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Managing the Atom

# Global Cleanout

## An emerging approach to the civil nuclear material threat

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# About the Author

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# Executive Summary

Terrorists and states hostile to the United States and its allies are pursuing nuclear weapons. The acquisition of even primitive nuclear weapons by terrorists willing to sacrifice their own lives to kill thousands of civilians would be catastrophic, while nuclear proliferation to hostile states poses grave dangers.

Obtaining fissile material, either highly enriched uranium (HEU) or plutonium, remains the single greatest obstacle to acquiring a nuclear weapon. A sophisticated terrorist organization could plausibly construct a rudimentary nuclear bomb if it obtained such material; a state almost certainly could. Yet dozens of insecure civil research centers scattered around the globe house HEU or plutonium, many protected by only the most rudimentary security measures. While security upgrades have a critical role to play, *only by ensuring that there is nothing left at a site to steal can the threat of nuclear diversion be entirely eliminated.*

The United States has conducted five operations over the past decade to "clean out" specific vulnerable civil nuclear material stockpiles supplied by the Soviet Union. These operations make clear the haphazard nature of past and current attempts to address this threat. Efforts to date have been characterized by a consistent pattern of passivity in site identification; incoherence in site selection; sluggish implementation due to ad hoc operations, the absence of clear lines of responsibility, and insufficiently empowered implementing officials (all of which stem in large part from a lack of awareness, engagement, and leadership by senior government officials); allowing Russia to effectively stymie progress; and failure to effectively engage third parties, including countries and perhaps non-state actors.

These shortcomings highlight the key ingredients of a viable "global cleanout" approach:

- **A comprehensive, global threat assessment** is a necessary ingredient of any systematic approach to the threat posed by civil nuclear material stockpiles. Existing U.S. government and International Atomic Energy Agency information, supplemented by limited amounts of targeted collection, should suffice to compile such a database.

- **A prioritized, global implementation plan** should lay out a systematic strategy for dealing with vulnerable sites, prioritized primarily according to proliferation threat—based on materials, security, and location—although opportunity will invariably play a role as well.

- **A coherent U.S. government program** requires the designation of a single legally, financially, and politically empowered implementation office, with adequate resources to get the job done. Establishing such an office will only be possible with high-level executive branch and congressional engagement.

- **A flexible approach to providing incentives** targeted to the needs of each facility (and the states where such facilities exist) will be essential to rapid progress in removing vulnerable nuclear materials from sites around the world.

- **Vigorous engagement with Russia** is required to communicate the priority with which the U.S. government views this issue and to induce Russia to play a more constructive role than it has at times in the past.

- **Diplomacy to engage other countries and perhaps non-state actors** is required for a truly global solution to a truly global threat. Third-party countries have facilities, expertise, and funds to offer, and may be more credible actors in some cases. And non-state approaches, such as purely commercial or non-profit deals, at a minimum merit exploration.

# Introduction

Nuclear proliferation to terrorists willing to sacrifice their lives to kill hundreds of thousands of innocent civilians represents a grave threat to the United States and its allies; nuclear proliferation to hostile states poses serious dangers. Yet poorly secured civil research sites with hundreds of nuclear bombs' worth of highly enriched uranium (HEU) and plutonium are scattered around the globe. Because obtaining such material is the greatest hurdle to constructing a nuclear weapon, these sites represent an urgent proliferation threat.

Over the past decade, the United States has conducted five major operations to secure and remove Soviet-origin nuclear material from sites in Kazakhstan, Georgia, Yugoslavia, Romania, and Bulgaria.[2] These operations make clear that securing bomb-usable nuclear material is eminently feasible from diplomatic, technical, and financial perspectives.

