# Project Vinca: Lessons for Securing Civil Nuclear Material Stockpiles

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By late afternoon the nuclear fuel, containing sufficient highly enriched uranium (HEU) for several nuclear bombs, had been loaded onto a canvas-sided flatbed truck.[2] The technicians and scientists were shepherded into a nearby building.[3] For the next dozen hours, they waited under heavy security, with strict orders not to contact friends or family and perhaps accidentally leak information about the impending transport.[4] Then, in the early morning hours of August 22, 2002, at a time kept secret even from participating American nuclear scientists, the transport operation began.[5] Project Vinca, a multinational, public-private effort to remove nuclear material from a poorly secured Yugoslav research institute, was entering its final phase.

Project Vinca is a compelling story of high-stakes diplomacy involving, in the words of one key official, "three countries, an international organization, a couple U.S. agencies, several institutes in each of the countries involved, [and] a private organization in the U.S."[6] The operation to remove vulnerable nuclear material from the Vinca Institute of Nuclear Sciences outside Belgrade, Yugoslavia, is a nonproliferation success story. But its real impact may be measured in the years to come, because Project Vinca has the potential to inform broader "global cleanout" efforts to address one of the weakest links in the nuclear nonproliferation chain: insufficiently secured civilian nuclear research facilities.[7]

Understanding Project Vinca holds the key to designing an effective program to remove nuclear material stockpiles from the most vulnerable civilian facilities worldwide. The operation illustrates both the challenges and the opportunities faced by any viable cleanout effort. It also helps to explain why efforts to address this urgent threat have made relatively little headway, even after the terrorist attacks of September 11, 2001, on New York and Washington so glaringly exposed the United States's vulnerability to those who wish it ill.

The lessons of Project Vinca fall into four broad categories: international politics, bureaucratic politics, required capabilities, and the role of nongovernmental actors. In the international context, the Vinca case highlights the extent to which dealing with vulnerable nuclear material stockpiles hinges on persuading countries to cooperate and hence requires occasional engagement from the most senior U.S. officials. Within the U.S. government, the inter- and intra-agency friction that hampered the opera-

tion highlights the need for a suitably equipped and empowered lead official and office. The case also makes clear the capabilities that office will require, including the flexibility to negotiate ad hoc compensation packages for countries willing to give up nuclear materials. Finally, Project Vinca illuminates the important role of nongovernmental actors in setting the policy agenda and prodding government to action.

## THE THREAT

Terrorists and proliferant states are actively seeking nuclear weapons.[8] Osama bin Laden has declared the acquisition of weapons of mass destruction (WMD) "a religious duty."[9] A nuclear-armed North Korea or Iran presents profound security headaches, but as more than 50 years of the nuclear age demonstrate, need not be catastrophic. Should Al-Qaeda acquire a nuclear bomb, there will be no negotiations of the sort in which both North Korea and Iran have recently engaged.[10] As the 2002 National Security Strategy of the United States of America correctly states, "We are menaced less by fleets and armies than by catastrophic technologies falling into the hands of the embittered few."[11]

Acquiring nuclear material—either plutonium or HEU—is the greatest hurdle faced by terrorists or pariah states attempting to obtain relatively primitive nuclear weapons. As the former director of the U.S. Lawrence Livermore National Laboratory said in the early 1970s, "The only difficult thing about making a fission bomb of some sort is the preparation of a supply of fissile material of adequate purity; the design of the bomb itself is relatively easy."[12]

The traditional route to acquiring nuclear material—developing an indigenous uranium enrichment or plutonium extraction capability—remains challenging for most potential proliferant states and essentially infeasible for nonstate actors. Even if this hurdle could be overcome, it would be very difficult for a nonstate actor to conceal a uranium enrichment or plutonium extraction operation and difficult, though certainly not impossible, for a state to do so.[13] The processes for constructing a nuclear weapon once fissile material has been acquired, on the other hand, are not only far less technically challenging but also far more readily concealable.[14]

Nuclear fuel that has not been irradiated in reactors—as is the case for much of the material located at vulnerable sites—is minimally radioactive. As a result, it can be stolen without risk of debilitating radiation exposure, does not require cumbersome shielding during transportation, and is difficult to detect. In other words, once stolen, such material is extremely easy to conceal. And extracting bomb-usable material from nuclear fuel requires relatively rudimentary chemistry, well within the capacities of scientists capable of constructing even a primitive nuclear weapon (see p. 5 for a discussion of this issue).

## A DANGEROUS NUCLEAR LEGACY

U.S. policymakers have long been concerned about the global "loose nukes" threat. Significant efforts to address this concern date to the end of the Cold War, when Senators Sam Nunn and Richard Lugar championed Cooperative Threat Reduction (CTR) efforts to address the threat of hemorrhage of former Soviet nuclear weapons, materials, and expertise. Spun off from those early efforts, U.S.-funded Material Protection, Control, and Accounting (MPC&A) programs have consolidated materials and substantially increased security at sites throughout the former Soviet Union. Although much work remains to be done, these efforts deserve credit for substantially decreasing the odds that material sufficient for thousands of nuclear weapons will fall into the wrong hands.[15]

But in the process, civilian nuclear facilities containing relatively small quantities of nuclear material—many outside the former Soviet Union—have fallen low on the list of priorities. Under the compact eventually formalized in the 1970 Nuclear Non-Proliferation Treaty, states that agreed to forswear nuclear weapons were promised assistance in developing civilian nuclear programs.[16] Spurred by widespread enthusiasm for the peaceful potential of nuclear technologies, in the 1950s and 1960s the United States, the Soviet Union, and a few other states exported nuclear research reactors around the globe, many fueled with technologically advantageous but proliferation-risky HEU.

Although some of those reactors have since been decommissioned and have had their fuel returned to its country of origin, many remain in operation or have been shut down but are still in possession of nuclear fuel. Currently more than 130 operating research reactors in more than 40 countries are fueled with HEU.[17] While most of the reactors contain only small amounts of HEU, some contain sufficient material for one or more nuclear weapons.[18] Additional research reactors have been shut down but still contain bomb-usable material.[19] And, according to nonproliferation expert Matthew Bunn, "Most research reactors around the world have very minimal security, both

because they have minimal resources and because they are located in places not conducive to high security, such as university campuses with a tradition of academic openness."[20]

Since obtaining nuclear material is the greatest impediment to constructing a nuclear bomb and such material can relatively easily be smuggled, the best hope for averting the detonation of a nuclear weapon in a metropolitan area is preventing the initial nuclear material theft. And while security upgrades have a critical role to play, only by ensuring that there is nothing left at a site to steal can that threat be entirely eliminated.

## AN INADEQUATE RESPONSE

U.S. policymakers have acknowledged the proliferation threat posed by civilian HEU stockpiles. (Plutonium, a reactor by-product found in bomb-usable quantities in spent fuel stockpiles located at civilian research sites, is a proliferation concern as well, but uranium poses unique challenges because of the global commerce in uranium fuel and the relative ease with which a nuclear weapon can be fashioned out of it.) The United States now has a patchwork of programs that address HEU fuel at civilian research sites.

Current U.S. efforts include converting U.S.-fueled reactors from HEU to low-enriched uranium (LEU) fuel, taking back U.S.-supplied fuel (often operating in tandem with reactor conversion), converting Soviet-fueled reactors, facilitating the transfer of Soviet-supplied fuel back to Russia, and consolidating and reducing the enrichment level of HEU located in Russia. To date, the United States has made substantial progress in dealing with U.S.-origin HEU, although even here much remains to be done.[21] Efforts focused on Soviet-supplied nuclear fuel have been dogged by delays.

The sense of urgency that drove the threat reduction project in the immediate post-Cold War world has faded. The 9/11 terrorist attacks on New York and Washington provided some additional impetus. But despite impressively supportive rhetoric, President George W. Bush and senior administration officials have been lukewarm at best in their support for cooperative efforts to neutralize WMD threats.[22]

But despite half-hearted White House support, threat reduction programs have institutional momentum and benefit from small but influential constituencies in Congress, among the nongovernmental foreign policy elite, and from select political appointees and career government officials. Hence cooperative efforts to address urgent mass destruction threats—including arguably the weakest links in the nonproliferation chain, sites like Vinca—are proceeding, if still far too slowly.

## THE TARGET: THE VINCA INSTITUTE OF NUCLEAR SCIENCES

Located on a substantial campus on the outskirts of Belgrade, the capital of the Serbian portion of what is now the Republic of Serbia and Montenegro (represented in the United Nations as "Yugoslavia"), the Vinca Institute of Nuclear Sciences is "surrounded by orchards, farms, and small villages, one of which the site is named for."[23] Founded in 1948, the scientific institute was Yugoslavia's first nuclear research center. Although the knowledge gleaned from the institute's work would have aided Yugoslavia's nuclear weapons program, its primary purpose was civilian research.[24]

The Vinca Institute housed two nuclear research reactors, referred to as "RA" and "RB." The more primitive "homemade" RB reactor was constructed in 1958, while the primary RA reactor was constructed with Soviet assistance in 1959.[25] Both reactors initially operated on 2 percent-enriched uranium-235 (U-235), or LEU fuel.[26] In 1976, both reactors were converted to 80 percent-enriched, or HEU, fuel, for which the reactors had originally been designed.[27] The RA reactor was mothballed in 1984 because of safety concerns, while the RB reactor remains in operation as of September 2003.[28]

Prior to Project Vinca, the institute housed a range of nuclear materials, including fresh HEU fuel, irradiated HEU and LEU spent fuel, and high- and low-level radioactive waste (see Table 1 for more information). U.S. and Yugoslav nuclear scientists involved in the operation to remove nuclear material from Vinca noted that "in addition to site access controls, physical protection and police guards were provided for each of the reactor buildings; in the last few years, additional upgrades had been implemented for the fresh fuel storage areas of the building."[29]

The fresh HEU fuel was housed in the RA reactor building.[30] Irradiated HEU fuel was stored inside the RA reactor fuel channel and in a spent fuel pool located in the RA reactor complex.[31] Irradiated LEU fuel was also kept in the pool, while both high- and low-level nuclear waste were stored in two sheds on the site.[32]

The site had been on International Atomic Energy Agency (IAEA) officials' radar since 1995, when Yugoslav scientists turned up unannounced and uninvited at a

**TABLE 1**
**NUCLEAR MATERIALS AT THE VINCA INSTITUTE OF NUCLEAR SCIENCES**

| Material | Total Weight | Uranium Enrichment (percent) | Uranium Quantity | Storage Location | Storage Type |
|---|---|---|---|---|---|
| Fresh HEU fuel slugs | ~ 800 kg (5,046 slugs) | 80 | 48.4 kg HEU | RA reactor storage areas[i] | Russian transport casks |
| Irradiated HEU fuel slugs[ii] | ~ 80 kg (480 slugs) | 80 | 4.6 kg HEU | RA reactor channel | Channel containers |
| Irradiated HEU fuel slugs[iii] | ~ 140 kg (884 slugs) | 80 | 8.5 kg HEU | RA reactor spent fuel pool | Channel containers |
| Irradiated LEU fuel slugs[iv] | ~ 3,000 kg (6,656 slugs) | 2 | 2,430 kg LEU | RA reactor spent fuel pool | Channel containers and aluminum barrels |
| High-level nuclear waste | Unknown | N/A | Unknown | Storage shed | 55-gallon drums |
| Low-level nuclear waste | Unknown | N/A | Unknown | Storage shed | Metal containers, cloth bags |

[i] While Vinca director Krunoslav Subotic claims all the material was stored in the RA reactor, Hopwood and his co-authors who worked on Project Vinca claim some of the material was stored in the RB reactor complex. Krunoslav Subotic, written communication with author, September 8, 2003, and William Hopwood, Stanley Moses, Milan Pesic, Obrad Sotic, and Thomas Wander, "Cooperative Efforts for the Removal of High-Enriched Uranium Fresh Fuel from the Vinca Institute of Nuclear Sciences," Presentation to the 44th Annual Meeting of the Institute of Nuclear Materials Management, Phoenix, Arizona, July 13-17, 2003, p. 4.

