

# International Regulation of Uranium Fuel Cycle Facilities<sup>1</sup>

Thomas B. Cochran<sup>2</sup> and Christopher E. Paine<sup>3</sup>

Discussion Draft

July 23, 2009

## Abstract

We propose a major supplement to current IAEA safeguards requirements for uranium enrichment (and later other nuclear fuel cycle activities) that would be universally applied and non-discriminatory. The heart of this proposal is that a new freestanding “International Nuclear Fuel Agency” (INFA), under the aegis of the UN, should be established alongside the IAEA to license the construction and operation of all uranium enrichment enterprises that seek to receive or supply nuclear fuel cycle services from or to the global marketplace. INFA would limit and supervise the conduct of these activities within “Sovereign Secure Leased Areas” (SSLA’s) controlled by the agency for periods of 50 -99 years.

The IAEA would be strengthened, not diminished, as its safeguards role would be extended to cover, without discrimination, all such facilities in all countries desiring access to the global market for nuclear fuel services. The IAEA would continue to be responsible for establishing safeguards requirements and conducting safeguards inspections, but would enjoy greater access to do so, and an increased ability to sanction those that do not comply with IAEA safeguards.

States would grant INFA exclusive extra-territorial rights to SSLAs containing the sites where uranium enrichment activities are conducted, similar in some respects to the rights of governments to maintain and secure their embassies in other countries. No enrichment activities could be conducted other than within INFA-SSLAs. In our view granting these extra-territorial rights to INFA would increase considerably the political and other costs should a host country contemplate unlawfully removing INFA and taking over the site. Likewise, accepting INFA jurisdiction and regulatory authority for activities occurring within the zone would send a strong signal to the international community that a host country does not view its acquisition of nuclear fuel cycle facilities as a nuclear security “hedge” for later incorporation into a nuclear deterrent capability.

## Rationale

Independent nonproliferation analysts have long voiced concerns regarding the ability of current International Atomic Energy Agency (IAEA) safeguards to meet their design objective of providing timely warning of a potential diversion of materials or technology from bulk-handling facilities, including uranium enrichment plants.<sup>4</sup> In addition, recent experience has shown that the international community lacks adequate tools to prevent both sudden and “creeping” or “latent” Nonproliferation

---

<sup>1</sup> An earlier version of this paper was presented at the International Forum on “Nuclear Proliferation and Nuclear Energy,” Amman, Jordan, June 23, 2009.

<sup>2</sup> Thomas B. Cochran, Ph., D., is a senior scientist and holds the Wade Greene Chair for Nuclear Policy at the Natural Resources Defense Council, Inc., Washington, D.C.; [tcochran@nrdc.org](mailto:tcochran@nrdc.org)

<sup>3</sup> Christopher E. Paine is the director of the Nuclear Program at the Natural Resources Defense Council, Inc., Washington, D.C.; [cpaine@nrdc.org](mailto:cpaine@nrdc.org)

<sup>4</sup> For example, see William J. Broad, “A Smuggling Boom Brings Calls for Tighter Nuclear Safeguards: World Rules are outdated, a New Report Says,” *New York Times*, August 21, 1994, p. 1, reporting on the conclusions of T.B. Cochran and C.E. Paine, “The Amount of Plutonium and Highly-Enriched Uranium Needed for Pure Fission Nuclear Weapons,” 13 April 1995, archived here: [http://docs.nrdc.org/nuclear/files/nuc\\_04139501a\\_144.pdf](http://docs.nrdc.org/nuclear/files/nuc_04139501a_144.pdf)

Treaty (NPT) breakout scenarios, in which a country acquires or develops sensitive nuclear technologies for the production of fissile materials under cover of its existing peaceful use safeguards agreements, and then abruptly changes direction, withdrawing from the NPT at a time of its own choosing when it has amassed the necessary capabilities.

In addition, the current application of IAEA safeguards discriminates between weapon-states and non-weapon states. In the past these disparities made a certain amount of sense in terms of the IAEA allocating its resources to the most cost effective risk reduction priorities. It made little sense to apply peaceful use safeguards against diversion of civil nuclear materials in nuclear weapon states when confronted with the overwhelming reality of two declared nuclear weapon state-parties to the treaty with tens of thousands of nuclear weapons. Throughout the Cold War and the 20 years that followed, these states expressed no plausible political intention of ever giving up their weapons, while most fuel-cycle facilities located in non-weapon NPT states were covered by a parallel EURATOM safeguards structure outside the IAEA.

Several factors have emerged to change this status quo:

- Fuel cycle facilities are spreading to emerging nuclear powers both within and outside the current NPT safeguards structure;
- The threat of seemingly implacable international terrorism has increased the threat to nuclear facilities, irrespective of their geographic location, particularly those with declared or secret stocks of highly-enriched uranium that can be swiftly assembled into a devastating improvised nuclear explosive device;
- In a new era bent on decarbonization of the global electricity supply to address climate concerns, nuclear power is poised to grow substantially in some areas of the world; and finally,
- The President of the United States, and leaders of other nuclear weapon states, have advanced—possibly for the first time—sincere proposals for systematically undertaking meaningful steps to begin the process of transitioning to a nuclear-weapons-free world, beginning with further reductions in their nuclear arsenals, a permanent end to nuclear test explosions, and a multilateral Fissile Material Cutoff Treaty that clearly implicates all nuclear fuel cycle facilities wherever located.

The “breakout” capability posed by sensitive nuclear fuel cycle facilities under purely national control represents a threat not only to the NPT, but also to the long-term prospects for a transition to a nuclear-weapons-free world. In a world characterized by the proliferation of such national nuclear fuel cycle capabilities, no current or future nuclear power is likely to agree to eliminate its nuclear arsenal. So the failure to deal decisively with the risks posed by these facilities places a floor under future nuclear disarmament efforts. This is a point that many developing world governments, who tend to harp on their “inalienable rights” to the full suite of nuclear technologies for peaceful uses, would do well to focus on if they are sincere about their demands for global nuclear disarmament.

