, we suspect, the critic is really concerned that Iran should not be allowed to have any indigenous nuclear capability e.g. centrifuges or advanced technology. Given the terms of the NPT this is a difficult argument to make and in any case is now rendered futile by the Iranian manufacture of centrifuges and "mastery" of the technology. So to avoid these difficulties, expropriation is used as a surrogate. Unfortunately, this line of argument tends to deflect attention from the overriding international community interest; namely that Iran should not have the bomb.

Appendices

Appendix I: Multilateralism as an Aid to Non-Proliferation

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 machines, the technology and the material they produce, which gives us electricity and medical treatment, will do just as well, after some extra work, for weapons. Low Enriched Uranium (LEU) for civil purposes can fairly easily be turned into 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 holdouts 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 of the two objectives but it created a regime that encouraged governments to make choices that avoided forcing the potential to become actual. Eventually, however, a few governments began to make choices that had the opposite effect and this process has put the non-proliferation regime in jeopardy. This is not the place to analyze the bad choices and the unfortunate effects produced but 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. Of these, the most important as well as the most influential, was the U.S. under the Bush administration.

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. Second, an effective international expert body, the International Atomic Energy Agency (IAEA), monitored the legitimate activities of the participants. 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 through the control of exports. These three institutions together formed the core of a regime, which 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 behavior so that a fair balance is re-created. Multilateralism, we contend, can make a significant contribution to helping the governments do this and thus reinvigorate the non-proliferation regime. Mohammed ElBaradei Director General of the IAEA has commended the multilateral concept and an expert group appointed by him in which twenty-five countries were represented produced a useful report in February 2005. The report attracted little attention and the conspicuous lack of enthusiasm by major governments seems designed to bury the concept without fuss.

Interment without examination is unjustified and shortsighted. We recommend 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 through the mechanisms of the existing global market, but that is doubtful. The existing market enshrines a monopoly position for the current small numbers of producers. Much of the world does not regard this or the rest of 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, it is obviously relevant, in our estimation, to see whether the balance of fairness can be redressed through multilateralization of critical facilities, especially enrichment and reprocessing plants. 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. This brings us back to the potential inconsistency in limiting nuclear weapons while promoting nuclear energy but this is inherent in the political life of the international community. We argue in putting forward the Forden-Thomson plan (described above) that multilateralization can effectively remove or at any rate greatly reduce the risk that civil facilities will be used for military purposes. And as a manifestation of regional international cooperation it promotes confidence, defuses disputes and supports the original bargain made in the NPT.

Multilateralization – not just in the case of Iran– can support non-proliferation also by providing a secure long- term source of reactor fuel irrespective of political quarrels, thus reducing if not removing the apparent need for national enrichment or reprocessing facilities. In addition, multilateralism facilitates participation in the production of environmentally clean fuel by smaller and poorer countries and generally promotes the use of nuclear fuel. It can be introduced step by step. It can be applied to a single stage of the full fuel cycle or to two or more at the same time. Commercial considerations can be applied and the business structure can be varied. The plants can be designed to facilitate the IAEA's monitoring tasks. The concept exploits national interests while adding a dash of international idealism. In short, multilateralism emerges as a useful and flexible policy.

Appendix II: 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[6] and possibly much less. One independent estimate[7] 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 the same amount of HEU.

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 in any case so that they could be contacted in case of emergency and they

[6] 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.
[7] Garry Dillon, "Wide Area Environmental Sampling in Iran", The Nonproliferation Policy Education Center. p. 5

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.

Western managers and bookkeepers would also know who came to replace broken Iranian centrifuges during the early phases of operation, before the more capable non-Iranian 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.

Appendix III: Centrifuge Self-Destruct and Disabling Mechanisms

It is understandable that some people would instinctively feel uncomfortable about installing in Iran an enrichment facility, using the world's most capable centrifuges. Their adverse views of Iran would lead them to 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 would unite 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.