[ii] The Vinca Institute spent fuel also contains about 6 kg of plutonium, most of that the Pu-239 isotope preferred by weapons designers; International Atomic Energy Agency official (name withheld by request), Vienna, Austria, written communication with author, August 10, 2003. Extracting that plutonium so that it could be used in a nuclear weapon would pose significantly greater technical challenges than removing the HEU from the fresh fuel slugs. Also, note that the enrichment level of the fuel would have been reduced by irradiation; how substantially that has occurred depends on the extent of irradiation, information that was not readily available.

[iii] Ibid.

[iv] Ibid.

Sources: William Hopwood, et al., "Cooperative Efforts "; Nuclear Threat Initiative, "Briefing Paper: Vinca Institute of Nuclear Sciences, Belgrade, Yugoslavia," undated; International Atomic Energy Agency official (name withheld by request), Vienna, Austria, written communications with author, August 10, 2003 and October 29, 2003; and Krunoslav Subotic, director, Vinca Institute of Nuclear Sciences, Belgrade, Yugoslavia, written communication with author, September 8, 2003.

meeting on managing aging nuclear reactors held at a research reactor near Hamburg, Germany.[33] According to an IAEA official, "They gave a presentation and people's mouths dropped open because they talked about a spent fuel problem at Vinca the dimensions of which we had not come across before. It was a horror story."[34] A State Department official concurred with the IAEA assessment that "the spent fuel situation at Vinca was a grim one, and still is," but also noted that "it's not as grim as [the IAEA] originally thought it was."[35]

### "Only" a Few Bombs' Worth

The Vinca Institute possessed "fresh," or unirradiated, nuclear fuel containing just over 48 kilograms (kg) of 80 percent-enriched HEU.[36] That quantity is barely sufficient for one nuclear bomb utilizing the inefficient but relatively simple gun-type design terrorists or low-tech states would likely attempt.[37] On the other hand, a more sophisticated implosion-type bomb design that took advantage of modern nuclear weapons design and engineering innovations could require as little as 5.5 kg of HEU, according to one unclassified estimate.[38] Publicly, the United States announced that the Vinca material was sufficient for two and one-half nuclear bombs, a conservative estimate based on the more sophisticated implosion design.[39]

The HEU was spread over 5,046 fresh fuel slugs located at the facility.[40] Each of those slugs was composed of 10.9 grams of uranium oxide and about 151 grams of aluminum, meaning the total weight of the fuel was more than 800 kg, or nearly a metric ton.[41] Obtaining bomb-usable material from the fuel would have required chemical processing to separate out the uranium. One State Department official recounted discussing possible extraction of the material with a representative of the French nuclear firm Cogema, who termed the effort required "work for monks in a monastery."[42]

But as nonproliferation expert Bunn observed, "Official studies suggest that for terrorists or proliferant states not concerned about safety measures or the profit and loss issues facing a commercial fuel processing firm, recovering this uranium would not be a major obstacle."[43] Bunn noted that "such aluminum-based fuels can be readily dissolved in nitric acid and the uranium can then be readily extracted by either common solvent extraction methods or precipitation from the solution" and cited an Argonnne National Laboratory report that states, "All process chemistry data are in the open literature…separation processes for unirradiated fuel can be carried out by contact methods, using commonly available equipment."[44] It seems prudent to assume that a group or state capable of constructing even a primitive nuclear bomb if supplied with the requisite fissile material would be able to extract the HEU from the Vinca fuel.

In light of the relatively rudimentary but labor intensive processing required, several administration officials argued that those with substantial time and resources and lacking access to weapons-usable fissile material by conventional means—such as terrorist groups—would have found the material attractive.[45]

The fresh HEU fuel at Vinca posed the greatest proliferation threat and was the focus of Project Vinca. But the threat posed by the spent fuel that remains at the site post-Project Vinca should not be discounted. The spent HEU fuel includes 480 slugs containing almost 5 kg of HEU still located in the shut-down RA reactor, in addition to 884 slugs containing an additional 8.5 kg of HEU stored in the spent fuel pool in the RA reactor complex.[46] The enrichment level of that material will have been reduced by its irradiation, increasing the amount of the material that would be required for a nuclear bomb. Given the modest quantity and reduced enrichment level, the material is clearly insufficient for a primitive gun-type or even an inefficient implosion bomb, but is likely sufficient for a more sophisticated implosion weapon.

The irradiation of uranium-238 (U-238), the principle isotope in low-enriched fuel, produces plutonium as a by-product; hence, the Vinca spent fuel also contains approximately 6 kg of plutonium.[47] Plutonium's physical characteristics prevent it from being used in the more primitive gun-type design, and the quantity in the Vinca spent fuel is relatively modest and spread over several tons of spent fuel; hence, the plutonium poses a lesser proliferation risk than does the HEU contained in the fuel.

Spent fuel is also generally considered less a theft risk than fresh fuel because it is protected by a "radiation barrier" that would subject anyone attempting to steal it without sophisticated protective measures to debilitating and ultimately fatal radiation. But according to an IAEA official, "The [spent] fuel is in fact very cool both thermally and radioactively [and] has definitely lost its self-protection."[48] Vinca Institute Director Krunoslav Subotic countered that, although the radioactivity had not been recently measured, the fuel is "certainly highly radioactive."[49] Regardless, as the IAEA official pointed out, "a prospective thief would need to take barrels from 6-7 meters down in the basins and would require a crane with significant capacity"—not an insignificant task even if the radioactivity is minimal.[50]

Obtaining bomb-usable material from spent fuel would also require at least marginally more sophisticated processing, since at least rudimentary measures would be required to protect those undertaking the extraction from debilitating radiation exposure. But for suicidal terrorists, primitive measures like a metal barrier around which they could reach in order to conduct processing might be sufficient to allow the task to be completed before they became incapacitated due to radiation poisoning.

### Who Might Have Been Interested?

Most of the U.S. administration officials interviewed for this paper identified theft by sophisticated terrorist groups as the source of their greatest nonproliferation concern with regard to the material at Vinca.[51] The terrorist attacks of 9/11 on New York and Washington were frequently cited as illustrative of a new and more menacing terrorist threat against the United States that could include WMD attacks.[52]

Proliferant states were also cited as possible consumers. One State Department official argued that countries like Iraq or Iran might "potentially" be interested, but noted, "The question is whether you judge that they have other sources of HEU or not."[53] There is a relevant precedent here: Iraq's crash program to rapidly assemble a single nuclear weapon after it invaded Kuwait was based on using both fresh and irradiated HEU from its research reactors, which would have required only modest processing easily within the country's capabilities.[54] And according to a State Department official, "There's no doubt the Milosevic regime had lots of ties to Iraq. [The regime] had a lot of bad guys and a lot of them are still around. Certainly you've got to see that there is a threat."[55] According to an IAEA official,

> There were those of us, including the people in [the Department of] Safeguards, who worried about the political situation there. And one or other of the warring parties or the government itself getting hold of that fuel and either transferring it to a rogue state or trying to do something with it themselves. The latter was probably unlikely because they'd run down both the staff and equipment at Vinca. I think the worry was that somebody might have come in and taken that fuel and offered it to a Saddam Hussein or somebody else…that was a worry, I think, always.[56]

The internal proliferation threat was given the least emphasis by U.S. officials. This despite the fact that Yugoslavia had an active nuclear weapons program until the mid-1980s, maintained a broad-based technical infrastructure capable of supporting a weapons program, and was until recently governed by a leader overtly hostile to the United States.[57] William Potter, director of the nongovernmental Center for Nonproliferation Studies and an avid student of Yugoslav nuclear history, suggested that the low salience of the internal proliferation threat stemmed in large part from ignorance about the Yugoslav nuclear weapons program he has sought to document.[58]

### How Vulnerable Was Vinca's Nuclear Material?

A site like Vinca could have faced three basic types of proliferation-related security threats: theft by a knowledgeable insider, an outsider assault, and diversion by governmentally sanctioned elements.

Underpaid site workers could have been tempted by the substantial sums a terrorist or proliferant state would presumably have been willing to pay for clandestine access to nuclear material. According to the IAEA official, in the mid- to late-1990s the Vinca Institute director had actually allowed underpaid workers to clock in and then immediately leave the site to work second jobs in order to support their families.[59]

Theft by a knowledgeable insider might have been complicated by the fact that the materials were only rarely accessed for occasional experiments after the mothballing of the main research reactor. Then again, this situation could have facilitated theft, since a breech in security might have been less quickly detected.

Obtaining a bomb-usable quantity of material would have required the theft of thousands of individual fuel elements weighing a total of hundreds of kilograms—a large-scale and risky effort. Vinca Institute Director Subotic called such an attempt "quite a hard task," but in a nod to international sentiment, noted that in the aftermath of the 9/11 terrorist attacks, "we…cannot exclude the possibility."[60]

Sources familiar with the site noted the apparent lack of radiation and even metal detectors.[61] The IAEA did recently collaborate with Vinca officials to implement basic security upgrades, such as a steel storage cage that would have prevented a relatively casual effort at diversion.[62] Institute director Subotic responded that "some kind of sensors are in the relevant places," and that as a result, nuclear materials "above some level of radioactivity cannot be smuggled."[63] Hence a major theft would require "brute force," Subotic argued.[64] Whether the sensors described by Subotic were sufficiently sophisticated to detect minimally radioactive fresh HEU fuel is unclear.

The small number of armed guards assigned to Vinca could have been overcome relatively easily by a small group of armed intruders, but would almost certainly have been able to call for outside reinforcement. Given Vinca's location in the vicinity of Belgrade, such reinforcement could have arrived relatively quickly, but armed intruders familiar with both the site and the nuclear material storage arrangements could conceivably have operated with sufficient speed to remove nuclear materials before those reinforcements arrived.

Finally, formally sanctioned diversion would by definition circumvent existing security measures and could conceivably be kept secret for as long as a month, the time interval between IAEA inspections.