There is much that the global nuclear industry and key nuclear states can do immediately on their own to address these concerns, build a new nonproliferation consensus, and chart a pathway to a more secure and less contentious future for nuclear power. Whether that better future for nuclear power actually materializes will then become—as it should—a function of a rising carbon charge on fossil fuels and nuclear’s actual economic performance relative to other low-carbon options.

We address our proposal particularly to the major suppliers (and their governments) that comprise the global nuclear fuel cycle industry. This industry has to date enjoyed and continues to enjoy a multi-billion dollar free ride when it comes to defraying the costs of the essential international safeguards

required to make the weapons proliferation risks of the nuclear fuel cycle minimally tolerable for international security. The cost of these safeguards, and the much costlier government intelligence and export control efforts that back them up, are not and never have been included in the cost of nuclear fuel services, nuclear reactors, or nuclear-generated electricity, although they are an intrinsic and unavoidable cost of spreading nuclear power technology.

Similarly, on a global basis, very little of the cumulative environmental damage wrought by the nuclear fuel cycle over time is accounted for in the cost of nuclear power. And over time, many participants in the uranium mining and milling industry have compiled what can only be called an appalling environmental justice record, defrauding indigenous peoples and contaminating their lands and water all around the globe. While some companies have made substantial improvements, it is still a very unlevel playing field that favors the lower-cost polluting suppliers. This needs to change.

The time has long since passed for a new and more responsible operational status quo for the global nuclear industry, and we think that our proposal for an International Nuclear Fuel Agency (INFA) is the best vehicle available for defining and gaining an initial global consensus among the major participants in the global nuclear fuel services market. Much of the intellectual heavy lifting needed to frame a workable proposal for submission to the General Assembly can and should come from the nuclear suppliers themselves, following both wide-ranging informal and more structured discussions with governments, NGOs, independent technical experts, international agencies, affected indigenous populations, and other stakeholders to insure that the initial agency template incorporates “must-have” standards for safeguards, security, health and safety, and the environment.

This paper provides a preliminary roadmap of the functions, powers, and licensing requirements of such an agency, and how they could be enforced by maintaining a sovereign on-site presence that could only be undone by hostile host nation actions that are tantamount to a declaration of war on the international community. Such an assault would provide an unambiguous signal to the international community of a host nation’s intent to acquire nuclear weapons, and thus empower the Security Council or a subset of its members to take decisive action. Dilatory ambiguities would be minimized. There would be no “creeping withdrawals.”

Clearly, wide-ranging consultations are the indispensable first step, because no independent agency created under the aegis of the UN can tolerate or contribute to outcomes on the ground that are inconsistent with or erode the principles of the UN Charter and other UN covenants and agreements. On a more practical level, there will be no buy-in, and indeed rising resistance from environmental organizations worldwide, if the “nuclear renaissance” yields new zones of contaminated land and water, impaired fisheries, and the like, or impairs the health and welfare of nearby communities. A comprehensive new code of conduct for the global nuclear fuel supply chain is clearly required if the “nuclear renaissance” is to gain a wider constituency worldwide.

The authors propose improved uranium enrichment and conversion safeguards, and a global licensing structure that insures universal, non-discriminatory application of safeguards, physical security, inspection, and operating license requirements, while interfering as little as possible with the operations of the current world commercial market for enrichment services. The desired common goal is a global nuclear supply chain that equitably reconciles the energy supply, international security, environmental, and human rights concerns that currently beset the global nuclear fuel cycle and lead directly to political deadlocks, jury-rigged and illegitimate patchwork fixes, rising risks of proliferation, serious environmental contamination, and even guerilla warfare and preemptive strikes on sensitive nuclear facilities. This status quo should be unacceptable to nuclear power proponents, nonproliferation experts, and environmental advocates alike. There has to be a better way. We think there is.

The crux of our proposal is to locate some existing and yet-to-be built nuclear fuel cycle facilities within “Sovereign Secure Leased Areas” (“SSLAs”) that would have special protected international status as irrevocable leasehold properties of the INFA for the period of their construction, operation, and decommissioning, e.g. 50-99 years. Within these areas, INFA would exercise licensing and inspection authority over a wide range of relevant issues relating to the safe and secure operations of the plant, and the IAEA (or EURATOM) would apply improved safeguards and conduct independent inspections in a manner that preserves a credible arms length relationship between the IAEA, INFA, and the operating companies.

The near term focus of INFA would be on bringing all uranium enrichment facilities under its umbrella, followed by other nuclear fuel cycle facilities. In subsequent years, and especially if there is increasing commercial interest in thermal Mixed-Oxide (MOX) plutonium-uranium fuels, or fast reactor cycles that would breed plutonium or “transmute” long-lived actinide fuels to stable and shorter lived-elements, the INFA structure could be extended to back-end nuclear fuel cycle facilities currently covered by EURATOM or IAEA safeguards, and to those “hard cases” still remaining outside of safeguards.

INFA would be funded entirely by equitable fees embedded in the market price of nuclear fuel services in proportion to the overall expenditure of INFA resources to license and oversee each stage in the process. This issue is discussed further in the body of this paper.

## **Introduction**

Credible technical and political concerns persist regarding the adequacy of IAEA safeguards for meeting the fundamental standard of ensuring “timely warning” of the diversion from modern uranium enrichment plants of nuclear materials in peaceful use, which requires that the interval between the diversion of safeguarded material and its detection by the IAEA be sufficiently brief that appropriate measures can be taken to prevent the government or organization concerned from converting this material into a nuclear explosive device. In the case of highly-enriched uranium product in hexafluoride form, the required conversion time is very short.