In the past year, the threat posed by civil nuclear material stockpiles has attracted increased attention in both the executive and legislative branches of the U.S. government. Recently announced policy initiatives and legislation have the *potential* to resolve many of the issues addressed in this paper, but rapid and comprehensive implementation will be needed. These efforts can benefit from the lessons of past operations. Despite the evident tractability of the threat, dozens more sites still remain unaddressed, their 'nuclear-bombs-in-waiting' protected from terrorists, hostile state agents, and black-market nuclear profiteers by little more than chain link fences and single guards. This despite the fact that securing civil nuclear material stockpiles would leave a lasting legacy: a world in which nuclear terrorism and nuclear threats from states were far less likely. Terrorists and states hostile to the United States and its allies are racing to acquire weapons of mass destruction, including nuclear weapons. It is not yet clear whether the United States is racing to stop them.[3]

# The Threat: Vulnerable Material Poses Unacceptable Dangers

Terrorists and states hostile to the United States and its allies are pursuing nuclear weapons. Osama bin Laden has declared the acquisition of weapons of mass destruction "a religious duty."[4] His al Qaeda terrorist organization has nuclear ambitions, documented in an extensive set of papers unearthed after the 2001 U.S. war against al Qaeda and its Taliban hosts in Afghanistan. Nongovernmental analyst David Albright concluded after review of much of this material that "al Qaeda had only achieved a limited technical capability to make nuclear weapons, assuming it acquired plutonium or highly enriched uranium illicitly" but also that "if al Qaeda had remained in Afghanistan, it would have likely acquired nuclear weapons eventually."[5] States hostile to the United States and its allies are also pursuing nuclear ambitions. Foremost among these are North Korea and Iran. North Korea may already have acquired one or more primitive nuclear devices that could be smuggled into a target country. Iran appears to have a well-developed weapons program, although it may be in the process of rolling that program back in response to international nonproliferation pressures.

Should Al Qaeda acquire a nuclear bomb, there would be no negotiations of the sort in which both North Korea and Iran have recently engaged. The detonation of even a crude nuclear bomb in a major city could cause devastation far beyond that wreaked by Al Qaeda terrorists in New York and Washington on September 11, 2001, with potential civilian casualties in the hundreds of thousands.[6]

Nuclear proliferation to states also poses threats. At the extreme, these include the catastrophic consequences of state use of nuclear weapons or loss of control or deliberate transfer of those weapons to non-state actors. Less extreme but still worrisome are scenarios involving

what policymakers term "nuclear blackmail," in which the United States or its allies are deterred from intervening in support of an ally, for example.[7]

Obtaining fissile material—either HEU or plutonium—is the most substantial hurdle to acquiring nuclear weapons. Nuclear weapons remain difficult to steal, although given documented vulnerabilities in Russia's nuclear complex and the uncertainties surrounding the nuclear weapons arsenals of other countries, notably Pakistan and North Korea, that path cannot be ruled out.[8]

Given the requisite quantities of fissile material, sophisticated terrorists and states could plausibly construct a primitive nuclear weapon and employ it to generate mass civilian casualties.[9] 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."[10] This is all the more true in light of the global nuclear black market supplied by Pakistan's chief nuclear scientist, Abdul Qadeer Khan, which was revealed in 2003. Khan's network peddled a range of nuclear weapons-related items, including detailed blueprints.

These observations are particularly applicable in the case of HEU, with which a primitive gun-type device of the sort the United States used against Hiroshima could readily be constructed by a sophisticated terrorist group.[11] Plutonium would require a more sophisticated implosion-type design of the sort used by the United States against Nagasaki, an approach that would pose a more substantial challenge for a terrorist group, but would be well within reach for most proliferant states.

Where might terrorists and states acquire fissile material? The traditional route taken by states—developing either indigenous uranium enrichment facilities or a nuclear fuel cycle and reprocessing capabilities to extract plutonium—remains technically challenging for most potential proliferant states and essentially infeasible for non-state actors. Concealing such facilities presents an additional difficulty even if technical hurdles could be overcome. Because of its sovereign territory, a state would face far more modest concealment hurdles, hence so would a non-state group that aligned itself with a state, as terrorist group Al Qaeda did with Afghanistan's Taliban government, or a non-state group operating in a failed state. The processes for constructing a nuclear weapon once fissile material has been acquired are, by contrast, readily concealable.