Although all the U.S. administration officials interviewed for this report acknowledged that Vinca posed a proliferation threat, several sought to downplay that threat, particularly relative to what they characterized as breathless press accounts. As one State Department official said, "I tend not to see these things as somehow urgent. You know, the fact that you hear intelligence reports that the Iranians are sniffing around this place, et cetera, et cetera…I've been [in government] long enough to be skeptical when I hear those things."[65] Suggesting a motive, the official said "It's exaggerated for political purposes. But the political purposes are things we all agree with. That is, everyone agrees that it's a very good idea to gather up as much of this stuff as we can and consolidate it in secure places."[66]

### Early Efforts Unsuccessful

The vulnerable nuclear material at the Vinca Institute was the subject of discussions in the Clinton administration. A Defense Department participant in the 1994 Project Sapphire effort to remove almost 600 kg of HEU from Kazakhstan reported learning about the existence of nuclear weapons-usable material at Vinca in late 1994 or early 1995.[67] Rose Gottemoeller, who was responsible for Department of Energy (DOE) nuclear nonproliferation efforts in the latter half of the Clinton administration, indicated, "We…understood that there was some fresh fuel stored there and we were concerned that that could fairly readily fall into terrorist hands…that was the crux of the concerns."[68] But according to Gottemoeller,

> We couldn't take it to the United States because that had turned into such a heavy lift with regard to [the 1994 Project] Sapphire [and] there was a lot of interagency strife over implementing [the 1998 Operation] Auburn Endeavor [and] a lot of political noise that affected Tony Blair after the British agreed to take the material…so there was a feeling that we couldn't go back to that well again.[69]

As a result, Gottemoeller said administration officials focused on returning the material to Russia, the source of the Vinca fuel.[70] According to Gottemoeller,

> We did try fairly vigorously to work it with the Russians…the reason we didn't get the project off the ground during the Clinton administration was because…the Russians were not prepared to move forward. They argued that they did not yet have the national legislation in place that would provide the legal basis for them to accept the material.[71]

Gottemoeller did recall administration efforts to avoid inadvertently targeting the site during the NATO bombing campaign against the Milosevic regime.[72]

Nonproliferation expert Potter devoted considerable energy to lobbying Clinton administration officials, including Gottemoeller, to address the Vinca material.[73] Most notably, Potter attempted to persuade officials to include the issue in negotiations at the end of the NATO campaign in Yugoslavia.[74] One senior Clinton administration official memorably left a message with Potter's assistant saying, "If you think that the administration would burden the current negotiations over Kosovo with this additional element, you must be smoking something strong."[75]

Potter suggested that blame for the failure to address the Vinca material during the Clinton administration did not reside entirely with the Russians, an interpretation buttressed by the fact that senior Russian officials have been on record for years expressing interest in dealing with the proliferation-vulnerable material at the Vinca site.[76] Potter argued that efforts to address Vinca were hampered by State Department reluctance at that time to deal with individual sites absent agreement with the Russians on repatriating all proliferation-vulnerable Soviet-origin nuclear fuel, including both fresh and spent material.[77]

Efforts to secure such a broad-based commitment from Russia realized some progress in the final years of the Clinton administration. In 1999, the United States, Russia, and the IAEA began discussions intended to secure broad-based agreement from Russia under a "Tripartite Initiative," so-named to distinguish it from the Trilateral Initiative under which the three parties are working to verify stockpiles of weapons-origin fissile material. A State Department official characterized the initiative as

> A broader dialogue going on about bringing all of the HEU back from these Russian-built reactors to Russia for downblending and/or safe storage. And that has been a negotiation that's been going on for some years and it's been stuck over a number of issues, including cost.[78]

An IAEA official observed that part of the problem stemmed from the fact that "we're three different legs of a tripod with three different reasons for being involved. The U.S. reason is mainly nonproliferation. Ours is mainly safety. And the Russians' is mainly to make money."[79]

Notably, as this article was going to press, U.S. Energy Secretary Spencer Abraham indicated that Washington and Moscow were "on the brink" of finalizing the Tripartite Initiative agreement.[80] And on September 21, 2003, the United States funded an operation to remove fresh fuel containing 14 kg of HEU from a Romanian research reactor, heralded by U.S. officials as the first operation under the nascent agreement.[81]

## MOBILIZING TO ADDRESS A NONPROLIFERATION THREAT

Although the United States had been interested in addressing the proliferation threat posed by Vinca during the 1990s, by mid-2001 those efforts remained effectively stalled. As one State Department official noted, "I spent a lot of time [during the late 1990s] just talking to people here in the department about this situation and trying to figure out if there's anything we can do about it."[82] But echoing statements made by several other officials, he added,

> At the same time, as long as the Yugoslav government was the kind of government it was, and as long as the situation was the way it was, there really was no way to make an approach. And the last thing people wanted to do was give Milosevic a bargaining chip. So we basically did nothing until he was handed over. And then the new people who came in were very anxious to work with us. Actually, after that things went quite quickly.[83]

### A Window of Opportunity

Another State Department official concurred, saying, "I think it was maybe not so much the threat that drove things quickly, but it was seen to be a window of opportunity. And you never know how long that opportunity is going to be there."[84] Every one of the interviewed State Department officials highlighted this perceived window of opportunity as the biggest driver for the operation.[85] ("Quite quickly" begs qualification, because actually removing the material required another year of difficult international and intra- and interagency negotiations.)

Milosevic, who had conceded electoral defeat and stepped down in October 2000, was taken into Serb police custody in April 2001. Around that time Debra Cagan, a "troubleshooter" covering nonproliferation, arms control, and political-military affairs as director of the Office of Policy and Regional Affairs in the State Department's Bureau of European and Eurasian Affairs, began work on a broad diplomatic package to engage the newly cooperative Yugoslavia.[86] Addressing the weapons-usable nuclear material at Vinca was a key part of that package.[87] As a State Department official noted,

> My sense is that the European bureau believed that there was an opportunity to do something with the Federal Republic of Yugoslavia on this, and that you had this stuff there in a somewhat vulnerable situation in a fairly politically unstable environment and therefore that that would give this a fairly high priority. And so they put forward a proposal and were able to convince people that yes, indeed, for a variety of reasons this ought to have sufficient priority that we move ahead quickly with this.[88]

### Bureaucratic Politics

All of the State Department officials involved in the day-to-day implementation of Project Vinca emphasized the conscious effort to keep the team small and focused on the task at hand.[89] As a result, a core group of three State Department officials ultimately planned and implemented the operation with occasional firepower from superiors and intermittent reliance on embassy staff and other relevant officials.

Cagan conceived the operation in the spring of 2001 and oversaw it throughout. According to one State Department official, "Her office initiated the proposal, and Debra's kind of a forceful person, and so she was pushing it forward and trying to make it happen quickly."[90] William Severe, who Cagan had transferred to her department in winter 2002 specifically to work on Project Vinca, served in a critical day-to-day management and coordinating capacity. Allan Krass, a nuclear energy expert in the department's Nonproliferation Bureau, who serves as the State Department's primary liaison to the U.S.-Russian-IAEA "Tripartite Initiative" negotiations to address Soviet-origin HEU fuel, served as technical advisor.

In the spring of 2001, Cagan approached Steven Saboe, director of the State Department's Nonproliferation and Disarmament Fund (NDF). Established in the aftermath of the 1994 Project Sapphire operation to remove almost 600 kg of HEU from a vulnerable site in Kazakhstan,

> [NDF] is a sharply focused fund to permit rapid response to unanticipated (or unusually difficult), high priority requirements/opportunities to halt the proliferation of nuclear, biological, or chemical weapons, their delivery systems, and related materials; destroy or neutralize existing weapons of mass destruction, their delivery systems, and related sensitive materials; and limit the spread of advanced conventional weapons and their delivery systems.[91]

One of its unique characteristics is that, under the fund's authorizing language, it may act without being constrained by "any other provision of law."[92] This language allows the fund to operate in countries subject to sanctions or in contravention of environmental regulations, for example. This tremendous potential freedom of action is controlled through extensive, high-level oversight by a review panel composed of four assistant secretaries, and officials emphasized that in practice the "notwithstanding" authority is rarely used.[93] But at the time of Project Vinca, Yugoslavia was still under sanctions, so the ability to circumvent those sanctions, if necessary, was almost certainly a factor in Cagan's decision to approach the fund. Also, Vinca

was clearly well-suited to the fund's core nonproliferation objectives.

Cagan and Saboe ultimately coordinated on broader strategic issues. Saboe raised the prospective operation before his review panel in May 2001 and received approval the following month.[94] Ray Smith, an NDF negotiator, came on board as chief of delegation for the detailed negotiations required to hammer out the relevant agreements and, together with Severe and Krass, formed the team responsible for day-to-day implementation of the effort.

Early on, Cagan obtained the support of Deputy Secretary of State Richard Armitage.[95] Armitage subsequently briefed National Security Advisor Condoleezza Rice on the effort in fall 2001 and obtained her support.[96] According to Nuclear Threat Initiative (NTI) Vice President for Russia/NIS Programs Laura Holgate, the organization's liaison to Project Vinca, Cagan's ability to point to Rice's support helped her to overcome resistance within the State Department, particularly when she later relied on an unconventional and controversial tactic by bringing the nongovernmental NTI into the deal.[97]

Cagan's decision to remove Vinca from ongoing efforts to address the broader problem of returning Soviet-era fuel to Russia under the Tripartite Initiative and effectively to freeze out the Energy Department officials who had been engaged in those efforts was highly controversial. Those Energy Department officials declined to be interviewed for this article, but according to nongovernmental experts familiar with the interagency dynamics, both Energy Department and IAEA officials resented being sidelined on an operation to address a site they had put considerable work into and with whose personnel they had developed strong working relationships.[98]

One State Department official involved with the operation explained the decision:

> The feeling was…without prejudice to those ongoing discussions, that this stuff, because of its location, political instability in the region, and that sort of thing, was of sufficient urgency that we ought to break that out and use the Nonproliferation and Disarmament Fund to make that happen.[99]

Another official emphasized speed as the primary motivation, saying, "The nature of the program and the politics involved made it inevitable that this be done [in the European bureau]," in large part "to get the pace to go faster."[100] The crucial accelerating factor appears to have been the decision by State Department officials to go ahead with Vinca absent Russian agreement to address the broader set of vulnerable sites.

