Reforming the Nuclear Fuel Cycle: Time Is Running Out

Revelations earlier this decade about Iran's clandestine nuclear activities reignited global concerns that the spread of such sensitive fuel-cycle technology would lead to nuclear weapons proliferation. In a 2003 *Economist* op-ed, International Atomic Energy Agency (IAEA) Director-General Mohamed ElBaradei proposed that the time was right to re-examine multilateral approaches to the nuclear fuel cycle.[1]

Similar studies had already been undertaken in the 1970s and 1980s but had not produced concrete results.[2] Nonetheless, states responded with a plethora of proposals aimed at thwarting the unchecked spread of uranium-enrichment and spent fuel reprocessing technologies, for example, by suggesting means of assuring nuclear fuel supplies and establishing international nuclear fuel-cycle centers.

In June 2007, ElBaradei catalogued these proposals in the report "Possible New Framework for the Utilization of Nuclear Energy," delivered to the agency's Board of Governors. The report, which remains restricted, was designed to be of help to the board in considering the issue at a subsequent meeting, and ElBaradei later indicated that he was turning over the responsibility for leading the discussion to the IAEA's member states.[3] Subsequently, the Board of Governors has apparently not formally discussed any of the proposals, although about a half dozen of them have been refined during the year that followed. ElBaradei himself sees attaining credible assurance of supply as part of an ambitious multilateral effort that would culminate in all new, and then all existing, enrichment and reprocessing facilities being placed under multilateral control.

The next six months are likely to prove critical in determining whether any of these proposals becomes a genuine blueprint for a new approach to this issue or whether, like similar efforts three decades ago, they simply gather dust.

A Dozen Proposals

Twelve proposals were put forward by the time of the 2007 IAEA board report. They have been summarized elsewhere, including in a list extracted from the board report,[4] and are recapped briefly before turning to focus on those proposals that have been developed further. In addition, another possible new framework is noted that attempts to include, or to lend itself to incorporation by, many of the existing proposals.

As they stood in June 2007, the proposals varied widely. They included plans to establish a fuel bank, a fuel cycle center, or fuel services program; to initiate a mechanism providing different levels of supply assurances, a concept that also, in practice, incorporated the fuel bank idea; or to support these other proposals.

The creation of an independent fuel bank not linked to any particular fuel-cycle center option or other assurance of supply mechanism characterized two of the proposals, one made by the United States and the other by the nongovernmental Nuclear Threat Initiative (NTI). The U.S. proposal, as announced in September 2005, committed the United States to downblend 17.4 metric tons of highly enriched uranium (HEU) to low-enriched uranium (LEU), which would be made available to qualifying countries, i.e., those not presently pursuing indigenous enrichment or reprocessing technologies.[5]
The NTI proposal, put forward a year later, comprised an offer of $50 million to allow the IAEA to create an LEU stockpile, which would be owned and managed by the agency. The release of the NTI funds would occur providing that, within two years, i.e., by the end of September 2008, the IAEA had taken the necessary steps to establish the reserve and an additional $100 million had been provided by member states, whether in funds or in an equivalent value of LEU.

A slightly different interpretation of the nuclear fuel bank idea was contained in the proposal by Austria in May 2007, which was more conceptual in nature and less of a "fuel reserve" than those envisioned by the NTI and the United States. Rather than establishing a bank simply as a storage site for a reserve of fuel, Austria suggested a two-track mechanism. The first would see states declare, to the IAEA and to each other, all existing nuclear programs, development plans, and activities and all transfers of nuclear material, equipment, and related technologies. The second track would place all nuclear fuel transactions and, eventually, enrichment and reprocessing facilities and nuclear fuel supply under the auspices of a Nuclear Fuel Bank. [6] ElBaradei himself has long believed and frequently stated that credible assurances of fuel supply should be the first step of an ambitious multilateralization effort, which would culminate in all enrichment and reprocessing being placed under multilateral control.