Given the difficulty involved in producing fissile material, theft or black market purchase are appealing avenues for potential proliferators. Russia has enormous military and non-military fissile material stockpiles whose security in the aftermath of the Soviet Union's collapse was and in many cases remains questionable. Over the past decade the United States has invested several billion dollars (U.S.) to secure these stockpiles, although much remains to be done.

Other nuclear weapons states have nuclear material stockpiles as well. The stockpiles of established nuclear powers like the United States and Britain represent less of a concern. Even the military stockpiles of newer nuclear states like Pakistan are likely well guarded: no state has an interest in fissile material leaking to hostile parties. At the same time, neither external attacks nor insider operations can be ruled out.[12] And given the extraordinary dangers entailed in fissile material loss, all nuclear material everywhere represents some non-negligible threat and must be secured against plausible outsider and insider threats.

Sufficient nuclear material for hundreds of weapons is currently found in civil research facilities scattered around the globe. In contrast to Russia's weapons and weapons-origin fissile material, these stockpiles have received relatively little government attention. Although substantially smaller than military stockpiles, these materials are in many cases also far less well secured. 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."[13] No coherent approach to the proliferation threat posed by fissile materials can ignore these stockpiles.

In fact, poorly secured civil nuclear research facilities around the globe may be the most likely source of fissile material for terrorists and are certainly an attractive target for states with proliferation ambitions.[14] Under the compact eventually formalized in the 1970 Nuclear Non-Proliferation Treaty, states that agreed to forswear nuclear weapons were promised assistance in developing civil nuclear programs.[15] 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 HEU, which was then thought to offer substantial scientific advantages for such reactors. 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.

Information on civil nuclear material stockpiles is spotty; there appears to exist no comprehensive database of such materials, either publicly available or within governments or international organizations. Unclassified estimates suggest that there are roughly 20 tons of research reactor HEU around the world, roughly half of it in the nuclear weapon states and half in non-nuclear weapon states—although some official estimates suggest that there may be roughly this much in Russia alone, which would make the world total correspondingly higher.[16] There are currently approximately 135 operating research reactors in more than 40 countries fueled with HEU.[17] An unknown number of additional research reactors have been shut down but still contain bomb-usable material.[18] Data on how much material exists at each site is not publicly available. The best available unclassified estimates suggest that the number of sites with enough non-irradiated or "fresh" HEU for a bomb is small—perhaps in the range of half a dozen.[19]

Nuclear fuel that has not been irradiated in reactors 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. Extracting bomb-usable material from nuclear fuel requires relatively rudimentary chemistry, likely within the capacities of scientists or technicians capable of constructing even a primitive nuclear weapon.

There are likely to be dozens of additional sites with enough HEU for a bomb when irradiated fuel is included. Although its enrichment level will be somewhat reduced, this fuel typically remains HEU even after irradiation and in many cases will not be sufficiently radioactive to be considered "self-protecting."[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.

## The Status Quo: Ad Hoc Responses Incommensurate with the Threat

Notwithstanding notably supportive rhetoric, President George W. Bush and many senior administration officials have provided only intermittent high-level support for cooperative efforts to secure nuclear stockpiles.[21] But despite inconsistent White House engagement, "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 one of the weakest links in the nonproliferation chain, vulnerable civil cites containing HEU—are proceeding, if still far too slowly.[22]