The decision to pursue a relatively low-profile effort manifested itself in various ways. State Department officials located at the U.S. embassy in Belgrade were regularly used in place of outside negotiating teams.[101] Interagency negotiations were minimized by keeping the effort in house at the State Department as much as possible.[102] The Energy Department did have a role to play, but was effectively kept out of the operational planning loop.[103] And unlike previous similar operations, the Defense Department played no role at all, which two State Department officials emphasized was key to achieving the low profile operation they desired.[104] The decision to avoid the interagency process as much as possible appears to have been informed by the complex and time-consuming interagency efforts required to implement the 1994 Sapphire and 1998 Auburn Endeavor operations.[105]

But the low-profile, streamlined management structure was intended for more than just speed. Officials prided themselves on their ability to keep the operation quiet. As one official noted, "[We] picked people who can keep their mouths shut."[106] Proliferation concerns at least partially motivated this, as Potter has documented was the case in the 1994 Project Sapphire operation to remove nuclear material from Kazakhstan.[107] But political concerns were at least as much a factor—there was concern that if Project Vinca prematurely became public, it could become embroiled in controversy in Yugoslavia and might never be completed.[108]

## PUTTING A PRICE TAG ON NONPROLIFERATION

The issue of compensation has long been a sticking point in efforts to secure vulnerable civilian nuclear material stockpiles. Noting that "[the compensation issue] is the thing that makes us most nervous as we go into each of these deals," one State Department official indicated, "We don't want to establish the idea that this stuff has market value."[109] In fact, as another State Department official noted, "We tell [countries] honestly…fresh fuel…has real negative value to you, because it's something you have to provide adequate physical protection for…this costs money."[110] Holgate, on the other hand, pointed out,

> In addition to whatever scientific or monetary value this material has, it is also performing, in a perverse kind of way, a prestige role for the institute or the individuals associated with it…By having this material at their facility, institute directors and scientists get to play in a different arena than they otherwise would. And that is a privilege or set of relationships they are loathe to

> abandon. Therefore the process of abandoning them requires some ability to provide for other things on their hierarchy of needs.[111]

State Department officials acknowledged Holgate's point. As one State Department official involved with the operation noted, "We've obviously established that we are willing to do something along the lines of some kind of 'compensation' for the 'value' of this material… what we're doing is somehow or another buying it from them."[112]

As was done in the 1994 Project Sapphire and the 1998 Operation Auburn Endeavor, State Department officials ultimately decided to offer payment roughly equivalent to the "market value" of the HEU contained in the Vinca fuel.[113] The $700,000 sum allocated for the fuel (plus an additional $20,000 added late in the negotiations to cover transport costs) was "all we could…justify without risking charges of bribery or payoffs," a State Department official indicated.[114] This despite the fact that extraction of the HEU from the aluminum fuel elements was sufficiently costly to make the fuel essentially worthless—illustrated by the fact that while the market value of the HEU contained in the fuel was deemed to be $700,000, the United States ultimately agreed to pay Russia about $1.3 million to extract the uranium from the aluminum fuel elements and blend it down to LEU.

A State Department official indicated that the sum was ultimately written into the contract as intended "to cover packaging of the material, expenses related to removal… because we didn't want to establish a precedent."[115]

### Yugoslavs Want a Package Deal

But even in the early stages of work on Project Vinca, it was clear that simple compensation for the nuclear material was unlikely to suffice. In fact, the broader outlines of Yugoslavia's demands were already relatively clear before negotiations began. According to Holgate, during a fact-finding visit to the Vinca Institute conducted under the Tripartite Initiative shortly after commencement of those talks in 1999, Energy and State Department experts had discussed "the notion of removing the material with the Yugoslavs."[116] Yugoslav officials "made their point clear at that time that they weren't prepared to address the fresh fuel problem independently of the spent fuel problem."[117] As one State Department official put it,

> "[Serbian Minister for Science, Technology, and Development Dragan] Domazet's intent from the beginning was to try to get a package deal in which they would be paid for this HEU, which he said that they felt was a strategic and very valuable resource of the Serbian government, and that he could not give it up without getting something substantial in return."[118]

Another U.S. government official observed, "The Serbs were adamant about dealing with the spent fuel problem" and ultimately "[used] the fresh fuel as leverage to try to get attention to the spent fuel issue."[119]

But according to a State Department official, dealing with the spent fuel was "way beyond our mandate."[120] (In the aftermath of Project Vinca, that assertion has proven controversial, with State Department officials arguing they could have funded the effort—see An Ongoing Dispute, p. 16, for further discussion.) If Project Vinca was going to proceed, officials were going to have to find another way to sweeten the deal for the Yugoslavs.

### An Unconventional Tactic: Bringing NTI on Board

In order to break the anticipated stalemate with Yugoslavia, Debra Cagan resorted to an unconventional tactic by bringing the nongovernmental NTI on board. Founded by media magnate Ted Turner and former Senator Sam Nunn in January 2001, NTI's mission is to reduce nuclear, biological, and chemical threats by raising public awareness, catalyzing new thinking, and taking direct action.[121]

Vinca was already on NTI's radar; the site "was identified even in the scoping study that preceded NTI as a candidate facility," according to Holgate.[122] She explains that, "We identified even before NTI was set up that the material at Vinca posed a threat, it was clearly not being addressed by the U.S. government…it was part of the example of how a private organization can make a difference in this area." NTI President Charles Curtis also emphasized that Vinca fit the "advocacy plus action" role the organization had been established to implement.[123]

NTI had actually considered trying to address Vinca directly. As Holgate observed, the problem was "small enough in its character that it's the kind of thing that an NGO can do."[124] As a result, Holgate said, "I had a very preliminary conversation with a commercial firm about them going and doing a scoping study just to go look, what is the material, does it have commercial value, is there a commercial deal here to be done, legitimate of course, under IAEA safeguards."[125] Holgate mentioned her interest and efforts to government officials, "and before I knew it I had Debra Cagan on the phone saying, 'stay the hell away from Vinca, we've got a plan…' So we ceased and desisted with our conversations about Vinca."[126]

But in July 2001, Cagan contacted Holgate again. In light of NTI's previous interest in addressing the Vinca

situation, Cagan asked the organization to consider contributing $5 million to address spent fuel remediation at the Vinca site.[127] Cagan explained that "now that the government of Yugoslavia has handed over Milosevic we want to demonstrate to them the value of a good relationship with the United States."[128] She described "a package of activities that could support an improved relationship on substance…an agenda for U.S.-Yugoslav cooperation [with] this Vinca issue in the middle of the package."[129] Cagan told Holgate, "The deputy foreign minister of Yugoslavia is coming to Washington for the first big post-Milosevic meeting; I want to present him a package. I need to have your commitment that you can be a part of that package. And I need that in a week."[130]

According to an IAEA official, "Five million…won't solve the spent fuel problem; it couldn't solve the decommissioning on its own, and probably couldn't even solve the waste management problem on its own."[131] But it was a sufficient sum to make substantial progress on beginning to address the spent fuel problem. State Department officials characterized it as Cagan's assessment of "what it would take" to obtain Yugoslav agreement.[132]

According to a State Department official, Cagan identified NTI both because of its ability and expressed interest in addressing the Vinca material and because of the speed with which the organization could authorize funds.[133] Holgate's initial response was to seek "a robust answer to why the government can't do this itself."[134] Cagan convinced Holgate that "the problem was that the material that needed our attention did not in and of itself pose a WMD threat, and every pocket of assistance designed to address this issue is designed to address material, individuals, facilities from which you can make weapons."[135]

Having been persuaded that the U.S. government was unable to fund activities related to the spent fuel cleanup, NTI rapidly convened a teleconference of its Executive Committee of the Board of Directors, composed of NTI founders Turner and Nunn and President Curtis.[136] According to NTI staff, Turner's first question was, "Why can't the government pay for this?"[137] After Nunn explained the situation, Turner, persuaded, expressed support for the project.[138]

But the functional side of the State Department under Undersecretary of State John Bolton was reluctant to have NTI involved.[139] So Cagan ultimately had to appeal to Deputy Secretary of State Richard Armitage to get approval for her unconventional approach. According to Holgate, "[Cagan] persuaded her colleagues on the functional side and her bosses up to Armitage that this novel thing would work."[140]

## NEGOTIATING THE DEAL

In early August 2001, State Department officials began a multi-pronged effort to raise their interest in dealing with the Vinca situation with Yugoslav counterparts. After NTI had been approached and had agreed to participate in late July, Assistant Secretary of State for Europe and Eurasia A. Elizabeth Jones presented a rough package deal, including the possibility of NTI funds, to Deputy Yugoslav Prime Minister Miroljub Labus in early August 2001.[141] (At a meeting on debt relief earlier the same day, Secretary of State Colin Powell had already broached the subject with Labus.[142]) Both Cagan and Saboe also met with the minister at that time to discuss the effort.[143] And the U.S. ambassador to Yugoslavia, William Montgomery, engaged with the Serb and Yugoslav governments.[144]

At around the same time, Cagan made initial overtures to the Russian government.[145] Russia's lack of cooperation had stymied previous efforts to deal with Soviet-origin HEU, so bringing Moscow on board early was crucial to a successful effort. According to a State Department official, "We did go and talk to the people in Yugoslavia [and] at Vinca first, and we got the feeling that we could make some deal work. After that we approached the Russians. Our feeling, initially, was that the hardest part of the deal might be to make it work with the Russians because they can be difficult."[146]

According to the official, the strategy "was to get a reasonably high-level Minatom official to sign on to the thing."[147] Cagan contacted Mikhail Ryzhov, then responsible for foreign affairs at the Russian Ministry of Atomic Energy (Minatom).[148] The two had a pre-existing professional relationship developed in the early 1990s during negotiations over transparency for a U.S.-Russian agreement under which Russian weapons-origin HEU is blended down to LEU fuel for commercial power reactors.[149] According to a State Department official, Ryzhov "saw [the Vinca operation] as something that should happen."[150]

Several State Department officials emphasized the remarkable degree of cooperation ultimately provided by the various Russian parties to Project Vinca.[151] One official speculated that "there might have been a little bit of a post-9/11 thing going on there, a desire to cooperate in meeting a potential terrorist threat."[152] Another posited that "they were a little worried about the long-term security [of the Vinca material], too."[153]

A third official speculated that the Russians may have been hoping "to establish the legitimacy" of such shipments and "saw [Vinca] as maybe politically useful."[154] As another official put it, "By bringing back the research

reactor fuel which is theirs they can help at least establish the precedents and within Russia potentially be able to make the power reactor return work someday."[155] (Russia has long sought to become an importer of spent power reactor fuel, which could earn the country substantial hard currency, and in 2001 passed legislation allowing such imports.[156]) Finally, an official noted that Russia does receive financial compensation for its cooperation.[157]

Regardless of its motivation, the high-level support Cagan was able to secure was ultimately critical to implementing officials' efforts to engage directly with two semi-autonomous Minatom institutes and thereby build Russian constituencies for the operation.

But the response from the Yugoslav and Serbian governments to the initial proposal was mixed, and in the aftermath of the 9/11 terrorist attacks, as Cagan focused on issues related to the run-up to the war in Afghanistan, Project Vinca stalled.[158] During this time, Senator Nunn called Armitage twice to keep the issue on his radar, arguing that the threat the 9/11 attacks exposed made dealing with the vulnerable Vinca material more, not less, urgent.[159]

### Formal Negotiations Begin and Quickly Stall

After several months of little activity, negotiations began in earnest in February 2002. Meeting with Serb Science Minister Domazet in February 2002, NDF negotiator Raymond Smith and technical advisor Allan Krass offered $700,000 for the fresh fuel.[160] According to one State Department official,

> We knew about the NTI money from the time the NTI board approved it, but we were under strict instruction not to discuss it with the Serbs. There was strong pressure from some corners of the State Department to avoid involving NTI if at all possible, and NTI was instructed not to discuss money with the Serbs until State gave the green light.[161]

But Yugoslav officials had been presented with a package that included NTI funds for spent fuel remediation the previous August and continued to expect a substantial quid pro quo for agreeing to remove the fresh fuel about which the U.S. government was concerned. According to a State Department official,

> Now, the NDF, this went way beyond our mandate. And we had instructions as we went out there that we weren't to negotiate a package deal. That we were there to get rid of some HEU that represented a proliferation threat and that we didn't have the funds or the authority to use for these other purposes that [Domazet] was interested in. So that was the crux of the negotiating problem with them. And Domazet really negotiated very hard, and he was very tough on this, he said he just had to have a package or he couldn't take it to his bosses and expect approval.[162]

After two days of essentially fruitless negotiation, the nonproliferation officials departed Belgrade. Just as substantive negotiations on Project Vinca were finally getting under way, they appeared to stall.