Broader efforts to establish a fuel cycle center or a consortium for fuel services lay at the heart of a U.S. proposal for the Global Nuclear Energy Partnership (GNEP); a Russian plan for a system of international enrichment centers, the first example being the International Uranium Enrichment Center at Angarsk; and a German proposal for a Multilateral Enrichment Sanctuary Project (MESP).

The GNEP idea was perhaps the most ambitious. As initially proposed, it contained both domestic and international components and technological as well as policy dimensions. Internationally, the program focused on the provision of reliable fuel services, especially the possibility of fuel leasing, where providers would be responsible for dealing with spent fuel. Technologically, the program emphasized the development and deployment of more advanced nuclear power reactors and, more controversially, the use of new spent fuel reprocessing technologies said to be more "proliferation resistant" than current methods because they would not produce pure separated plutonium. [7]

The Angarsk concept, like GNEP, was already well on the way to being realized by the time of the June 2007 board report. The proposal itself existed in two parts: a fuel cycle (enrichment) center and a fuel bank. By the time of the 2007 report, the Russian Duma had already approved enabling legislation that would grant participating countries the right to partake financially in the facility. In addition, Russia was also exploring a means through which a separate LEU stockpile could be set aside under IAEA safeguards and for the use of IAEA member states.

The German proposal favored the creation of a multilateral enrichment center under IAEA control and supervision and on a site that had been granted extraterritorial status. Under the MESP framework, the center would be a new entrant into the enrichment services market and could be established by a group of interested states.

The tiered approach to multilateralizing the fuel cycle characterized the ideas put forward by the World Nuclear Association (WNA), the industry trade group, and the Concept for a Multilateral Mechanism for Reliable Access to Nuclear Fuel, often known as the RANF proposal or the Six-Country Concept. [8] Both proposals envisioned the first, or "basic," assurance of supply mechanism as being the existing and normally operating market. The WNA proposal suggested that a second level of assurance could be provided by "collective guarantees by enrichers, supported by governmental and IAEA commitments." [9] Similarly, the RANF mechanism envisioned a second layer of assurance being offered by suppliers of enriched uranium agreeing to substitute for each other to cover certain supply interruptions. [10] A final, third layer of assurance in both proposals incorporated the fuel bank concept by suggesting governmental creation of enriched uranium stocks, either virtual or physical.

Finally, several of the proposals were intended to be supplementary to other efforts. The British proposal for an enrichment bond suggested a means of assuring states that if they met certain IAEA-determined criteria, they would be guaranteed enrichment services by national providers and would be provided with prior consent for export assurances. [11] The Japanese proposed increased
transparency by way of an database, managed and dispersed by the IAEA and comprising information voluntarily provided by states on capacities for uranium ore, reserves, conversion, enrichment, and fuel fabrication.\[12\] In addition, the European Union submitted a nonpaper to the IAEA Secretariat and the 2007 nuclear Nonproliferation Treaty (NPT) Preparatory Committee (PrepCom) meeting.\[13\] Its inclusion among the other proposals is something of a misnomer, however, because rather than proposing a stand-alone mechanism, the nonpaper instead offered a list of criteria by which such mechanisms could be evaluated.

**Refining the Proposals**

Several of the proposals have undergone substantial further development since the June 2007 ElBaradei report. U.S. contractors have begun downblending the 17.4 tons of former military HEU, which Washington had pledged. This process is expected to yield 290 tons of LEU by the time the effort is completed in 2010. In addition, the potential consumer base for the fuel has been broadened, with U.S. companies also being permitted to buy fuel in the event of supply disruption, rather than it only being available internationally and to countries that are not pursuing enrichment or reprocessing. The United States would make the fuel available at the prevailing market price.\[14\]