It is also the case that the current safeguards arrangements for these facilities present no significant obstacle, in the event of a nation’s decision to withdraw from the NPT and its IAEA safeguards agreements, to the subsequent use of the enrichment technology to provide fissile materials for the manufacture of nuclear weapons.

It appears unlikely that these problems can be resolved satisfactorily without implementing some form of internationalization of uranium enrichment. Numerous proposals have been made by governments, the nuclear industry and international organizations to strengthen international safeguards and security over uranium enrichment and nuclear fuel reprocessing and for assuring enriched uranium fuel supply. An excellent summary of twelve recent multilateral approaches has been made by Yury Yudin of the United Nations Institute for Disarmament Research.<sup>5</sup> Below we propose an international structure—similar in some respects to a recent proposal from the German Foreign Ministry—designed to radically improve the international community’s ability to ensure the peaceful use of uranium enrichment plants and related facilities, while making it more difficult and politically costly for states to misuse the technology.

Our proposal is designed to apply universally without discriminating between nuclear weapon states and non-weapon states. It also attempts to preserve the existing commercial structure for providing

---

<sup>5</sup> Yury Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, United Nations Institute for Disarmament Research (UNIDIR), Geneva, Switzerland, 2009.

enrichment services without placing onerous or undue restrictions on commercial firms that provide enrichment services. And in due course it could be expanded to include other sensitive nuclear fuel cycle activities.

### **Central Elements of the Proposal**

The central element of our proposal is the establishment of INFA, an independent international nuclear fuel agency that would acquire extra-territorial rights at all sites where uranium enrichment activities are conducted, and license all uranium enrichment activities at these sites. INFA would initially provide regulatory governance over all uranium enrichment activities, including those not covered under existing IAEA or EURATOM safeguards. INFA's purview would apply equally to weapons and non-weapons states.

The role of the IAEA would be strengthened, not diminished, as it would continue to be responsible for establishing safeguards requirements and conducting safeguards inspections, but under our proposal it would have easier—indeed assured—access to all facilities under INFA regulation, and an enhanced ability to monitor facilities and to force changes in operations where a facility or operator is not in compliance with IAEA requirements.

There are several considerations that need to be addressed regarding any new structure for close international regulation of nuclear fuel cycle activities, including:

- scope and timing of licensing activities with respect to enrichment and other stages of the complete nuclear fuel cycle
- creation of INFA and its relationship to the IAEA
- international control and management structure of INFA
- licensing authority of INFA
- territorial sovereignty
- enforcement of licensing requirements
- facility ownership and operations
- liability
- customer supply
- component manufacturing and supply
- IAEA safeguards
- physical security
- health, safety and waste management

Below, we address each of these considerations.

### **Scope**

As noted, the INFA would initially provide regulatory governance over all uranium enrichment activities, including those not covered under existing IAEA safeguards. This would be followed, or even accompanied, in certain cases, by similar licensing controls over:

- over uranium conversion activities between the production of uranium concentrate ( $U_3O_8$ ) and safeguarded fuel fabrication plants; and

- any other intermediate product storage sites that, in the view of the Agency, present a proliferation, physical security, or environmental hazard.

Once these front-end facilities are covered, the INFA could turn its attention to incorporating back-end facilities and ultimately, in the event nuclear weapons reductions begin to approach a nuclear disarmed world, uranium mines and mills.

Given the minimum \$25-30 billion upfront capital requirement (and decarbonization investment “opportunity cost”) of shifting to a partial Mixed Oxide (MOX) plutonium fuel cycle, and given the fact that this massive investment would actually yield zero net carbon reduction below that afforded by continued reliance on the LEU cycle, we judge the near- and medium-term commercial prospects of thermal MOX recycling to be far less than those of the once-through uranium cycle, and therefore the emphasis of this proposal is on the latter. But this could change for a variety of reasons, including intervention by political authorities seeking to foster the illusion of purposeful activity with regard to “management” of mounting inventories of spent nuclear fuel, and the INFA would need to be in a position to respond to this shift.

### **Creation of INFA and the role of the IAEA**

To ensure the credibility and independence of IAEA safeguards, INFA would be established as a separate independent agency of the UN operating in parallel with the IAEA. The relation of INFA to the UN would be similar to that of the IAEA as described in IAEA, INFCIRC/11, 30 October 1959. INFA would have periodic—at least annual—reporting requirements to the UN General Assembly, and, like the IAEA, the obligation to submit reports to the Security Council “whenever, in connection with the activities of the Agency, questions within the competence of the Council arise.”<sup>6</sup> INFA’s responsibility to the IAEA would be to ensure access by IAEA staff to enrichment facilities licensed by the INFA, facilitate IAEA (or where appropriate EURATOM) monitoring activities, and take appropriate actions where facilities were not in compliance with safeguards requirements, e.g., restrict or terminate the flow of materials into and out of the site, or in the extreme case, impose a complete shutdown.

States joining the INFA would have to ratify and implement a new “Additional Protocol on Isotope Separation and Enrichment” [hereafter, “Additional Enrichment Protocol”] to existing safeguards agreements between the IAEA and all State-members of the IAEA. Under the Additional Enrichment Protocol, member States would agree to the kinds of arrangements set forth below.

States that have not agreed to the Additional Enrichment Protocol—and the existing Additional Protocol providing for IAEA inspections of undeclared sites—would not be eligible to receive fuel cycle services from States that have agreed to the Additional Enrichment Protocol.<sup>7</sup> Similarly, States that have signed the Additional Enrichment protocol agree not to accept fuel cycle services from any State that has not agreed to the Additional Enrichment Protocol.