We believe that both safe and reliable self-destruct and disabling mechanisms[8] can be built into each and every centrifuge in the joint enrichment facility. We put forward two for consideration. Both of these mechanisms can 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 inherent in 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.

The details of both of these mechanisms will depend on the details of the centrifuge on which they are installed. In general, however, all centrifuges share a common design feature: the motor that spins the centrifuge rotor is fastened to the bottom of the stationary outer casing and is "potted" in place.[9] It is just this common design feature that we propose to make use of in both types of mechanisms by placing an encrypted electronic-key circuit inside the motor. (See Figure 1 below.) If Iran wanted to remove these key circuits they would have to disassemble the centrifuge, dissolve the epoxy surrounding the motor, remove the key circuit, repot the motor, and reassemble the centrifuge. While this is theoretically possible, Iran would have to develop the procedure—having never seen the insides of the centrifuge before—and then repeat the process thousands of times; once for each centrifuge. This could take a considerable amount of time, time that could be used for responding to Iran's actions. Of course, if a self-destruct command had been issued to the key circuit before the centrifuge stopped spinning, the centrifuge would be completely destroyed.

A Disabling Mechanism

There are several ways of implementing a disabling mechanism. In one, the encrypted key circuit could require a periodic digital signal just to keep functioning. Thus, for instance, an employee designated by the non-Iranian partners in the joint venture might be required to send a code to each centrifuge once an hour otherwise the key circuit would shut down the power going into each centrifuge. (This is not as tedious as it might appear since a central computer could

[8] We thank Mr. Julian Whichello for suggesting the disabling mechanism and for very helpful discussions on implementing both the self-destruct and disabling mechanisms.

[9] "Potting" involves embedding the motor, in this case, in a thick matrix of epoxy. While this epoxy can be dissolved, exposing the motor so that it can be modified or repaired, it takes a considerable amount of time to do so.

relay the different codes required for each centrifuge.) The enabling code is sent together with a message authentication code to assure that a forged signal is not being sent. Encrypting such authentication codes is now well known from electronic banking applications.

Alternatively, a designated operator could send a disabling code to each and every centrifuge that would permanently open the power circuit and prevent any centrifuge from receiving the power needed to keep its motor turning. This later method, however, has the disadvantage that it could be foiled by preventing a single command from being sent, perhaps by cutting the signal wires or blocking the employee from performing his duty.