The NTI offer of $50 million to establish an LEU reserve under IAEA auspices has made some notable progress over the past year. Although the required full amount of $100 million has not yet been raised, Congress pledged one-half ($50 million) to be allotted to this fuel bank and, as of August 4, 2008, had issued a letter officially donating the funds.\[15\] In addition, Norway has made a $5 million contribution, and it was recently announced that the United Arab Emirates (UAE) had pledged a further $10 million.\[16\] This leaves $35 million dollars still to be raised in order to meet the first of the NTI’s conditions and, in turn, leaves the IAEA not yet able to meet the second condition and take the steps necessary to establish the reserve. ElBaradei has decided not to approach the IAEA Board of Governors for a decision until all funding has been pledged.\[17\] At that point and given that the NTI has indicated that it expects the IAEA to agree on a set of release criteria for the material, the fuel bank would become part of a broader and yet more complicated discussion in the board on terms and conditions for use.

The NTI proposal is the only one made in the context of an official deadline, originally requiring that both conditions be met by the end of September 2008. At the request of the IAEA director-general and with the consent of the NTI, the deadline has now been extended to September 2009, which provides something of a cushion. Still, it is difficult to imagine that the money would be indefinitely earmarked, either by the NTI or by donor states, in the absence of other funds being raised, and thus some pressure would need to be brought to bear on other states to contribute funds toward the bank as soon as possible.

The GNEP proposal has also forged ahead, although not without setbacks and changes. GNEP was to be a consortium of nations with advanced nuclear technologies that would establish supply arrangements to provide nuclear fuel to and take back spent fuel from other participants. The GNEP International Partnership was established in September 2007, and GNEP countries soon thereafter established a steering group. That group then established two working groups, one of which was tasked with exploring reliable nuclear fuel services and making recommendations on practical measures in this regard.\[18\] The first meeting of this working group took place in April 2008. The proposed measures and the summary of work undertaken were to be summarized in a report to the GNEP Steering Group in May 2008 and to the partnership’s ministerial-level Executive Committee in October 2008.

However, GNEP has encountered difficulties internationally and domestically. Internationally, the United States shelved initial plans to require countries that joined the partnership to forswear enrichment and reprocessing. Instead, the United States has chosen to rely on a set of other bilateral incentives, such as help with financing, infrastructure, and workforce issues, as levers to convince countries to sign a bilateral memorandum of understanding (MOU) pledging to rely on the global nuclear fuel market instead of developing sensitive technology. For example, during the first half of 2008, three of the six states of the Gulf Cooperation Council (Bahrain, Saudi Arabia, and the UAE) signed MOUs with the United States. A draft MOU between the United States and Qatar, presumably with a similar undertaking on the part of Qatar, is currently under consideration. Although U.S.
officials express hope that other suppliers, such as France, will follow their lead, Paris has made no explicit commitment to do so.

Domestically, since the Democrats gained control of Congress in 2007, the program has seen its funding cut on Capitol Hill and its effort limited to research. At the end of June, the House Appropriations Committee expressed its skepticism of GNEP in a very visible fashion, by "zeroing out" international fiscal year 2009 funding for the program and sharply curtailing funding for domestic research. In its report, the panel stated that the "initiative to reprocess spent nuclear fuel...undermines our Nation's nuclear non-proliferation policy."[19] With the Bush administration only months away from leaving office and the future of GNEP under a new administration by no means assured, GNEP is, as one recent article has observed, in "limbo."[20]

Nonetheless and almost contradictorily, efforts at expanding GNEP are continuing, with invitations soon to be extended to 25 countries to join the partnership. To be sure, joining GNEP merely requires a state to sign the partnership's Statement of Principles, which is not legally binding. Nor are any sort of financial "dues" required to join the club, so a simple expansion of the membership is less indicative of GNEP's health than it might otherwise appear.