Today uranium enrichment services are dominated by a few commercial and mostly state-owned enterprises, namely, USEC, EURODIF (services marketed by Areva), URENCO and Rosatom (foreign services marketed by TENEX), with large uranium enrichment plants located in the United States, France, United Kingdom, Netherlands, Germany and Russia. The establishment of the INFA would of course require the approval the UN and the full cooperation of the IAEA, as protocols to existing safeguards agreements would be the primary means of implementation. But if the six major enrichment

---

<sup>6</sup> INFCIRC/11 30 October 1959, p. 3, [www.iaea.org/Publications/Documents/Infcircs/Others/infcirc11.pdf](http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc11.pdf)

<sup>7</sup> The requirement for the IAEA’s Additional Protocol on inspections presumably would not apply in the case of India, where the supplier countries have already agreed to a limited exception to the full-scope safeguards requirement as a condition of supply, but India would be expected to agree to the Additional Enrichment Protocol.

supplier countries agreed to establish and implement the Additional Enrichment Protocol, it would be difficult for other enrichment service supplier- and user-countries not to join. By staying outside the arrangement, they would be locked out of the commercial enrichment market and access to cost-effective enrichment and fuel fabrication services.

### **International Control and Management Structure of INFA**

INFA would have a Board of Directors and an Executive Committee of the Board. The Director General of the IAEA (or his designated representative) would have a permanent non-voting seat on the Board of INFA and its Executive Committee. The Board would have the responsibility for establishing INFA policies and procedures.

The Secretary General of the UN and the Director General of the IAEA would jointly propose a candidate for Chairman of the Board of INFA, whose selection would require ratification by a 3/5 majority of the Executive Committee and of the full INFA Board. The Chairman and the Executive Committee of the Board of INFA would be responsible for granting and enforcing licenses. The Executive Committee would nominate, and the full Board of INFA would approve the Executive Director for Operations of INFA, who would be the head of the INFA staff.

Each State member of the IAEA that has:

- a) Commercial enrichment facilities that supply at least one million kg “Separative Work Units” (SWU) per year to the commercial market, and/or;
- b) Sufficient commercial nuclear power reactors that together utilize three million kg SWU per year;

would be entitled to a seat on the Executive Committee of the Board of INFA. Using these criteria France, Germany, Japan, Netherlands, Russia, the United Kingdom, the United States and China would hold the initial seats on the Executive Committee.

Members of the Executive Committee would serve as permanent members of the Board of INFA. The agency’s founding agreement with the UN would establish the criteria and selection procedures for wider Board membership, the requirements applicable to all members for becoming and remaining a member in good standing, and procedures for the removal of Board members who fail to uphold these standards.<sup>8</sup>

The Executive Committee would nominate, and the Board of INFA would approve, the senior officers of INFA. INFA would establish a schedule of tariffs on enrichment services sufficient to cover the full cost of its operations. Since the SWU-cost represents a small fraction of the levelized, fully-amortized cost of nuclear-generated electricity, these tariffs would not adversely affect the economic viability of nuclear power.

---

<sup>8</sup> In addition to the initial eight members of the Executive Committee, a reasonable proposal for constituting the remainder of the full INFA Board is to allocate seats to the 10 additional countries that currently have national fuel cycle facilities under IAEA safeguards – Argentina, Belgium, Brazil, Canada, India, Iran, South Korea, Romania, Spain, and Sweden – plus the largest suppliers of uranium (e.g. >3000 tons/U/yr in 2008) to the world market not already included on the preceding two lists – Australia, Kazakhstan, Namibia, and Niger. Together these lists yield a potentially inclusive but manageably-sized 22-member Board for the Agency, with the caveat that not all countries may qualify immediately for membership because of their failure, in the view of the Secretary General, to conduct their activities “in accordance with the Purposes and Principles of the United Nations Charter, and in conformity with the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies.” See INFCIRC/11 30 October 1951, Article 1, Principles, para. 4.

## Licensing Authority of INFA

The INFA, with the concurrence of the host state's nuclear regulatory authorities, would approve and license all existing and new uranium enrichment and subsequently other nuclear fuel cycle facilities. Whether some or all of the additional facilities brought under its purview would likewise require enclosure in SSLAs or merely rigorous international licensing and improved safeguards would be at the discretion of the INFA Executive Board based on the professional recommendations of its staff and recommendations received from participating governments.

This paper concentrates on what would be INFA's initial and most proliferation sensitive priority—uranium enrichment plants. The licenses would set forth requirements related to ownership, operations, safeguards, physical security, and environment, safety and health in much the same way that individual state regulatory agencies license nuclear facilities today. The license would specify limits on:

- enrichment level, e.g., U-235 concentrations would be limited to levels between 5 and 20 percent, depending on customer requirements;
- plant capacity, and;
- inventories of feed materials and enriched product stored at the site, or other intermediate storage sites, if these are specifically permitted by the terms of the license.

For the next several decades global uranium enrichment services could be readily met by upgrading technology and expanding capacity at existing uranium enrichment and conversion plants. Nonetheless, countries may wish to enter the enrichment market by constructing new facilities, possibly using entirely new technology, or for reasons unrelated to ensuring security of fuel supply, such as a uranium exporting nation desiring to add value to its exports of uranium concentrate. Before licensing a new facility or expanding the licensed capacity of an existing plant, the INFA staff, in consultation with the relevant staff of the IAEA, would be required to prepare a “Nonproliferation Impact Statement” which would analyze the potential nonproliferation and security impacts of the proposed facility and consider reasonable alternatives to it that could meet its proposed legitimate purpose and need.

## Territorial Sovereignty

INFA would enter into an INFA-State “Lease Agreement and Nuclear Facility Oversight Contract” with each state currently hosting, or planning to host uranium enrichment (and in due course other nuclear facilities), for the purpose of establishing extra-territorial rights, physical security and other arrangements outlined below. The INFA would have the prerogative to lease—for one dollar per year—Sovereign Secure Leased Areas (SSLAs) under long-term agreements with the host nations. The INFA-State Lease Agreements would confer on INFA for a defined period (e.g., 50-99 years) extra-territorial leasehold rights over all sites where uranium enrichment takes place or where new uranium facilities are under construction.<sup>9</sup> The INFA's extra-territorial leasehold rights would remain in force even if the State chose to withdraw from the Nonproliferation Treaty (NPT) or its safeguards agreement with the IAEA.