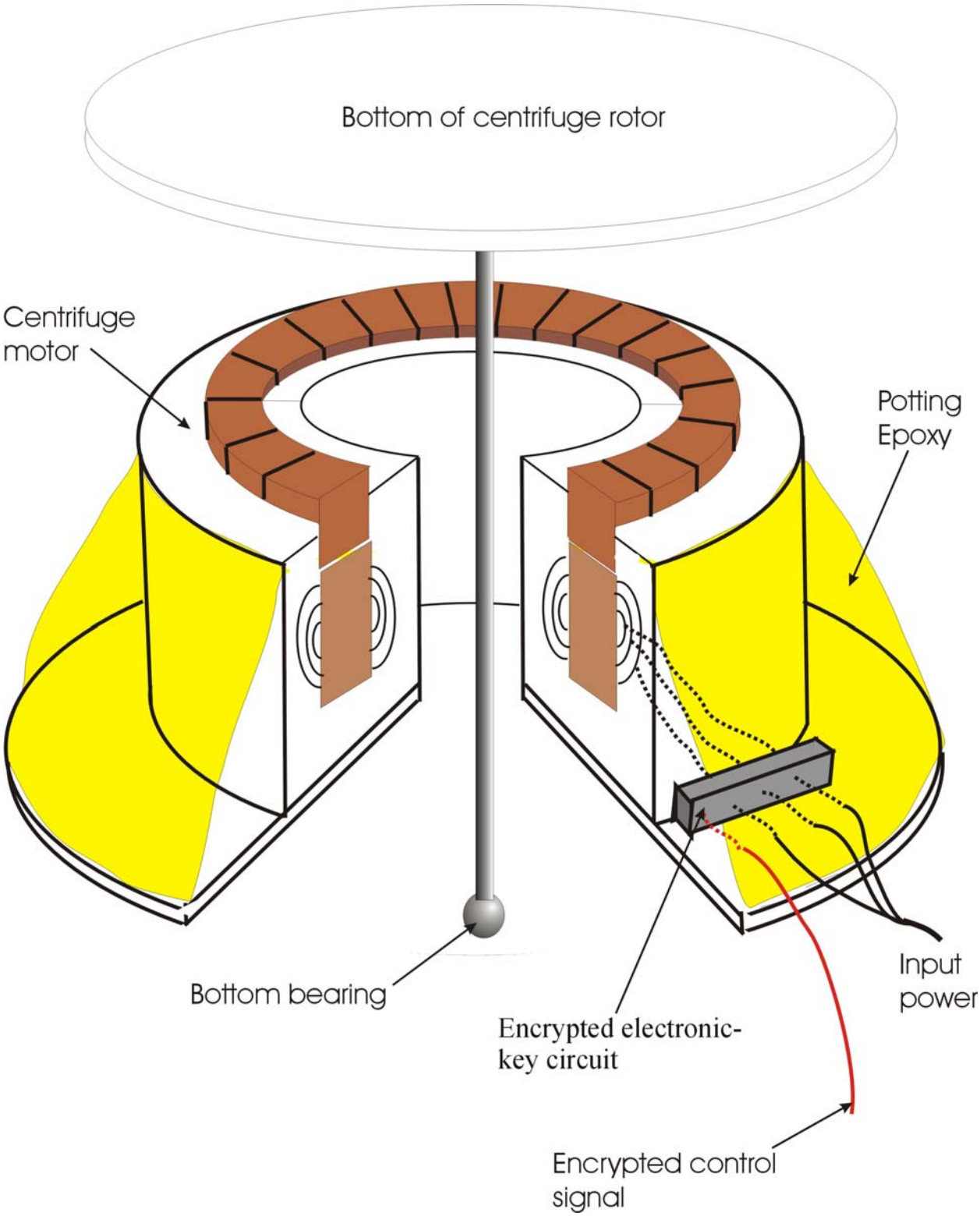
A Self-Destruct Mechanism

The same electronic-key circuit used to disable the centrifuges could also be used to destroy them. Instead of merely interrupting the incoming power, the circuit could reverse the order of two of the three input power "phases."[10] When that happens, the induction magnet spinning the centrifuge would loose its ability to systematically turn the rotor and would cause it either to crash catastrophically against the outer casing or to destroy the main bearing that the centrifuge sits on. A catastrophic crash would clearly render the centrifuge inoperable but could represent a potential safety hazard to workers inside the cascade hall. (Modern centrifuges are designed to contain any shrapnel or fragments that might be created during a crash but it still might be dangerous to have 50,000 of them crash all at once. More detailed knowledge about the designs of centrifuges than is publicly available is needed before a definite answer on worker safety can be given.) It is also possible that this reversing of phases could be done in a way as to assure that only the rotor's critical bottom bearing is destroyed. This bearing is so critical to the centrifuge's operation, and is so technologically sophisticated, that if destroyed the centrifuge is rendered permanently inoperable.

No centrifuge manufactured today has had either a self-destruct or a disabling mechanism built into it and so no matter what solution is found, there will have to be a development program. However, we feel confident that both of the mechanisms discussed here can be effectively adapted for existing centrifuge designs and that they will withstand attempts to circumvent them.

[10] In order to have as uniform a power level as possible, centrifuge motors are run with three input electronic phases as opposed to the more widely known single phase circuits used in most houses. While the single-phase wires in most American homes have one wire held at ground and the other oscillates between minus 120 volts and plus 120 volts, a three-phase system delivers power more equally on three separate wires.