Russia's proposed international enrichment center at Angarsk was legally established in September 2007 as a joint stock company. By the time shares were issued in November 2007, a deal had already been signed with Kazakhstan, which purchased 10 percent of the shares. At that time, Armenia indicated its interest in joining, a step that was taken through an exchange of notes in February 2008. In order to address concerns regarding the spread of technology, the International Uranium Enrichment Center (IUEC) will be structured ("black-boxed") in such a way that no access to enrichment technology or classified knowledge will be accessible to the foreign participants. Traditionally, black-boxed technology has been in place in cases where the host state is to be prevented from accessing the technology. Russia, for instance, constructed a black-box centrifuge plant for China in 1995. In such cases, the obvious concern stems from a possible takeover of the facility by the host state. The fact that the host state is, in this case, also the technology holder allows this concern to be assuaged, although it still remains to ensure that physical access to the technology and know-how is nonetheless restricted and that the black box is indeed opaque. Any IAEA member state that also meets "the established nonproliferation criteria" is eligible to participate in the IUEC, although it has previously been indicated that members should also not be "envisaging the development of indigenous sensitive nuclear technology."[21]

In December 2007, the Russian government took the decision to include the nuclear material in the enrichment center in the list of facilities it is willing to submit to IAEA safeguards. Safeguards are also to be applied to the 120-ton LEU stockpile that is to be set aside, separately, as a fuel bank in the event of a supply disruption for political reasons unrelated to nonproliferation. Although an agreement between the IAEA and Russia on the safeguards arrangements was originally expected to be concluded in the first half of 2008,[22] such an agreement has not yet been finalized and appears likely to be held up for at least another few months. It is therefore likely to land on the board's plate while the future of the NTI proposal and GNEP are likewise coming to a head.

The German proposal for a multilateral enrichment center is also being actively pursued. Such efforts followed an initial delay, which was apparently the consequence of internal disagreements. Germany made a presentation at the IAEA in February 2008, which gave further details regarding the proposal, and the German government also initiated and ultimately co-hosted a conference in Berlin in April 2008 with the Netherlands and the United Kingdom on nuclear fuel assurances. At that time, it was noted that the three states also stood ready to undertake further development of the enrichment bond concept.

The proposal, as developed thus far, has recommended that the host country for such a center should not already possess enrichment capabilities. Although the IAEA would have responsibility for oversight of such a center, the MESP idea also wisely confers responsibility for day-to-day management and operation of the center to a private firm rather than to an international organization. The IAEA also would not have any other means of access to sensitive technology or know-how.
One of the most difficult aspects of the MESP idea is finding a host country. In addition to requiring that the country is not already a current supplier of enrichment services, the MESP proposal also notes the need for the host country to have a suitable infrastructure and political stability, adhere to safeguards agreement, and be in good standing with the NPT. It is not yet clear how difficult it will be to find a willing host and, once found, how acceptable that host country will be to possible participants in the center.

Of all the proposals made, however, the MESP concept is perhaps the most explicitly welcoming to all interested parties, including those who might wish to develop an indigenous enrichment technology, by noting that they would "remain free" to do so if they so chose "and circumstances require."[23] This inclusiveness is sure to increase the appeal of the MESP idea, particularly to states who have long been concerned that participation in multilateral ventures was dependent on not pursuing indigenous enrichment and reprocessing activities. It remains unclear, however, whether the "circumstances required" for states to explore their own capabilities while participating in the center will be identified or formalized in any way. If so, this might be viewed as limiting the MESP's apparent inclusiveness. If not, such inclusiveness might then come at the expense of the proposal's nonproliferation value.

A working paper, providing still more detail on the MESP idea and suggesting next steps for this and other proposals, may be presented by Germany to ElBaradei in September 2008. This would serve to provide an interesting backdrop to the NTI-GNEP-Angarsk developments.