Because efforts to address the threat posed by poorly secured civil nuclear research facilities have fallen low on the list of security policy priorities, they have been ad hoc and idiosyncratic. In the immediate aftermath of the Soviet Union's collapse, attention focused on nuclear warheads, long-range delivery systems, and weapons-origin fissile materials. As one senior Clinton-era policymaker with operational responsibility for threat reduction programs observed, "I couldn't have even told you what a research reactor was when I was at the Pentagon."[23] The former official explained that efforts were intended principally to ensure implementation of Soviet-era arms control commitments and to counter proliferation to state rather than non-state actors. Hence nuclear-related threat reduction programs were implemented to secure the warheads, delivery systems, substantial quantities of fissile material, and highly trained scientists that states would need to create an effective deterrent, rather than the smaller quantities and more rudimentary capabilities that a non-state actor would require to assemble a single weapon. The threat posed by non-state actors prepared to sacrifice their lives to kill thousands of civilians only became clear on September 11, 2001, the official explained. With little high-level leadership of cooperative threat reduction efforts either before or after the terrorist attacks on New York and Washington, the programs have been slow to adjust.

Nonetheless, in recent years U.S. policymakers have begun to acknowledge the proliferation threat posed by non-military nuclear material stockpiles, and particularly HEU.[24] The United States now has a patchwork of programs that address both U.S. and Soviet-origin HEU fuel at civil research sites, although ignoring the modest quantity of HEU originating from other countries. Current U.S. efforts include programs that:

- Convert U.S.-fueled reactors from HEU to low-enriched uranium (LEU) fuel,
- Take back U.S.-supplied fuel (often operating in tandem with reactor conversion),
- Convert Soviet-fueled reactors,
- Facilitate the transfer of Soviet-supplied fuel back to Russia, and
- Consolidate and reduce the enrichment level of non-military HEU located in Russia.

In late May 2004, as this report was being prepared, U.S. Energy Secretary Spencer Abraham announced the "Global Threat Reduction Initiative" (GTRI), an ambitious plan to "comprehensively" secure or remove "all vulnerable nuclear and radiological materials throughout the world" that "pose a threat to the United States and to the international community…as expeditiously as possible."[25] Conceived in substantial part to address the kinds of concerns raised in this paper, GTRI is to "consolidate, accelerate, and expand" existing efforts to remove potential bomb material from vulnerable sites, and to "establish a comprehensive global database to identify and prioritize nuclear materials and equipment of proliferation concern not being addressed by existing threat reduction efforts."[26] Around the same time, Senators Pete Domenici (R-NM) and Dianne Feinstein (D-CA), joining with a number of their colleagues, successfully championed an amendment to the fiscal year 2005 Defense Authorization bill that would authorize expanded efforts to address vulnerable nuclear material stockpiles. Whether this or similar language will be approved in the bill's final House-Senate version remained unclear as this report was finalized.[27]

# The Precedents: Five Case Studies

Since the end of the Cold War, the United States has conducted five major operations to remove Soviet-supplied nuclear material from vulnerable sites.[28] To date, there have been three essentially ad hoc operations undertaken due to National

Security Council or Department of State initiative in 1994, 1998, and 2002, and two operations led by the Energy Department in 2003, after its long-term effort to develop an approach to Soviet-origin material that incorporated both Russia and the International Atomic Energy Agency (IAEA) began to pay off. The announcement of the GTRI in May 2004 suggests that future efforts will also be led by the Energy Department. Whether the GTRI will succeed in developing a prioritized plan to secure and remove vulnerable material around the world based on a comprehensive threat assessment, whether sufficient attention and resources will be devoted to making that plan viable, and whether the United States can overcome the various hurdles to the fast-moving, mission-oriented, coordinated global cleanout program that is required, all remain to be seen.

The five cases that follow have a two-part purpose. Taken as a whole, they reveal the absence of a coherent U.S. government approach to the threat posed by civil nuclear material stockpiles. And they highlight the key issues any viable approach to that threat must address.