---

<sup>9</sup> This would be similar to the Multilateral Enrichment Sanctuary (MES) under the German proposal. See, <http://www.auswaertiges-amt.de/diplo/de/Aussenpolitik/Themen/Abruestung/Downloads/MESP-Sitzstaatsabkommen.pdf>, and Yury Yudin, “Multilateralization of the Nuclear Fuel Cycle,” p. 18 (proposal # 10), and pp. 46-48, where the German proposal is discussed.



No state or commercial entity would be permitted to construct or operate a uranium enrichment facility—or a uranium conversion facility should an SSLA be established for a facility of this type—except within an SSLA where the INFA enjoyed such extra-territorial rights. States would in effect relinquish sovereignty over the SSLA for the period of construction, operation and decommissioning of the enrichment facility, but their state-owned or commercial nuclear suppliers would continue to operate the facilities located within the zone.

### **Safeguards and an IAEA-INFA Agreement**

The IAEA would retain responsibility for establishing safeguards requirements, conducting safeguards inspections and enforcing the terms of safeguards agreements. The IAEA would prepare an IAEA-INFA Agreement. This agreement would set forth the steps that INFA must take in the event that the IAEA finds that any State or INFA licensed facility is not in compliance with an IAEA-State safeguards agreements or facility license, including INFA's authority and obligation to shut down any enrichment facility found to be in non-compliance with IAEA safeguards, and to take operational control of materials and or equipment at the site.

The IAEA-INFA Agreement would provide the IAEA with unimpeded access to the site for the purpose of monitoring and enforcing IAEA safeguards, and provide the IAEA with the authority to establish independent monitoring of materials, equipment and personnel entering and leaving the site.

### **Physical Security**

The host nation would have the responsibility for ensuring the physical security of the outer perimeter of the SSLA under its INFA-State Agreement. Security perimeters and access controls at specific facilities and protected areas within the zone would be the responsibility of the individual commercial enrichment and conversion enterprises, which would continue to operate under private-, state-, or multinational ownership, much as they do today. The Executive Committee of the INFA Board, however, would have ultimate responsibility for insuring site physical security and for regulating the flow of materials and equipment to and from each SSLA. If at any time it is not satisfied with the physical security arrangements provided by the host nation, or in the event of a breach of the INFA-State Agreement or facility license, then the Chairman and Executive Director of INFA could at their sole discretion supplement, replace or take command of the security forces at the site.

Such "Emergency Security Responses" (ESRs) would require explicit extension, modification, or reversal by the INFA Executive Committee within seven days, and similar consideration by the full Board within 30 days. But an ESR originating with or endorsed by the Director General of the IAEA in response to a safeguards violation could not be reversed by the INFA Executive Committee or INFA Board. A provision of the INFA-State Agreement would provide that in the event of war, civil strife, or credible warning of a terrorist threat to the facility, the Executive Committee of the INFA Board could call upon security forces of the UN, or any state or group of states represented on the INFA Board, to provide trained security personnel to bolster security at an INFA site.

### **Enforcement of licensing requirements**

One of the weaknesses in the current safeguards regime is the lack of enforcement and the seemingly endless debate within the IAEA and the UN over what kind of sanctions to apply in the event a state is not in compliance with its IAEA safeguards obligations. Under our proposal, the license for enrichment and conversion activities would include predetermined provisions and imitations on activities of the enrichment or conversion facility and host nation in the event of noncompliance with IAEA safeguards or INFA license requirements.

The Executive Committee of the INFA Board would be directly responsible for enforcing the conditions of its own INFA licenses, and of IAEA Safeguards Agreements when directed to do so by the IAEA or the UN Security Council. The Executive Committee at its sole discretion would have the authority to restrict or end the flow of materials and equipment to and from any licensed facility and impound the materials, equipment, records and other assets at any covered enrichment or conversion site in the event that the Executive Committee believed there was an existing breach, or an imminent threat to breach, any of the conditions set forth in the INFA-State Agreement or facility license.

The Executive Committee of the Board could call upon the UN, or any state or states represented on the INFA Board, to provide security forces if needed to enforce INFA licensing decisions. In the case of less than severe disagreements or non-imminent threats, it would be obligated to take due care not to cause serious damage to the facility while resolution of the problem is under review. But when circumstances warrant, under its licensing agreement with the national or multinational operating company, the INFA could impose requirements that permit the agency to shut down or disable the enrichment facilities if takeover of the site by the host-nation appeared imminent.

We believe the territorial sovereignty requirement and other aspects of this proposal will significantly reduce the likelihood that any host nation would attempt to break out of the international safeguards regime and use its enrichment facilities for weapon purposes. The INFA-State Lease Agreement is independent of a State's NPT and IAEA obligations. So, even if the State withdrew from the NPT and terminated its IAEA Agreement, it would still be bound by its lease agreement with INFA, a UN agency.

Kicking the UN agency out would be tantamount to declaring war on the UN. Although there are few historical precedents, for the most part states have honored extra-territorial agreements that accord special status to foreign embassies and multinational agencies, and even former colonial territories, e.g., China honored the British lease of the Hong Kong territory until control was transferred peacefully under a diplomatic agreement. If a State nonetheless did attempt to expel INFA and take over the site, the Security Council would have a stronger case for imposing sanctions or authorizing the use of all necessary means to prevent the use of the enrichment facility for weapon purposes.