Figure 1. A sketch of a centrifuge motor with an encrypted electronic-key circuit embedded in its power train.



Appendix IV: The Urgent and Critical Nature of the Iran Crisis

(Extracted from the third edition of the Forden-Thomson plan, 24 May 2007.)

Iranian authorities at every level claim that they are behaving in accordance with the Non-Proliferation Treaty (NPT) and are not aiming to make a nuclear weapon. Western countries disbelieve this claim and assert with varying degrees of assurance that Iran seeks to make a bomb. Russia and China are in-between, believing apparently that the most probable explanation for Iranian behavior is bomb-making but also believing that the West is using this issue to cloak its real objectives: regime change in Iran, promotion of Israeli power, Western dominance of the Middle East and its energy resources. The Iranians share these suspicions.

Thus each side, Iran and the West, is convinced that the other has bad intentions, is deceptive and probably will stop at nothing to get its way. A huge issue of confidence separates the two sides and after four fruitless years of on-again, off-again negotiations, bad tempers dispose each side to think the worst of the other. At bottom, it is a matter of suspicion; there is no absolute proof of either side's allegations.

Some people on each side hold that it is or may be mistaken to suppose that the other has a clear and firm policy. Maybe it is a case of tendencies without actual decisions. For instance, the Iranians may have had a military nuclear program until it was discovered in 2002 that they ran large secret operations. They may then have stopped or suspended that program as they turned urgently to convince the IAEA that all their activities were peaceful. That would explain the lack from 2003 onwards of convincing evidence of a continuing military program. On the U.S. side, numerous large-scale military movements both announced and unannounced may not betoken a firm decision to strike Iran. They can be seen as merely ratcheting up the pressure on the Iranian government and people to accede to Western demands.

It may be that President Bush has taken a decision not to strike Iran or more probably that he has postponed any decision as he waits to see what diplomatic pressures will achieve and what might be the risks of military action in 2008.

Opacity on both sides should suggest caution but as always, those who are certain of their allegations have an advantage over those who hedge their conclusions. One practical consequence in this case is the universal supposition that pressure on Iran, particularly military pressure, is strengthening the case of those in Tehran who want a nuclear deterrent against the U.S. Tension tends to favor the hard-liners on both sides and unfortunately weakens those moderates in Iran who are not fixed on a weapons program.

Time works against the West in this and other more important ways. President Bush has defined three "red lines" that Iran must not be allowed to cross: no nuclear weapons, no machines that could be used to make them, no technical know-how to run the machines. But the Iranians already have the essential machines, the P-1 centrifuges, which Pakistan used to make the fuel for its bombs and which A.Q. Khan sold to Iran. According to the IAEA, the Iranians have several hundreds, if not thousands, of these centrifuges in store and are constantly making more. Although the Pakistanis with an industrial base inferior to Iran's, mastered the art of

making these inefficient centrifuges work, the Iranians have not yet quite done so. They have got small numbers of them spinning sufficiently to produce a tiny amount of Low Enriched Uranium (LEU), but they have not achieved a large continuous flow. What they lack is not the basic science but certain engineering tricks. The best estimate is that they may master the techniques to the point of extracting LEU from five hundred centrifuges as soon as April 2007. On the same basis, it is assessed that they may be enriching LEU from 1000 centrifuges in the fall of 2007.[11]

In short, the Iranians have already crossed President Bush's red line in regards to possession and production of machinery and partly crossed it in technical proficiency. They may fully master the technology at any moment and possibly no later than the fall of 2007. When this happens, their negotiating position will be strengthened and the West will be left only with the red line of no weapons. Fortunately, this is the only really crucial point.