## Project Sapphire

*The first "cleanout" operation, Project Sapphire, was a high-profile effort in response to a specific opportunity and a perceived urgent proliferation threat, launched by U.S. officials eager to back prior nonproliferation rhetoric with concrete action. The operation was coordinated by the White House National Security Council and implemented on an interagency basis by the Defense, Energy and State Departments with participation by other government agencies as necessary. The effort required substantial engagement from officials at all levels of the U.S. government, including the Vice President, and was characterized by considerable interagency friction and an ultimately effective but time-consuming interagency process.*

When the Soviet Union collapsed in 1991, the Ulba Metallurgy Plant near Ust-Kamengorsk, Kazakhstan, contained approximately 600 kilograms of weapons-grade HEU, sufficient for tens of nuclear weapons.[29] About five percent of the material—sufficient for one relatively primitive nuclear weapon—would have required little processing to make it bomb-usable, while somewhat greater processing would have been required for the remainder.

Established in 1949, the Ulba plant produced uranium dioxide powder and fuel pellets as well as HEU fuel for Soviet Alfa-class nuclear submarines.[30] HEU fabrication appears to have ceased in the 1980s, prior to the Soviet Union's collapse in 1991.[31] The facility was located in one of the formerly closed, secret Soviet "nuclear cities" in which scientists and other personnel lived lives of relative privilege, isolated from the surrounding world by high fences and armed guards. The degree of protection provided to these nuclear cities declined rapidly in the aftermath of the Soviet collapse. The HEU was stored in an earth-floored cinderblock building with half a dozen doors secured with padlocks.[32] A loading dock for trains leaving the city was located immediately behind the building.[33] Material accounting was based on old Soviet-style paper ledgers.[34]

U.S. knowledge of the Ulba facility was limited, prior to Kazakhstani independence, and it remains unclear when U.S. officials became aware of the HEU remaining there after the Soviet collapse.[35] By mid-1992, the U.S. Central Intelligence Agency reportedly learned of visits to the facility by Iranian nuclear experts.[36] There were also reports of beryllium purchases by Iran from the facility in 1992 and 1993, although these were subsequently denied by Kazakhstani authorities.[37] U.S. scientists later discovered canisters with Tehran addresses in a room adjacent to that where the HEU was stored, likely containing beryllium. After the United States expressed concern and the middleman in the deal was informed by the laboratory personnel that export licenses would be required, he disappeared, according to an American official.[38]

U.S. officials cited the considerable quantity of material at the site and fears of both state and non-state acquisition of the material as drivers for the operation to secure it.[39] Iranian interest in the facility was the most frequently mentioned proliferation concern. A key U.S. official characterized security as "poor" and indicated—based on both physical security and

U.S. intelligence that indicated foreign interest in the facility—that "the risk of proliferation was high."[40]

The HEU at Ulba was first brought to American officials' attention through a highly unusual diplomatic pathway. In August 1993, U.S. embassy official Andrew Weber was alerted to its existence by his local automobile mechanic, a communication that appears to have been authorized at senior levels of the Kazakhstani government.[41] It remains unclear why that means of communication was chosen. According to one source, the idea of approaching the Americans was that of the newly appointed director of the Kazakhstani Atomic Energy Agency, Vladimir Shkolnik, and was personally authorized by President Nursultan Nazarbayev.[42]

It also remains unclear whether Kazakhstan had approached Russia or other countries prior to the United States. Some Kazakhstani sources have stated that Russia was approached but declined to negotiate compensation for the material, while others have denied that account.[43] William Perry and Ashton Carter, then U.S. secretary of defense and assistant secretary, respectively, note the degree of trust evident in the decision to approach the United States and argue that this trust had been earned through earlier U.S.-funded "Nunn-Lugar" threat reduction efforts throughout Kazakhstan, Russia, Ukraine, and Belarus.[44]

Weber informed U.S. Ambassador to Kazakhstan William Courtney, who cabled Washington about the matter. The State Department quickly sought confirmation of the material from Russia, but neither the Ministry of Atomic Energy nor the Ministry of Foreign Affairs acknowledged the existence of the HEU at Ulba.[45] Courtney received instructions to pursue the matter further.[46]