Another Possible Framework

Finally, another framework that makes use of the three-layer approach contained in the WNA proposal and Six-Country Concept has been noted. Like the others, the first level of such a mechanism is simply the current market and its existing supply arrangements. The second level, again much like that suggested by the WNA and in the Six-Country Concept, would be based on the existence of backup commitments that would be undertaken by suppliers and the relevant governments of enrichment services and of fuel fabrication. In the event of any failure in the current market and assuming that the IAEA director-general considered that certain predetermined criteria were met, this second layer of assurance would be enacted. As a final guarantee, a third level consisting of a physical or, more likely, a virtual LEU fuel bank could be created. Under this framework, which would be open to all IAEA member states, the LEU reserve would be stored "in one or several separate locations and made available to consumer states through a set of arrangements and agreements, involving the IAEA and supplier states and companies."[24]

Selected Remaining Issues

Several of the proposals made on fuel assurances foresee the IAEA's involvement in deciding when services may be supplied or fuel from a fuel bank released. It is often assumed that criteria would be agreed on in advance by the Board of Governors and that the director-general would therefore, at the time of the request, need only to approve it on the basis of whether it met or failed to meet these criteria. This would seem to be the only way that potential recipients could have confidence that the supply they require would be timely and would not be waylaid by debate in the board. It follows that, as ElBaradei has stated, such criteria would have to be "non-political" and "applied in a consistent and objective manner."[25] This would allow the director-general to check the request against the list of conditions for release, which would proceed as a last-resort supply in the event of denial of services for political reasons not related to proliferation concerns.

Conditions agreed to in advance would likely require that the consumer state be in good standing with its IAEA safeguards obligations, as indicated in the agency's Safeguards Implementation Report. Whether the state would have to have been in good standing for only the most recent year or for a predetermined number of previous years would also need to be agreed. Naturally, safeguards would be applied to the material supplied.

Those safeguards, however, would almost certainly not include the 1997 Model Additional Protocol, which provides further legal authority beyond the required NPT safeguards agreement, allowing the IAEA to draw conclusions regarding the absence of undeclared nuclear materials and activities. After
Reforming the Nuclear Fuel Cycle: Time Is Running Out
Published on Arms Control Association (https://www.armscontrol.org)

all, the additional protocol remains voluntary, and until the Board of Governors takes a decision to the contrary, many states feel strongly that the protocol should not be required as a criterion for supply. This does not sit well with some other states, who not only support the universalization of the protocol, but who may have domestic legislation in place requiring a recipient state to have an additional protocol in place as a condition of bilateral supply. Whatever conditions are proposed, perhaps the only sure conclusion is that the agreement of nonpolitical advance criteria in a forum that has become increasingly political over the past few years will be a difficult task.

Such politicization has been reflected in the concerns and suspicions regarding eligibility criteria. The questions of which states are able to participate and what, if anything, those states would have to give up in order to do so have been a running theme in the discussions. As initially introduced, several of the proposals, such as the Six-Country Concept and GNEP, were understood to place requirements on potential consumers not to pursue indigenous enrichment or reprocessing activities. This triggered fears that the current supplier countries were attempting in effect to establish a cartel, despite the fact that, as stated by South Africa, some nonsupplier states "might choose to pursue sensitive fuel cycle activities in a limited way or only for research activities."[26] Although efforts have been taken by the supplier states to assuage these concerns, many other states, some of whom, Brazil and Japan, for instance, have expressed interest in eventually being suppliers themselves, retain their misgivings and continue to be concerned that multilateral approaches to the fuel cycle might serve to curtail their Article IV rights under the NPT to the research, development, production, and use of nuclear energy for peaceful purposes. It remains to be seen whether this skepticism can be overcome.

The ability of fuel assurance mechanisms to address the back end of the fuel cycle and, in particular, to resolve the issue of spent fuel is also a cause for concern. The return of spent fuel is traditionally a controversial idea, being politically and often legally difficult. Accordingly, the establishment of regional or international spent fuel storage or disposal facilities has proved to be a tough sell. A mechanism that provides for a take-back of spent fuel, however, would certainly hold greater appeal to states whose nuclear power programs are in their early stages. It would also provide greater nonproliferation assurance against the possibility of reprocessing the spent fuel for plutonium. The taking back of spent fuel to the country of origin is actually envisioned under GNEP, and unsurprisingly, this aspect of the proposal has proven to be one of its more controversial elements among such GNEP members as Australia and Canada, its nonproliferation benefits notwithstanding.