Good negotiators know it is an error to persist with a policy, which has been tried over several years and has largely failed. However sensible the Western demands may have been and however desirable they still are in principle, none of them in their present form is attainable. Specifically, the requirement that Iran should have no centrifuges has, as a matter of fact, been lost and the denial of technology is all but lost. When the Western powers recognize that they have failed to eliminate any possible Iranian capability to make weapons, presumably some or all of them will demand that the Iranians roll-back their knowledge of how to make centrifuges and how to run them. In the present day and age, destroying knowledge is not a practical objective. Politically, the prospects of getting the Iranians to give up what they already have and know are virtually nil. Iran is not North Korea. If we are to rein in Iranian capability, the fewer centrifuges and the less technology the Iranians have the better but the longer we persist on our present course, the more they will have of each, deal or no deal. So, again, time is against the West.

Western policy is avowedly gradualist. The essence is progressively to ratchet up pressure on Iran to accept Western demands. In addition, some carrots formerly offered remain available, but have been spurned by Iran. So the policy is primarily a matter of sticks, especially formal and informal economic sanctions designed to hurt the general public and particularly certain influential groups such as the bazaar. Also included are restrictive measures intended to damage the nuclear program and the top people who run it. Iranians are hurt by these measures and want to get rid of them.

But is their pain sufficient to make them resile from the national objective of enrichment on Iranian soil? Almost certainly, no.

But what if, as the West intends, the pressures (and presumably the pain) mount with each turn of the sanctions screw? The West – or at least the Europeans – have always declared that they will operate the ratchet patiently, progressively and proportionately. They admit that it will take a long time. Logically, they have a point: there must be some threshold of pain at which the Iranians would give up. But the history of sanctions whether U.S. against Iran since

[11] David Albright in prepared testimony March 15, 2007 before the House Committee on Foreign Affairs, Subcommittee on Terrorism, Non-Proliferation and Trade, Subcommittee on the Middle East and Asia

1980 or international against Serbia and South Africa bears out the saying that "there is a lot of ruin in a nation". These sanctions all created pain but they did not produce their intended result quickly or, in some cases, at all. The Iranian economy has many weaknesses but is more resilient than most. Maybe on one distant day the Iranians would cry "uncle" but there is virtually no chance of this in 2007 or 2008.

As we have seen, that distant day will be far too late to prevent Iran from having a weapons capability and probably to forestall the making of an actual weapon. Worse than that, persistence in the present policy is counter-productive. Effectively, it allows the Iranians to get more centrifuges and more technology. Staying the course is condemned as an option by the time discrepancy between Iranian progress with centrifuges and technology on the one side and on the other, the slowness of progressive sanctions to create sufficient pain. The verdict is reinforced by the Western challenge to Iranian nationalism on the one issue which bonds the leadership and the nation, by the inadequacy of the negotiating carrots, the smallness of the sticks and by the leadership's insistence that enrichment on Iranian soil is non-negotiable. Khamenei, the Supreme Leader publicly reaffirmed this in the plainest terms as recently as the third week of March 2007. Staying the course reduces the arguments for Iran to compromise and raises the barriers which the West will have to surmount if it is to keep nuclear weapons out of Iranian hands.

Yet all is not lost. Western policy can be modified without retreating from the objective of no weapons in Iranian hands. How? Amongst the ideas mentioned publicly, several propose to cap the Iranian centrifuge program, probably at the number in use at the time. From this comparatively small number Iran could continue to produce LEU under strict IAEA surveillance. This "pilot plant" idea could be put into effect quickly and cheaply and would be a good option if gaining time were the object. But it is hard to imagine that it could be a permanent solution. It would leave Iran both with a national nuclear program capable, albeit very slowly, of bomb production and with ideal cover for clandestine operations.

We prefer a multilateral solution which leaves no enrichment-related facilities exclusively in Iranian national hands and which is permanent. However, it might be possible as an interim measure to start with a scheme for capping before moving on to a properly worked out multilateral solution. In the following paragraphs, we describe in some detail the main lines of such a solution.

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