### **Facility Ownership and Operations**

Capital assets at the enrichment and conversion sites would be owned by commercial entities, including State-owned commercial and multinational enterprises. The company or companies responsible for operating enrichment and conversion facilities must be approved and licensed by INFA. Similarly, new enrichment facilities would be built and operated by commercial entities. The management structure would be similar to the operation of enrichment plants by USEC, a private U.S. company, on sites that are owned by the U.S. government. The difference here is that the plants would be located within secure sites under the control of INFA, rather than privately owned, or owned by the host-government.

### **Liability**

The Additional Enrichment Protocol and the INFA-State Lease Agreements would absolve INFA of any commercial, environmental, or personal injury liabilities associated with the INFA lease arrangement of the site. In effect, under our proposal liability apportionment of liability under existing national government laws and international conventions would remain unchanged, and the operating nuclear companies or consortia, (or their state shareholders) would remain the financially responsible parties.

## **Customer Supply**

Customers would order enrichment services from enrichment facility operators, much as they do today. INFA would have the responsibility and obligation to insure that all financially solvent customers who are in compliance with their IAEA safeguards agreements have an available source of enrichment supply. INFA would have the standby authority, to be used as necessary in the event of a breakdown in commercial supply arrangements, to direct one or more enrichment facility operators and fuel fabricators to provide fuel cycle services to customers to insure that their needs for such services are met.

INFA would take over responsibility for managing existing and proposed buffer stocks—so-called “fuel banks”—of enriched product in the form of uranium oxide . Consequently, it is unlikely that INFA’s standby authority would ever be exercised, except possibly in the case of a disruption of fuel fabrication services to a customer otherwise in good standing

## **Component Manufacturing, Testing and Supply**

The INFA would maintain a list of sensitive uranium enrichment components and materials. Only manufacturers with a valid license from the INFA would be permitted to produce such components. The INFA would approve the location and license existing and new facilities that manufacture and test sensitive uranium enrichment components. Manufacturing and testing such components without a valid INFA license would represent a serious breach of a country’s IAEA safeguards obligations and a crime under international law. Brokerage and resale of such components by third parties would be prohibited.

All purchase orders for sensitive enrichment components would be placed through INFA, and all shipping and delivery would be handled by a small number of INFA-licensed shippers and be routed directly from the factory to the customer’s plant, without transshipment or intermediaries. Each unit in a batch of sensitive components would be assigned a unique and difficult-to replicate “tag” indicating its date and location of production and its status as an INFA-licensed product. Products not bearing this tag could not be used in any new INFA-licensed facility or facility expansion.

## **Health, Safety, Waste Management, and Supply Chain Certification**

INFA would be responsible for establishing baseline international health, safety, environmental and waste management and disposal criteria and requirements, and enforcing these standards at licensed sites. Host nations would retain the discretion to establish more (but not less) protective health, safety, environmental and waste management standards, and the right to enforce facility compliance with these more protective standards. INFA would facilitate access by host-nation regulators to examine environment, safety, and health (ES&H) records and make independent environmental measurements within the site security boundary. INFA would have the obligation to seek resolution of any data discrepancies.

Universal compliance with a common code of environmental performance is an important part of fair competition in the global uranium marketplace. This competition should not be based on cutting corners to evade the costs of responsible environmental stewardship, but rather on the efficiency of a given company’s uranium extraction, conversion, or enrichment technologies and operations, and/or the inherent advantages of its ore deposit. Mining low-grade deposits as quickly and cheaply as possible, and leaving behind a polluted mess, is an unacceptable business model, and INFA would be tasked with taking stern action against such producers.

Conversion and enrichment customers would have to disclose to INFA their uranium concentrate supply chain, and would have an ongoing obligation to inspect the mining, milling and uranium recovery operations of their uranium concentrate suppliers, and certify to INFA that the uranium was

produced in accord with an environmental code of conduct to be agreed upon in a consensus building process among the major uranium suppliers, national environmental regulators, representatives of nongovernmental organizations with expertise in the field, affected populations, and INFA staff.

Should this international voluntary approach demonstrably fail to deliver the desired level of effective environmental protection—which in all candor seems likely given the history of the uranium mining industry—INFA would exercise its inherent discretion to extend its regulatory authority over any uranium supplier not in compliance with the code, by subjecting it to formal licensing requirements that, if not met, could result in fines, stiff environmental bonding requirements, or the supplier’s suspension from participation in the legitimate global marketplace.

INFA would maintain a comprehensive database and reporting system covering uranium mining operations and production worldwide. National environmental protection agencies would be obligated to report environmental abuses to INFA, and state or provincial agencies would have the option of doing so.

INFA would also maintain a special channel for receiving reports from protected confidential sources in uranium mining countries where reporting environmental abuses can get you jailed, tortured, or killed. The Agency would be required to investigate reports of both serious individual contamination incidents and lower-level but prolonged patterns of environmental negligence, and take appropriate action, including the ultimate sanction of sending a “cease and desist” order or “leprosy cable” instructing all uranium fuel cycle customers and suppliers not to deal with the country concerned until further notice from the Agency.

### **Comparison with Other Proposals**

We believe the proposal set out here is more comprehensive and preferred over alternatives offered to date. None of the alternative proposals, for example, address the weaknesses in enforcement of current IAEA safeguards requirements, or the supply chain for sensitive uranium enrichment plant components. It is also worth noting that our proposal does not conflict with most other proposals.