**Conclusion**

More than a year has now passed since the report to the Board of Governors. Although the likelihood of successfully implementing a multilateral approach to the nuclear fuel cycle is by no means assured, recent events have indicated that greater progress to this end has already been made than was possible during the 1970s and 1980s. In terms of assurance of supply, however, it appears that the remaining months of 2008 will be indicative of how much the proposed mechanisms will be able to accomplish in practice.

The ultimate goal of the exercise envisioned by the director-general, of all enrichment and reprocessing activities being under multilateral control one day, seems a longer-term prospect to say the least and remains deeply unpalatable to many states for the time being. Although the complementarity of the proposals is often noted, the MESP and NTI ideas (and supported by the enrichment bond principle), hold a vision of an IAEA-administered fuel-cycle center or fuel bank that, of all the proposals that have been refined over the past year, is perhaps the most in keeping with the spirit ElBaradei's long-term vision. If attained, they would serve as an important departure from the traditional approach to enrichment and reprocessing.

Nonetheless, several significant hurdles remain. The sponsors of these proposals currently appear to have the necessary political will to push them forward, although this will not be sufficient without the concomitant political will on the part of other IAEA member states. The momentum that has been generated on fuel assurances and on multilateral approaches to the nuclear fuel cycle cannot be sustained indefinitely. The recent UAE contribution of $10 million to the NTI fuel bank is an encouraging sign, as is the extension of the deadline. The safeguards approach to Angarsk is apparently soon to be agreed, albeit nearly a year later than originally expected. There are
indications that the MESP proposal may soon be put forward for formal discussion.

Still, GNEP is suffering from funding difficulties. The director-general who revived and argued in favor of the new fuel-cycle arrangements will soon head into the final year of his tenure. More than a year has now passed since the June 2007 report to the Board of Governors identified the board as the appropriate forum for the next considerations of the issue. If the board does not take up the discussion soon, whether because sufficient funding has been raised for the fuel bank or on the basis of draft agreements or release criteria suggested by member states, it seems increasingly possible that the project will go the way of those that preceded it, 30 or so years ago.

Fiona Simpson is a research associate at the Center on International Cooperation at New York University. Previously she worked at the Weapons of Mass Destruction Branch of the UN Office for Disarmament Affairs. From 2003 to 2005, she served at the International Atomic Energy Agency in the Office of External Relations and Policy Coordination.

ENDNOTES


3. Mohamed ElBaradei, "Introductory Statement to the Board of Governors," IAEA, March 3, 2008. In March 2008, the director-general stated that he expected the authors of the proposals to initiate the related discussions in the board, much as he himself would undertake to seek board consideration of an IAEA fuel bank when the necessary funds became available.


8. The six countries for which the proposal was named are those six states primarily involved in the supply of enrichment services: France, Germany, the Netherlands, Russia, the United Kingdom, and the United States.


12. IAEA, "Communication Received on 12 September 2006 From the Permanent Mission of Japan to
the Agency Concerning Arrangements for the Assurance of Nuclear Fuel Supply," INFCIRC/683,
September 12, 2006.

13. "Multilateralization of the Nuclear Fuel Cycle: Guarantees of Access to the Peaceful Uses of


release).

16. "UAE Commits $10 Million to Nuclear Fuel Reserve Proposal; September Deadline Extended for

17. IAEA, "Introductory Statement to the Board of Governors," March 3, 2008,

18. GNEP, "GNEP Working Group on Reliable Fuel Services: Terms of Reference," December 12,
2007. The other GNEP international working group was tasked with examining infrastructure
development.


23. "To Ensure Access to Nuclear Fuel Supply and Services: Multilateral Enrichment Sanctuary

24. Rauf and Vovchok, "Fuel for Thought."

International Conference on Nuclear Fuel Supply: Challenges and Opportunities, Berlin, April 17,
2008.

November 2006, pp. 40-44.

Source URL: https://www.armscontrol.org/act/2008_09/Simpson