### NTI Breaks the Stalemate

At around this time, Holgate, who was then in Moscow discussing unrelated nonproliferation efforts, received a call from the U.S. embassy in Belgrade.[163] Officials asked her to explain NTI and its role in the deal in a telephone conversation with Domazet.[164] Holgate argued that this sort of sensitive discussion was poorly suited to a telephone exchange and offered to visit Belgrade on her way back to the United States.[165]

Days after the nonproliferation representatives had departed, Holgate, accompanied by Bill Severe, met with Domazet.[166] Having Holgate at the table pledging NTI's support provided the necessary impetus to jumpstart the stalled negotiations. According to a State Department official,

> When [the nonproliferation representatives] failed to even start a negotiation in February, and we managed to close a deal the next Monday with NTI present, we were able to get support from [Deputy Secretary of State Richard] Armitage to keep Bolton out of the picture.[167]

Holgate characterized the outcome of those initial negotiations as "agreement in principle."[168] But Domazet still wanted explicit linkage between the fresh fuel removal and the NTI funding for spent fuel efforts, fearing that without a clear-cut agreement he might lose the leverage provided by the fresh fuel without being able to count on spent fuel remediation commitments being filled. The U.S. government was unwilling to explicitly link the NTI funds with its own fresh fuel removal. As one State Department official indicated, "Issues involving movement of HEU, from the State Department's point of view, don't belong in the hands of a private organization, however well intentioned it is…linking [NTI] as part of the deal…there was just a feeling among people here that that wasn't an appropriate role."[169] So officials attempted a compromise approach. According to Holgate,

> The challenge [was] sequencing paper that the [Yugoslav] proponents of this idea could use to demonstrate to those they would have to convince, including not just neutral parties but opponents, that they had a paper from the U.S. government that talked about taking the [valuable] stuff away, and they had a paper from

> NTI that talked about what they would get to deal with the spent fuel. And every time they had a new decision they wanted parallel pieces of paper. [170]

However, as said by Holgate, "This did not turn out to be possible in every case."[171] Domazet eventually agreed to a more informal process where roughly parallel agreements were negotiated between the U.S. government and Yugoslavia on one hand and NTI and Yugoslavia on the other.[172] Parallel sets of agreements facilitated informal linkage of the U.S.-Yugoslav and NTI-Yugoslav agreements, but also required cumbersome multi-party negotiations at every stage of the process.

### The IAEA Engages as a Funding Conduit

After obtaining preliminary agreement from Yugoslavia, NTI began assessing how it would contract for the spent fuel remediation, reactor decommissioning, and radioactive waste storage upgrades, toward which it had agreed to contribute $5 million.[173] As Holgate noted, "Our challenge was to be sure that at the end of five million dollars, there was something to show for it."[174] But Holgate recounted that "the more we looked into it the more we thought, this is a really big, complex thing, we don't have the expertise here at NTI to manage it and the liability issues start to become very strong."[175]

After investigating the options of contracting with private firms and offering the State Department the funds to be spent by the U.S. government—an offer that was declined—NTI decided to approach the IAEA as an implementing agent.[176] Holgate explained that "the IAEA would actually execute these projects because IAEA has nuclear safety experts, they know how to let contracts and manage projects…they have a liability agreement in place."[177] NTI President Charles Curtis noted that the IAEA also provided accountability for NTI's contribution.[178]

Working through the IAEA was facilitated, both formally and informally, by a preexisting NTI relationship with the organization. NTI had previously provided funding for the agency's physical protection efforts.[179] As a result, as NTI President Charles Curtis observed, NTI could leverage institutional goodwill at the IAEA.[180] Also, that effort had established the precedent of nongovernmental funding for the agency, previously barred because of concerns about private actors having undue influence.[181]

But the Yugoslavs were initially reluctant to work with the IAEA. According to Holgate, Domazet said, "We have a really bad experience with the UN agencies here…they come in here, they lease the best houses, they drive around in white fancy cars, jeeps or whatever, and we've still got buildings that are crumbling and people that aren't being fed and we're still having our disaster."[182] Holgate observed, "[Domazet] doesn't know the IAEA from anybody. They're thinking of the UN development program."[183]

Holgate was eventually able to convince Domazet. Vinca Institute scientists played a role as well, since they had extensive experience cooperating with the IAEA, including previous efforts to address the most critical spent fuel threats.[184] Agreement was facilitated by an IAEA commitment to rely on institute staff and procure materials locally where possible, although in practice an IAEA official indicated the organization subsequently had only limited success in fulfilling that pledge.[185] Sweetening the deal for Yugoslavia, the IAEA also offered to supplement the NTI contribution with approximately $2 million of its own funds.[186]

### Businesslike Negotiations with Russian Institutes

In May and again in June 2002, lead negotiator Ray Smith traveled to Moscow for negotiations with two Russian institutes that ultimately agreed to transport, process, and downblend the uranium under contract with the U.S. government. A State Department official characterized these negotiations as "businesslike," saying, "basically these negotiations involved setting an appropriate level of costs for the sets of deliverables…there weren't any issues of principle."[187]

The Secure Transport of Nuclear Materials (STNM) institute had recently been set up by Russia's Ministry of Atomic Energy to provide transport for unirradiated nuclear fuel. According to a State Department official, "The Institute for the Safe Transport of Nuclear Materials was a fairly new institute and I think they were looking for things to do that would earn them some hard currency."[188] STNM was ultimately allocated $425,000 to cover transport cask rental and the transport flight from Belgrade to Dmitrovgrad, and received an additional $42,000 for longer-than-expected cask use.

Project Vinca scored a coup when a preexisting Energy Department effort, the Materials Consolidation and Conversion (MCC) program to consolidate and blend down Russian nonweapons-origin HEU, was integrated into the effort. According to a U.S. government official, program director Tom Wander learned about Project Vinca in April 2002 after Russia had decided it would send the Vinca material to the Russian Institute of Atomic Reactors (RIAR) site in Dmitrovgrad, one of two sites where the

MCC program operated.[189] Wander contacted State Department officials working on the project, who were "quite receptive" to the program's incorporation into the Project Vinca effort.[190] According to the official, in prior negotiations the Russian side had asked for "much higher" compensation than the going rate under the MCC program, so its incorporation saved the U.S. government money.[191] According to one State Department official, incorporating the MCC program

> had several advantages from our point of view. It meant that those were funds that NDF didn't have to expend for that purpose. And it also meant that you were at an institute where there was already a process and a program in place with DOE oversight and some security enhancements and that sort of thing. So it was a very good cooperative relationship with that program.[192]

Another State Department official noted, "That's not something you always get, such a positive interaction between a DOE program and a Department of State program" and a third characterized the cooperation as "remarkable."[193] The State Department ultimately compensated RIAR $912,000 for separating the HEU from the aluminum fuel elements, and the Energy Department agreed to compensate the institute approximately $400,000 to blend the material down to a level below 20 percent.[194]

Even after compensation issues had been worked out, both Russian institutes remained engaged in negotiations because the operation ultimately required complex contractual arrangements between the various parties.

### Negotiations Go Down to the Wire

Final negotiations were conducted in July 2002 with representatives from the State Department, the U.S. embassy in Belgrade, the IAEA, NTI, and STNM present.[195] U.S. officials were eager to move the material the following month, and negotiations intensified toward the middle of July.[196] According to one non-U.S. participant, the negotiations

> [became] fairly aggressive and fairly confrontational…the implication was, you get this stuff on the way next month otherwise other U.S. aid is not going to be forthcoming…It was rather pushy. And the guy, Domazet, was clearly a little bit nervous. And they were asking him to immediately phone his prime minister, which he was reluctant to do but did do in the end.[197]

With Yugoslav officials still reluctant, Bertram Braun, a U.S. official at the embassy in Belgrade, arranged a last minute concession: The United States would organize an international donors' conference to help Vinca fund the spent fuel and nuclear waste cleanup, expected to require far more than the funds NTI and the IAEA had pledged to provide.[198] The embassy also agreed to facilitate visits to the United States by Vinca scientists, who were seeking new activities to replace the research reactor work that would conclusively end once the reactor fuel was removed.[199]

On July 15, negotiations extended into the evening, with the final agreement hammered out at a restaurant over what had been planned as a celebratory post-negotiation dinner and the final draft edited on the restaurant owner's computer, according to one participant.[200]

## A Successful Operation

Following months of complex negotiation, the operation to remove the material was conducted in a few short weeks with no major complications. Scientists from the Energy Department's Oak Ridge nuclear laboratory observed, advised, and documented "all phases of the operation, from initial container opening through liftoff of the cargo plane with the material."[201] Two IAEA safeguards inspectors oversaw the process, from opening the storage containers through reviewing records, analyzing the fissile material content of the fuel, and sealing the shipping containers with tamper indicating devices.[202]

Although Vinca scientists had conducted preparatory activities, the actual packaging effort began after the shipping containers arrived by aircraft at the Belgrade Airport and were delivered to the Vinca Institute August 14.[203] The packaging operation, originally intended to take five days but completed in 20 hours over the course of two successive days beginning August 15, was performed by a multidisciplinary team of Vinca scientists.[204] To reduce the risk of theft, the material was handled only in multiple-individual operations, all egress points from the building were controlled by guards, and a metal detector was installed at the entry point to the work area.[205]

On August 17, Serbian customs officials visited the site, reviewed records and containers, and applied lead seals.[206] The transport aircraft returned to the Belgrade airport August 21 and that afternoon the HEU fuel containers were loaded onto the transport truck.[207] After loading was completed in late afternoon, the truck was moved to a restricted location on the site and remained under protection of a substantial guard force.[208] The Vinca staff and American and Russian observers remained on site in the reactor building until the early morning hours of August 22, when the transport operation commenced.[209]

The hour-long transport from the Vinca Institute to the Belgrade Airport was provided a remarkably high degree of security. Twelve hundred armed Yugoslav and Serb guards secured the transport.[210] These included tactical units escorting the material, rooftop snipers along the planned route, helicopter escorts, and uniformed police stationed at every intersecting roadway, allowing the convoy uninterrupted passage.[211] Three separate convoys drove three separate routes, with two serving as decoys and only one convoy transporting nuclear material.[212] Yugoslav nuclear scientists equipped to deal with unexpected contingencies like hazardous material leakage accompanied the transport, as did U.S., Russian, and IAEA officials.[213]