Seven of the twelve proposals compared in Yury Yudin’s review for UNIDIR address nuclear fuel security.<sup>10</sup> These include:

- the September 2005, U.S. proposal for a reserve of nuclear fuel (# 1 in Yudin’s review);
- the May 2006, World Nuclear Association’s proposal (# 4 in Yudin’s review);
- the June 2006, Concept for a “Multinational Mechanism for Reliable Access to Nuclear Fuel” proposed by France, Germany, the Netherlands, Russia, the United Kingdom and the United States (# 5 in Yudin’s review);
- the September 2006, proposal by Japan for “IAEA Standby Arrangements” (# 6 in Yudin’s review);
- the September 2006, Nuclear Threat Initiative’s “IAEA Fuel Bank” (# 7 in Yudin’s review);
- the September 2006, United Kingdom’s “Enrichment Bond” Proposal (now called the Nuclear Fuel Assurance proposal; (# 8 in Yudin’s review);
- and the June 2007 Nuclear Fuel Cycle non-paper by the European Union (# 12 in Yudin’s review).

---

<sup>10</sup> Yury Yudin, “Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals,” 2009.

Many experienced observers do not believe that “fuel assurance” is a serious issue for anyone save those who have enmeshed themselves a serious unresolved IAEA safeguards problem, but if it were a serious issue, having access to enriched uranium hexafluoride, or enriched uranium oxide does not completely resolve it, because the customer still needs assured access to a fuel fabrication supplier, if not also a uranium conversion facility.

Under our proposal, the INFA guarantees nuclear fuel services to all customers in compliance with IAEA safeguards and with sufficient good credit to arrange payment for the services. Moreover, any of the fuel assurance proposals could be incorporated readily into our proposal by having the INFA manage the fuel bank and/or fuel assurance activities.

Other proposals reviewed by Yudin lack the universality and/or non-discriminatory aspects of our proposal:

- The January 2006, Russia’s “Global Nuclear Power Infrastructure” proposal (# 2 in Yudin’s review) envisions creating a system of international centers for front and back end nuclear fuel cycle facilities under the control of the IAEA. In May 2007 Russia put forward the “Russian International Uranium Enrichment Centre at Angarsk (# 9 in Yudin’s review). These proposals do not address existing or future national enrichment and conversion facilities that do not become international enrichment centers. In any case, the Angarsk Electrolysis Chemical Complex and similar centers could easily be incorporated into our proposal, although the centers would fall under the purview of the INFA rather than the IAEA.
- In February 2006, under the George W. Bush administration, the United States proposed the “Global Nuclear Energy Partnership” (GNEP) (# 3 in Yudin’s review). The GNEP program has been terminated by the Barack Obama administration, although closed fuel cycle R&D will continue, and elements of the GNEP related to assurance of fuel supply may be retained.
- The May 2007 “Multilateral Enrichment Sanctuary Project” proposed by Germany (# 10 in Yudin’s review) is the prior proposal that most closely resembles our own. However, we believe we have strengthened the German proposal by expanding the sanctuary concept to apply to all enrichment plant sites, both existing and proposed, and by shifting supervision of non-safeguards issues—including new defenses against breakout—from the IAEA to a smaller, independent, and potentially more agile body, the INFA.
- The May 2007, “Multilateralization of the Nuclear Fuel Cycle” proposal by Austria (# 11 in Yudin’s review) is described by Yudin (# 11 in his review) as a “vague, conceptual vision of eventually placing all sensitive nuclear technologies and activities, including existing civilian enrichment and reprocessing facilities and fuel supply, under multilateral control.”

### **Relevance to Iran**

Some will argue that this proposal does not adequately address current developments in Iran, or that it would simply allow Iran to continue to expand its enrichment facility at Natanz while this proposal is debated and developed. We do not propose to solve the Iranian enrichment issue by this proposal alone; rather we are looking beyond Iran—to strengthen the nonproliferation regime so the Iran issue is not repeated. Nonetheless, we also note that acceptance and implementation of our proposal by Iran would require the following:

- (1) Implementation of the Additional Protocol;
- (2) A cap on the enrichment level, facility capacity, and amounts of LEU product and feed material stored on-site that would better protect IAEA timely warning objectives, and either:

- a. prompt export to a foreign fuel fabricator, or;
- b. INFA-licensed and secured storage under IAEA safeguards at another site, remote from Natanz, of any excess low-enriched UF<sub>6</sub>—allowance for such a site would be at the discretion of INFA, and only in response to a legitimate commercial fuel-cycle need, such as the eventual startup of an LEU fabrication facility within the country;

- (3) Long-term lease of the site (e.g. 50-99 years) to INFA with extra-territorial rights conveyed to the agency, backed by the writ of the UN Security Council;
- (4) Formal licensing of the Natanz operation by INFA, with a continuous on-site presence, complete access to every aspect of the operation by INFA personnel, and the regulatory discretion to shut it down, take possession of, or even disable the equipment in the event any irregularities or unsafe or insecure conditions were detected at the plant, or in the event of evidence of Iranian noncompliance with other aspects of its and IAEA safeguards and NPT obligations, that in the view of the regulator, merits such steps;
- (5) Declaration and closure within Iran of any other enrichment technology or production facility lacking such a license, which would be entirely within INFA's discretion to grant or deny;
- (6) To address the residual breakout threat involving the supply of natural uranium fuel to the heavy water reactor under construction in Arak, which in principle could produce weapons plutonium in a breakout scenario, the conversion facility at Isfahan could be placed within an INFA-SSLA simultaneously with the creation of an SSLA for the Natanz plant;
- (7) Going forward, the use in the Natanz facility of only INFA certified parts—Iran's reliance on clandestine supply networks would be terminated and compliance would be ascertained through intrusive inspections; and
- (8) An INFA charter from the General Assembly that would provide for direct referral of serious breaches of Iran's Additional Enrichment Protocol to the UN Security Council, with INFA's Executive Board, in consultation with the Director General of the IAEA, jointly determining what constitutes a serious breach meriting immediate referral.