Once loaded onto the transport aircraft, the material was subject to inspection and inventory.[214] Shortly after 8:00 am August 22, the aircraft departed Belgrade.[215] Two Yugoslav combat aircraft escorted the shipment to the country's border with Russia, according to one participant.[216] The transport aircraft flew directly to an airport in Ul'yanovsk, Russia, from where the shipment was transported via truck approximately 60 miles to RIAR in Dmitrovgrad, where it was secured awaiting verification by a joint team of RIAR, Minatom, and Energy Department representatives.[217]

At least one involved official characterized security as excessive and criticized it as setting an unnecessary and unhelpful precedent and driving up the cost of the operation.[218] But as Holgate pointed out, "I know other people involved in this know certain things about the black market in Yugoslavia. We lost tactical surprise because it was published…somebody at the lab who saw the preparations going on spoke to a [local] newspaper."[219]

In fact, in the weeks prior to the shipment two Vinca scientists who vehemently objected to the fuel removal began writing letters to the editors of Belgrade newspapers, for example arguing that "this nuclear fuel represents the only valuable thing left in the field of high nuclear technologies…by giving up on this fuel, the road towards those technologies would be permanently closed."[220] Their inflammatory rhetoric could easily have stirred sufficient political opposition to undermine the deal, but as two State Department officials observed, their campaign occurred during the traditional European summer holiday.[221] Most of the country was on vacation and the government essentially shut down; hence the last-minute protests gained little traction.[222]

Explaining the high degree of security, one official close to the negotiations noted that the U.S. government had reiterated to the Yugoslavs the need to provide sufficient security a week before the operation.[223] In addition to the loss of tactical surprise, the official mentioned as a concern "people at the plant that don't want [the material] to leave and would be willing to make a big mess to make sure it didn't leave…anti-nuclear protesters…[and] anyone who might want to make the U.S. look bad."[224]

## LOOSE ENDS

While the fresh HEU fuel that posed the most pressing proliferation threat is now stored at a relatively secure facility in Russia and will soon be downblended into a low-enriched, proliferation-resistant form, Project Vinca left many other loose ends.[225] The spent fuel and nuclear waste remain at the Vinca site, although limited progress has been made toward beginning the cleanup process.[226] And despite the fact that the State Department gave NTI assurances that the U.S. government lacked the authority to address the spent fuel issue on its own, questions persist about both the accuracy of those assurances as well as the government's ability to undertake similar operations in future without having to rely on nongovernmental actors.

### An Unfinished Project

Although the most vulnerable nuclear material has been removed, Project Vinca is far from over. Asked for his assessment of the operation, Institute Director Subotic noted that, "We made [an] agreement to do this job in a situation where [a] great part of the further development was implied" and said "these agreements from that time have to be confirmed by the results of the future."[227] A State Department official countered, "We promised not to run off on them. I guess that's the only real promise."[228]

As of late summer 2003, an IAEA official indicated the organization had spent about $500,000 of the NTI and IAEA funds that were committed in the Project Vinca context.[229] The IAEA has provided "basic equipment like dosimeters and protective clothing" as well as more advanced equipment that allows scientists to analyze samples taken from the spent fuel storage pool.[230] The IAEA has also funded an inventory of unidentified material in the pool.[231] And previous work to deal with the spent fuel has been proceeding with the new funding stream.[232] These efforts are critical because the spent fuel must be both accurately inventoried and in a physically stable form before removal from the site can take place.

But even if the spent fuel can be analyzed and stabilized, it is not clear when it could be removed. A State Department official noted that the material would fall under the Tripartite Initiative efforts that in September 2003 resulted in an initial shipment from Romania to Russia.[233] According to the official, the Vinca Institute spent fuel will be eligible, "in the same sense that fourteen other countries are eligible to ship spent fuel back to Russia."[234] But "at the same time we've told them, and this is where they get disappointed, that they are not necessarily a high priority."[235] The official explained that only a small amount of the Serbian fuel is proliferation-vulnerable HEU and "we've got spent fuel HEU in a number of places that we'd like to get first."[236]

The official also noted that the U.S. government has been unwilling to commit to funding the full spent fuel removal. Another State Department official noted that the promised donors' conference had yet to take place and suggested that the Serbs should "try and get some of the Europeans because this is definitely in their backyard. I think they'd like to see it cleaned up."[237]

### An Ongoing Dispute

In the aftermath of Project Vinca, one of the persistent questions has been whether the U.S. government could have funded the spent fuel remediation that proved to be a key incentive in obtaining Yugoslav cooperation on the fresh HEU fuel removal. At the time Project Vinca was conducted, this issue did not appear in doubt. Cagan approached NTI claiming the U.S. government did not have the requisite authority, a contention she bolstered with a legal analysis she cited to Holgate but that other officials involved do not recall.[238] The State Department fact sheet on the operation released August 23, 2002, clearly stated, "The U.S. Government lacks the authority to fund this critical element of the project."[239]

But post-operation, State Department officials involved in the effort cast doubt on the accuracy of that assertion. As one State Department official observed, "NDF has 'notwithstanding authority,' which means that we can waive any provision of law."[240] But as the official noted,

> The question is whether…that would have been an appropriate way to use NDF funds and whether that would have had support either in this building from the undersecretary or even the assistant secretaries and whether it would have had support on the Hill and been understood on the Hill as an appropriate use of NDF funds. [Those funds are] fairly limited…so if you start going into environmental cleanup you're out of our range very quickly. So I think the feeling was that we needed to stay out of that and focus on the strict nonproliferation effort of getting this HEU into a less dangerous situation.[241]

Other officials explained that issues of precedent-setting and the urgency of the operation played a key role. One State Department official noted that "we didn't want the U.S. government perceived as taking on the spent fuel problem."[242] Another State Department explained that NTI facilitated the rapid operation officials desired: "Could the U.S. government have done this? Absolutely. Could it have done it in [the desired] time[frame]? Unlikely."[243]

The issue has also been raised in Congress, where there is concern about an apparent lack of authority that hampered the U.S. government's ability to address a clear proliferation threat.[244] NDF, after all, was created in the aftermath of the 1994 Project Sapphire specifically to fund unusual nonproliferation activities.[245] Holgate attended a fall 2002 congressional staff meeting at which the issue was discussed, and reported, "I listened, absolutely flabbergasted, as assistant secretary-level people in both [the Energy and State] departments asserted that they had all the authority and all the money they needed."[246]

Whether accurate or not, these and other official statements that current authorities are sufficient have hampered efforts by global cleanout proponents like the Nuclear Threat Initiative to prod Congress to provide additional authorities or even clarify existing ones. Nonetheless, as this article goes to press there are several sets of language targeted at the "global cleanout" threat working their way through the Congress. Which, if any, will become law remains unclear.

## LESSONS FROM VINCA

Project Vinca was in many respects unique, as its various participants emphasized. But the operation nonetheless highlights the issues policymakers must confront as they attempt to fashion a coherent response to the threat posed by vulnerable civilian nuclear material stockpiles.

### Securing International Cooperation

For all the Tom Clancy-style glamour of the transport operation, with its rooftop snipers, helicopter escorts, and decoy convoys, Project Vinca was fundamentally a series of unspectacular, in-the-trenches negotiations. The principal challenge of Project Vinca was neither the technical packaging effort nor the high-security transport—it was persuading Belgrade and Moscow to cooperate.

In this regard Project Vinca is emblematic of a larger security policy reality: Combating proliferation, much like suppressing terrorism, will require "years of unspectacular civilian cooperation with other countries in areas such as intelligence sharing, police work, tracing financial flows, and border controls," as Joseph Nye observes.[247] And "as the most powerful country the United States must mobilize international coalitions."[248] That is ultimately what Project Vinca was—an international coalition incorporating Washington, Moscow, Belgrade, the International Atomic Energy Agency, and the Nuclear Threat Initiative, all collaborating to neutralize an acknowledged mass destruction proliferation threat.

But international cooperation is elusive. Target countries are understandably reluctant to part with nuclear material they consider scientifically valuable and have paid substantial sums to acquire. And Russia—whose participation is essential to addressing Soviet-origin material that is politically difficult to transport to the United States or other countries—although nominally supportive, has often been a reluctant partner in such efforts.

As a result, a viable approach to the global cleanout challenge requires diplomatic engagement by the most senior U.S. government officials. Global cleanout operations can and probably should be planned and implemented with little high-level involvement, but bringing countries to the table and persuading them to participate will often not be a feasible task for mid-level bureaucrats or even ambassadors. A serious global cleanout effort requires putting the issue on the foreign policy agenda, and that agenda is set in the highest echelons of the government.

### Overcoming "Bureaucratic Friction"

Despite years of bureaucratic engagement and sustained pressure from nongovernmental actors, progress on Vinca was hampered by intra- and interagency conflict, fueled by disagreements over substance and undoubtedly a degree of "turf warfare." The in-house State Department friction in particular posed substantial barriers to the implementation of the operation, even once the effort had gained momentum that included support from the highest levels of the department.

Overcoming "bureaucratic friction" in the Vinca case required sustained leadership from an official who "played above her pay grade" and was able to marshal support from the highest levels of the foreign policymaking apparatus (including the deputy secretary of state and the national security advisor). Similarly, any viable approach to the global cleanout problem will require the institutionalization of such capabilities in the position of a lead official and dedicated office, with clearly articulated support from senior officials.

Whether the lead official and office should be placed in the State Department or Energy Department is a contentious issue among global cleanout proponents. The State Department has broader negotiation expertise. The Energy Department can marshal its technical resources and has considerable negotiation expertise from its implementation of other cooperative security programs. A reasonable case can be made for either department's assumption of the lead role, although the Energy Department's experience addressing vulnerable fissile material stockpiles and expertise in dealing with nuclear reactors and materials broadly suggests it may be the most apt home for the office.

One thing that *is* clear is that the office that spearheaded Project Vinca, essentially a troubleshooting operation with responsibility for a range of civil-military issues, is not the appropriate place for the job. In fact, the office's focus on negotiating basing rights and other agreements in the run-up to the war against the Afghan Taliban post-9/11, to the detriment of the Vinca operation, highlights the need for a dedicated office that can keep attention focused on both specific efforts and the broader global cleanout agenda.

### Implementing Global Cleanout

Despite the U.S. government experience in two previous and very similar global cleanout operations, Project Vinca was an essentially ad hoc operation, a characteristic that goes a long way toward explaining why it took so long to plan and negotiate. And Project Vinca was made possible by remarkably close and perhaps unprecedented cooperation between the U.S. government and a nongovernmental organization.

Both of these characteristics highlight the need for a designated lead office equipped with the necessary capabilities. A lead office that carries out multiple cleanout operations can dramatically streamline the implementation process. And that office must be empowered with well-defined authority to negotiate compensation packages as necessary to secure the release of vulnerable nuclear materials.