One can certainly allege that none of the measures individually or cumulatively would make a difference in the level of proliferation risk posed by Iran's program, but we do not find this assertion credible. The above measures collectively would substantially reduce the proliferation risk. Whether this reduction would be a sufficient basis on which to resolve the current impasse with Iran; whether Iran is likely to accept and faithfully implement such a proposal; and whether Israel could derive sufficient security assurance from it, are of course matters for debate, and perhaps resolution in further detailed agreements tailored to the specifics of the Iranian situation.

INFA would have inherent powers and discretion to mitigate, or even further reduce to very low levels, the risks posed by Iran's enrichment program and other national programs that are likely to follow. Once established, INFA would have inherent powers to grant licenses for new enrichment facilities in countries and at proposed sites that it deems suitable and appropriate. INFA could develop sound objective criteria, relating to a host nation's internal security, regional security, political stability, transparency of governance, and the economic viability of a domestic fuel cycle program, which would make it extremely unlikely that other countries in the Middle East would or could replicate Iran's path anytime soon.

## Agency Financing and Economic Issues

At current SWU prices, a modest tariff of perhaps five percent tacked on to the market price of a SWU would yield on the order of \$250 million per year to fund INFA startup operations. This tariff would have a negligible effect on the economics of commercial nuclear power, which is overwhelmingly a function of the sky-high capital costs of nuclear reactors, a seemingly perpetual feature of the industry that the world is rediscovering yet again.

Nonetheless, in a carbon constrained world, the competitive market position of conventional nuclear power generation should improve relative to fossil fuels used for power generation—mainly coal and natural gas—as these become more costly, and improving enrichment technologies could further reduce SWU costs. The combined effect of carbon charges and more efficient enrichment would more than offset the market impact of the INFA tariff. Because every enrichment market participant would pay these costs, there should be no adverse market impacts on an enrichment enterprise’s comparative market position due to the imposition of this tariff.

The INFA would require similar surcharges on other stages of the fuel cycle as they are brought within its purview. The intent is for INFA to be largely if not entirely self-sustaining, based on the premise that its costs are a legitimate and necessary part of managing the risks associated with using the nuclear fuel cycle. Detailing of member government laboratory experts for rotating tours with the agency, and other types of in-kind contributions, could obviously supplement the agency’s budget, but would not be expected to play a major part.

Our broader economic point, however, is that the world nuclear industry, which is already a kind of quasi-governmental global oligopoly—aptly captured in the coined term “CompetiMates” that we have heard recently from our friends in the industry—needs to stop running continually to governments and taxpayers around the globe to pick up the bill for its inherent “externalities,” which are of very long standing and should have been assumed by the industry long ago. As we move toward an ever more integrated global market for nuclear power production, these externalities should be increasingly and everywhere reflected in the actual market price of a nuclear kilowatt hour of electricity, and let the chips fall where they may.

Any suggestion by the industry that such truth-in-pricing would kill its economic prospects should be taken for what it is—a preemptive admission of economic defeat. If fossil fuels are now to be assessed for their heating-trapping consequences, the nuclear fuel cycle should be fairly assessed for its security risks and environmental impacts, including the costs of operating the global regulatory agency needed to reduce to these risks and impacts to acceptable levels.

## Personal Observations

It may seem strange for two longstanding critics of the global commercial nuclear industry to be proffering advice, but the twin threats of proliferation and climate change makes these unusual times. So for what its worth, here’s our advice:

*For at least the next 15 years, focus on reducing the proliferation risks, costs, and environmental harms of the clearly dominant and more cost-effective uranium fuel cycle, and bring INFA into being as soon as possible to help the industry achieve this objective. A war in the Middle East or elsewhere sparked by poorly managed nuclear proliferation concerns will sharply limit the prospects for an orderly global nuclear expansion, so we don’t have infinite time to get this right.*

Finally, given the emerging “CompetiMates” oligopoly structure of the world nuclear industry, the transition to the proposed INFA regulatory regime does not appear to us to entail significant changes in the way the commercial end of the business is currently handled. It would, however, remove a large element of proliferation risk from the global nuclear power business, improve health and safety, help ensure environmental and economic justice for affected communities, and reduce environmental harms.

## **Afterword**

*We strongly encourage participants in the global nuclear industry, U.S. foreign government, and international agency officials, environmental regulators, and independent analysts to contact us regarding this proposal, and give us your reactions, criticisms, and refinements. Through such a process, a more precise shared understanding of the nature of the problems, and likely sticking points, can be built.*

*Our respective emails are provided in footnotes at the bottom of page one of this document. Please address your comments to both of us, to increase your chances of receiving a timely reply in the event that one of us is traveling or otherwise engaged.*

*If you would like to discuss the proposal in person, which we encourage, please indicate in your email when you are likely to be next in Washington, D.C. or New York, and we will do our best to accommodate your schedule. Depending on the level of interest and amount of travel involved, it may also be possible to meet with you at your company or agency offices at sites outside New York or Washington.*

### **About the Natural Resources Defense Council (NRDC)**

Founded in 1970, NRDC and its 300-plus attorneys, scientists, economists and other professionals work to safeguard the earth, its people, plants, and animals and the natural systems on which all life depends. NRDC played a large role, which it continues today, in creating and protecting the statutory authority, implementing regulations, and judicial record for most of the environmental protections that Americans now take for granted, such as the Clean Air Act, the Clean Water Act, and the National Environmental Policy Act. NRDC serves its 1.2 million members and on-line activists from offices in New York, Washington DC, Chicago, San Francisco, Los Angeles, and Beijing.

For 35 years, the NRDC Nuclear Program has sought to reduce the risks from both the military and civil applications of nuclear energy. The Program played a key role in the citizen scientist diplomacy that helped to end the Cold War and nuclear weapons test explosions, and the Program remains a leading nongovernmental authority on world nuclear forces and a prominent voice in the academic and policy debates over the future of nuclear power and proliferation in an era of climate change.

For more information, please visit [www.nrdc.org/nuclear](http://www.nrdc.org/nuclear).