The following discussion is not intended to be exhaustive, but highlights some of the key issues any viable effort will need to address. The global cleanout office should:[249]

- *Identify and prioritize vulnerable nuclear materials sites.* This is the most important and currently perhaps most neglected issue. Operations conducted to date have been ad hoc and determined more by political circumstances than comprehensive threat assessments. Prioritizing sites according to quantity of material and level of vulnerability would allow resources to be effectively channeled. Currently there exists no single list of civilian sites containing weapons-usable materials, although a combination of U.S. government information from multiple sources and existing IAEA databases should contain all the information needed to compile such a list.
- *Facilitate interim security upgrades.* Targeting nuclear materials identified as vulnerable for rapid security upgrades pending further assessment or removal would yield substantial security dividends. The global cleanout office should identify sites and fund security upgrades, which could be performed by Energy Department personnel with material protection, control, and accounting expertise.
- *Negotiate ad hoc compensation packages.* This lesson is the most important of the Vinca case and vital to addressing the global cleanout agenda successfully, and hence deserves fuller discussion. Project Vinca, with its incorporation of NTI funding for spent fuel remediation as a crucial deal sweetener, as well as the last-minute agreement to organize a donors' conference to secure additional funding, makes clear the need for incentives specifically tailored to targeted sites.

One innovative tactic a global cleanout effort could adopt would be seeking synergies with preexisting programs. As Bunn points out,

> At DOE, they have all sorts of authority in the Atomic Energy Act to take action to defend the security of the United States against nuclear threats, but they often don't put the authorities and the programs together. For example…there are lots of other DOE programs that sponsor joint R&D with foreign countries. Nobody has ever said, 'Hey, let's tell them we'll give them $5 million to keep their scientists busy doing interesting work for 5 years if they'll give up the HEU.'[250]

Such synergies need not be merely enabling. They can also accomplish important nonproliferation goals in their own right. "Brain drain," the leakage of nuclear expertise to potential proliferators, is recognized as a serious nonproliferation threat. Hence employing scientists at a nuclear research institute in exchange for removing vulnerable materials may be more than a mere deal-sweetener, it may also ameliorate a nonproliferation risk in its own right.

It should be emphasized that much more than mere legal authority is needed. A successful cleanout program also requires the inclination to use the authority provided. The State Department's Nonproliferation and Disarmament Fund has a remarkably broad mandate that arguably allows it to undertake almost any conceivable effort that would address an urgent nonproliferation need, subject to the constraints of its oversight process and limited budget. Yet in the Vinca case NDF officials interpreted spent fuel remediation as "beyond our mandate."[251]

A combination of legislative direction and engagement from senior executive branch officials will be required to ensure that flexible authorities are used as intended. It should also be noted that like NDF, any office that is given such broad authority will also require significant internal (senior officials) and external (congressional) oversight.

One key issue will be avoiding a "moral hazard"-type problem where countries, aware that the United States is willing to compensate them in innovative and substantial ways for their nuclear material, will raise the cost of accomplishing global cleanout to untenable heights. One helpful dynamic will be the pressure U.S. negotiators can bring to bear in the context of larger bilateral relationships, much the way Project Vinca negotiators implied that pending aid considerations were a factor. But it should also be recognized, as Potter observes, that having countries eager to sell the United States their nuclear material is a good thing, and even a multi-million dollar compensation package of the sort negotiated in Project Vinca is a bargain compared to the cost of defending against nuclear aggression by other means or even a worst-case nuclear attack.[252]

Finally, it is important to note that carrots are not the only means of persuasion. As in the Vinca case, where diplomats sought in the final negotiations to draw an implicit connection between the operation's success and the availability of U.S. economic aid, there is clearly a role for sticks in a larger global cleanout effort. But a note of caution is in order, because while coercion may be effective in select instances, the tactic may not be sustainable across a broad set of vulnerable sites. Coercion could backfire if it leads already reluctant countries to refuse to even come to the table. But at a minimum the issue deserves further study.

### The Nongovernmental Role

The Vinca case also highlights the crucial role played by nongovernmental organizations in the cooperative security arena. The Nuclear Threat Initiative's direct engagement as a funder and implementer of the operation is both remarkable and unlikely to be repeated soon. But NTI officials and other nongovernmental advocates—perhaps most notably William Potter—also played a critical role in keeping the Vinca threat on the U.S. government's radar screen.

Although from their perspective the process may have been frustrating—Potter, for example, had been lobbying U.S. officials since at least the mid-1990s to deal with Vinca—nongovernmental advocates' indirect role in the ultimately successful operation should not be underestimated. The policymaking process is characterized by a constant press of short-term imperatives that often trump longer-range strategizing.[253] When the Vinca efforts briefly derailed following the 9/11 terrorist attacks, continued outside pressure from nongovernmental advocates—including telephone calls from NTI's Senator Nunn to Deputy Secretary of State Armitage—were undoubtedly important and perhaps even instrumental in keeping the issue on the State Department's radar. As arms control proponent Frank von Hippel observed after a short stint in the Clinton administration White House, "Outside public-interest and academic experts have little impact on day-to-day arms control and nonproliferation policymaking in the government. However, they largely set the long-term agenda."[254]

### How Do Current Efforts Compare?

In theory, current efforts to address the threat posed by civilian nuclear materials cover nearly all the sites of concern and have all the legal authority needed for a serious global cleanout program. But in reality current efforts bear little relationship to the fast-moving, mission-oriented, coordinated effort that is required. There is no designated lead actor buttressed by the necessary resources and authorities. Senior officials were mobilized for the ad hoc Vinca effort, but broader efforts to address the universe of vulnerable sites have not been accorded similar high-level engagement. And whether the necessary flexibility in structuring incentives for states giving up nuclear material is not authorized by current law or current legal authorities are merely ambiguous, those currently working to address the threat clearly do not feel empowered to take the necessary actions, as the State Department's need to rely on NTI for Project Vinca makes clear.

As long as global cleanout is not a high priority, and as long as the United States waits for opportunities rather than making them, cleanout operations will only happen every few years at best, as has been the case to date. It will take only one major theft to make such a status quo approach to the threat posed by vulnerable civilian nuclear material seem horrifically short-sighted.

## CONCLUSIONS

Project Vinca is an important nonproliferation success story. But the real test will be what happens now. The current administration's rhetoric is encouraging. The 2002 National Security Strategy contains all the crucial ingredients, identifying the threat posed by weapons of mass destruction, emphasizing the necessary cooperation with other nations, highlighting the need for timely action, and condemning complacency:

> The gravest danger our Nation faces lies at the crossroads of radicalism and technology. Our enemies have openly declared that they are seeking weapons of mass destruction, and evidence indicates that they are doing so with determination. The United States will not allow these efforts to succeed….We will cooperate with other nations to deny, contain, and curtail our enemies' efforts to acquire dangerous technologies….History will judge harshly those who saw this coming danger but failed to act.[255]

As this article goes to press, administration proponents of cleanout efforts appear to be making headway, as evidenced by more intensive interagency discussions of the issue and the first operation to break the one-every-four-years operational tempo sustained to date. On September 21, 2003, the U.S. government funded an operation to remove fresh fuel containing 14 kg of HEU from a Romanian research reactor and ship it to Russia for downblending.[256] Like Project Vinca, that operation had been planned for years. Its implementation seems to indicate that officials are serious about the one-a-year tempo they have proposed.[257] But even if this four-fold improvement can be sustained, terrorists and proliferant states will still have decades of access before the most vulnerable nuclear material stockpiles are secured. As NTI officials observe, a gazelle running from a cheetah is taking steps in the right direction. Those steps do not ensure the gazelle's survival; only speed does.[258]

The stakes are high. Some proponents of cooperative efforts to reduce the WMD threat ask: The day after a nuclear 9/11, what will U.S. officials wish they had done?[259]

If Washington fails to get serious about the global cleanout challenge, neutralizing the proliferation threat posed by a site like Vinca may be the rueful answer to that question.

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[2] William Hopwood, Oak Ridge National Laboratory, Oak Ridge, Tennessee, telephone interview by author, July 3, 2003.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] U.S. Department of State official (name withheld by request), Washington, DC, telephone interview by author, July 3, 2003.

[7] Matthew Bunn deserves credit for coining the term "global cleanout."

[8] Matthew Bunn, Anthony Wier, and John P. Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Cambridge, MA: Harvard University, 2003) pp. 14-15 and 223-231.

[9] ABCNEWS.com, "Interview with Bin Laden: 'World's Most Wanted Terrorist,'" <http://more.abcnews.go.com/sections/world/DailyNews/transcript_binladen1_990110.html>, as cited in Bunn et al., *Controlling Nuclear Warheads and Materials,* p. 223.

[10] David E. Sanger, "Bush Sees Slight Opening for North Korea Progress," *New York Times*, October 23, 2003, p. A12, and Elaine Sciolino, "Iran Will Allow U.N. Inspections of Nuclear Sites," *New York Times*, October 22, 2003, p. A1.

[11] The White House, "The National Security Strategy of the United States of America," September 2002, p. 1.

[12] John Foster, "Nuclear Weapons," *Encyclopedia Americana,* Vol. 20 (New York: Americana, 1973) pp. 520-522.

[13] North Korea is currently demonstrating the feasibility of concealment with a covert uranium enrichment facility that reports indicate U.S. intelligence has been unable to locate as well as a possible covert plutonium extraction plant. Thom Shanker with David E. Sanger, "North Korea Hides New Nuclear Site, Evidence Suggests," *New York Times,* July 20, 2003, p. 1; David E. Sanger, "North Korea Says It Has Made Fuel for Atom Bombs," *New York Times,* July 15, 2003, p. A1; and David E. Sanger, "North Korea Says It Has a Program on Nuclear Arms," *New York Times,* October 17, 2002, p. A1.

[14] Both the primitive "gun-type" HEU-fueled nuclear weapon a sophisticated terrorist group or technologically relatively unsophisticated proliferant state might pursue and the more challenging "implosion-based" HEU- or plutonium-fueled weapons design could be constructed covertly. But unlike a conservatively executed gun-type design, an implosion design would require testing to achieve high confidence in its efficacy.

[15] For a comprehensive discussion of what remains to be done, see Bunn et al., *Controlling Nuclear Warheads and Materials,* passim.

[16] Treaty on the Non-Proliferation of Nuclear Weapons (NPT), Article V, <http://disarmament.un.org/wmd/npt/>.

[17] Bunn et al., *Controlling Nuclear Warheads and Materials*, p. 13.

[18] Ibid., pp. 13-14.

[19] Ibid., p. 14.

[20] Matthew Bunn, Cambridge, Massachusetts, written communication with author, August 13, 2003.

[21] U.S. Secretary of Energy Spencer Abraham announced September 19, 2003, that the United States has "converted to LEU…50 percent of the known reactors with U.S.-origin HEU fuel outside the United States." Department of Energy, "Remarks by Energy Secretary Spencer Abraham at the Second Annual Carnegie Nonproliferation Conference," Moscow, Russia, September 19, 2003.

[22] For example, the National Security Advisory Group, principally composed of former Clinton administration national security officials, concluded in July 2003 that the Bush administration was allowing "Nunn-Lugar" threat reduction efforts to "stagnate," noting that "after an extensive 'review' that dragged on long after 9/11, the Bush administration finally decided to support the decade-old Nunn-Lugar [Cooperative Threat Reduction] programs but did little to expand the scale, scope, and pace of these programs so that they can eliminate nuclear, biological, and chemical weapons threats worldwide." National Security Advisory Group, "An American National Security Policy: Challenge, Opportunity, Commitment," July 2003. See also Bunn et al., *Controlling Nuclear Warheads and Materials*, 2003.

[23] William Hopwood, Stanley Moses, Milan Pesic, Obrad Sotic, and Thomas Wander, "Cooperative Efforts for the Removal of High-Enriched Uranium Fresh Fuel from the Vinca Institute of Nuclear Sciences," Presentation to the 44th Annual Meeting of the Institute of Nuclear Materials Management, Phoenix, Arizona, July 13-17, 2003, p. 2.

[24] Working with former Yugoslav nuclear scientists, leading nonproliferation expert William Potter—perhaps the most knowledgeable non-Yugoslav authority on the program—has documented the existence of a sporadic Yugoslav program from the late 1940s through the late 1980s, although those efforts appear never to have acquired either the sense of urgency or the resources necessary for the development of a nuclear weapon. William C. Potter, Djuro Miljanic, and Ivo Slaus, "Tito's Nuclear Legacy," *Bulletin of the Atomic Scientists* 56 (March/April 2000), p. 2; Andrew Koch, "Yugoslavia's Nuclear Legacy: Should We Worry?" *Nonproliferation Review* 4 (Spring-Summer 1997) p. 12; and David Albright, "What About Yugoslavia's Nuclear Explosive Material?" Institute for Science and International Security Policy Paper, April 21, 1999, p. 12.

[25] Koch, "Yugoslavia's Nuclear Legacy," p. 124.

[26] Krunoslav Subotic, director, Vinca Institute of Nuclear Sciences, Belgrade, Yugoslavia, written communication with author, September 8, 2003.

[27] Ibid.

[28] Ibid. Note: Since the HEU fuel was removed in Project Vinca, the reactor is presumably being fueled with LEU fuel.

[29] Hopwood et al., "Cooperative Efforts," p. 2.

[30] Subotic, written communication with author, September 8, 2003. But see note Table 1, Note i, regarding discrepancy with Hopwood et al., "Cooperative Efforts," p. 4.

[31] Nuclear Threat Initiative, "Briefing Paper: Vinca Institute of Nuclear Sciences, Belgrade, Yugoslavia," undated.

[32] Ibid.

[33] International Atomic Energy Agency official (name withheld by request), Vienna, Austria, telephone interview by author, July 7, 2003.

[34] Ibid.

[35] U.S. Department of State official (name withheld by request), Washington, DC, interview by author, June 20, 2003.

[36] Some sources, including institute director Subotic and NTI, cite 48.4 kg of HEU, while others, including an IAEA official, cite 48.2 kg. The State Department simply cites 48 kg. NTI, "Briefing Paper: Vinca Institute of Nuclear Sciences"; Subotic, written communication with author, September 8, 2003; and IAEA official (name withheld by request), written communication with author, August 10, 2003.

[37] For comparison purposes, the relatively primitive South African nuclear weapons reportedly contained just about 55 kg of HEU each, although likely somewhat more highly enriched than the 80 percent Vinca material. The U.S. uranium-fueled atomic bomb used against Hiroshima, Japan, contained about 60 kg of HEU with an enrichment level approximately equivalent to the Vinca material. See David Albright, "South Africa and the Affordable Bomb," *Bulletin of the Atomic Scientists* 50 (July/August 1994) and Owen Cote, Jr., "Appendix B: A Primer on Fissile Materials and Nuclear Weapon Design," in Graham T. Allison, Owen Cote, Jr., Richard A. Falkenrath, and Steven E. Miller, *Avoiding Nuclear Anarcy* (Cambridge, Mass: Harvard University Press, 1996), p. 222.

[38] Cote, Jr., "Appendix B," p. 207.

[39] U.S. Department of State, Fact Sheet, "Project Vinca,"August 23, 2002.

[40] Hopwood et al., "Cooperative Efforts," p. 4.

[41] Ibid., p. 2.

[42] U.S. Department of State official (name withheld by request), interview with author, June 20, 2003.

[43] Bunn, written communication with author, August 13, 2003.

[44] Ibid. and R.A. Lewis and F.H. Martens, "Technical and Economic Assessment of the Use of HEU (Greater Than 20 Percent U-235 Content) in Critical Experimental Facilities, Research and Test Reactors, and Power Prototype Facilities," Applied Physics Division, Argonne National Laboratory, RSS-TM-3, June 10, 1977.
[45] U.S. Department of State official (name withheld by request), Washington, DC, telephone interview by author, July 8, 2003, and U.S. Department of State official (name withheld by request), interview by author, July 3, 2003.
[46] Nuclear Threat Initiative, "Briefing Paper: Vinca Institute of Nuclear Sciences, Belgrade, Yugoslavia," undated.
[47] International Atomic Energy Agency official (name withheld by request), Vienna, Austria, written communication with author, August 10, 2003.
[48] Ibid.
[49] Subotic, written communication with author, September 8, 2003.
[50] Ibid.
[51] U.S. Department of State official (name withheld by request), interview by author, July 3, 2003; U.S. Department of State official (name withheld by request), interview by author, June 25, 2003; and U.S. administration official (name withheld by request), Washington, DC, telephone interview by author, July 8, 2003.
[52] U.S. Department of State official, interview by author, June 20, 2003, and U.S. Department of State official, interview by author, July 3, 2003.
[53] U.S. Department of State official, interview by author, July 3, 2003.
[54] Frank von Hippel, Princeton, New Jersey, written communication with author, August 8, 2003.
[55] U.S. Department of State official (name withheld by request), interview by author, June 20, 2003.
[56] Ibid.
[57] Potter et al., "Tito's Nuclear Legacy."
[58] Ibid. and William Potter, Monterey, California, written communication with author, August 7, 2003.
[59] International Atomic Energy Agency official (name withheld by request), interview by author, July 7, 2003.
[60] Krunoslav Subotic, director, Vinca Institute of Nuclear Sciences, Belgrade, Yugoslavia, telephone interview by author, June 27, 2003.
[61] Hopwood, interview, July 3, 2003, and Laura Holgate, Vice President for Russia/NIS Programs, Nuclear Threat Initiative, Washington, DC, interview by author, June 16, 2003.
[62] Hopwood et al., "Cooperative Efforts," p. 2 and Hopwood, interview, July 3, 2003.
[63] Subotic, interview, June 27, 2003.
[64] Ibid.
[65] U.S. Department of State official (name withheld by request), Washington, DC, interview by author, June 20, 2003.
[66] Ibid.
[67] U.S. Department of Defense official (name withheld by request), interview by author, Washington, DC, July 24, 2003.
[68] Rose Gottemoeller, Washington, DC, interview by author, June 26, 2003.
[69] Ibid.
[70] Ibid.
[71] Ibid.
[72] Ibid.
[73] William Potter, Monterey, California, telephone interview by author, June 25, 2003.
[74] Ibid.
[75] Ibid.
[76] Ibid. and Ann MacLachlan, "Top official says Russia wants to take back HEU spent fuel," *Nuclear Fuel,* November 2, 1998.
[77] William Potter, interview, June 25, 2003, and William Potter, written communication with author, Monterey, California, August 7, 2003.
[78] U.S. Department of State official, interview by author, July 3, 2003.
[79] International Atomic Energy Agency official, interview by author, July 7, 2003.
[80] U.S. Department of Energy, Press Release, "The United States, Russian Federation, Romania and the International Atomic Energy Agency Cooperate on Nonproliferation: Fresh HEU Nuclear Fuel Shipped Back to Russian Federation," September 22, 2003, and "U.S., Russia Advance Joint Nonproliferation Efforts," *Global Security Newswire,* September 23, 2003.
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[85] U.S. Department of State official, interview, June 20, 2003; U.S. Department of State official, interview, June 20, 2003; U.S. Department of State official, interview, June 25, 2003; and U.S. Department of State official, interview, July 3, 2003.
[86] Ibid.
[87] Ibid.
[88] U.S. Department of State official, interview, July 3, 2003.
[89] U.S. Department of State official (name withheld by request), Washington, DC, interview by author, June 25, 2003; U.S. Department of State official, interview, June 20, 2003; and U.S. Department of State official, interview, June 20, 2003.
[90] Ibid.
[91] Nonproliferation and Disarmament Fund, "Mission Statement," <http://www.ndf.org/html/goalsobj.html>.
[92] Title III of the Foreign Operations, Export Financing, and Related Programs Appropriations Act Fiscal Year 1994 (Public Law 103-87), enacted September 30, 1993.
[93] U.S. Department of State official, interview, June 25, 2003 and U.S. Department of State official, interview, July 3, 2003.
[94] U.S. Department of State official, interview, June 25, 2003.
[95] Holgate, interview, June 16, 2003.
[96] Ibid.
[97] Ibid.
[98] Holgate, interview, June 16, 2003, and Matthew Bunn, Cambridge, Massachusetts, written communication with author, October 5, 2003.
[99] U.S. Department of State official, interview, July 3, 2003.
[100] U.S. Department of State official, interview, June 20, 2003.
[101] U.S. Department of State official, interview, June 20, 2003, and U.S. Department of State official, interview, June 25, 2003.
[102] Ibid.
[103] Holgate, interview, June 16, 2003.
[104] U.S. Department of State official, interview, June 20, 2003, and U.S. Department of State official, interview, June 20, 2003.
[105] U.S. Department of Defense official, interview, July 24, 2003, U.S. Department of Defense official (name withheld by request), Washington, DC, interview by author, June 26, 2003, and William C. Potter, "Project Sapphire: U.S.-Kazakstani Cooperation for Nonproliferation," in John M. Shields and William C. Potter, eds., *Dismantling the Cold War* (Cambridge, MA: MIT Press, 1997).
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[117] Ibid.
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[132] U.S. Department of State official, interview, June 20, 2003.
[133] U.S. Department of State official, interview, June 20, 2003.
[134] Holgate, interview, June 16, 2003.
[135] Ibid.
[136] Holgate, interview, June 16, 2003.
[137] Brooke Anderson, vice president for communications, Catherine Gwin, director of communications, and Holgate, Nuclear Threat Initiative, Washington, DC, written communication with author, August 8, 2003.
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[139] U.S. Department of State official, written communication, July 21, 2003 and U.S. Department of State official (name withheld by request), Washington, DC, written communication, July 21, 2003.
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[249] Substantial portions of the following discussion are based on legislative concept drafting conducted by the author, with guidance from Graham Allison and Matthew Bunn, for Senator Richard Lugar, chairman, Senate Foreign Relations Committee, in May 2003.

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[257] Holgate, interview, June 16, 2003, citing a conversation between a senior Energy Department official and NTI Co-Chairman and Chief Executive Officer Sam Nunn.

[258] Nuclear Threat Initiative, "Working for a safer world," undated, p. 2

[259] Widely used by the Nuclear Threat Initiative to argue for more vigorous threat reduction efforts, this way of framing the weapons of mass destruction nonproliferation imperative is credited to Graham Allison.