In subsequent discussions with Courtney in October 1993, Kazakhstani officials expressed concern about their ability to adequately safeguard the material and more explicitly sought assistance from the United States.[47] They did not specifically request sending the material to the United States, but did suggest it be removed from Kazakhstan and placed under IAEA safeguards.[48]

The State Department's Office of Politico-Military Affairs was initially tasked with the issue.[49] But that office was principally focused on a variety of other proliferation challenges, including North Korea's refusal to comply with IAEA safeguards and Ukraine's reluctance to surrender the strategic nuclear weapons it had inherited from the Soviet Union. Kazakhstan's HEU was temporarily put on the back burner.[50]

In January 1994, the issue was tabled before a high-level White House National Security Council-chaired interagency working group that was meeting to discuss unrelated issues.[51] All participants were concerned about possible diversion of the material and agreed that addressing it was a high priority. Ashton Carter, then assistant secretary of defense for international security policy, agreed to take responsibility for resolving the issue at the suggestion of Rose Gottemoeller, then National Security Council senior director for nonproliferation.[52]

The group decided to designate an interagency "tiger team" to implement the effort. Chaired by the Defense Department's Jeffrey Starr, the tiger team included two representatives each from the State, Defense, and Energy Departments, and the military Joint Chiefs of Staff; three representatives from the intelligence community; and additional representatives from other agencies like the White House Office of Management and Budget, depending on the particular meeting.[53] The tiger team was given the authority to make decisions, as well as instructions to bring irresolvable issues back to the senior-level interagency working group. One official characterized the senior-level involvement as both a blessing and a curse, highlighting both the increased authority that stemmed from it and the fact that senior-level policymakers were often focused on other priorities.[54]

The tiger team met for the first time in February 1994 and subsequently on an ad hoc basis.[55] That month, Starr requested and authorized Energy Department physicist Elwood Gift to visit Ulba and obtain confirmation of the material's

presence and characteristics.[56] Accompanied by Weber, who arranged the visit from the U.S. embassy in Kazakhstan, Gift visited the facility, obtaining preliminary confirmation of the material as well as samples for further analysis in Washington.[57] In his report, Gift noted acerbically that the material was "protected by a good padlock."[58] Gift concluded that what he characterized as "poor security" was due largely to a lack of resources.[59] Gift's successful visit also provided confirmation of the Kazakhstani government's goodwill.[60]

The tiger team initially reviewed and contrasted four options: doing nothing, leaving the material at Ulba and upgrading security, moving it to another facility within Kazakhstan, or removing it from Kazakhstan.[61] Doing nothing was quickly rejected, since there was consensus that the threat posed by the material needed to be addressed.[62] Improving security at the site appeared an effective short-run strategy but participants were concerned about future political instability, necessary future maintenance and updating of security measures, and ongoing costs.[63] Moving the material within Kazakhstan—for example, to the caves and bunkers of the former Soviet nuclear test site of Semipalatinsk—appeared feasible but failed to address fundamental nonproliferation concerns.[64]

That left removing the material from Kazakhstan. But questions remained about where the material could be taken and whether Russia might stake a claim. At this early stage in U.S.-Russian threat reduction efforts there was also less confidence in Russia's ability to safeguard materials—a concern that has only partially been ameliorated today—hence sending the material to Russia was viewed as having many of the disadvantages associated with leaving it in Kazakhstan.[65]

Nonetheless, Energy Department officials—perhaps anticipating the political controversy that would ensue when the material was ultimately shipped to the United States—continued to advocate sending it to Russia, while their Defense Department colleagues sought to bring it to the United States, a debate that persisted for months.[66] Kazakhstani officials weighed in with concerns about avoiding a "trilateral" negotiation where Moscow might seek compensation even if the material were taken elsewhere.[67] And there were concerns that Moscow might try to veto independent U.S. action to address the site.[68]

State Department officials advocated discussion with Russia while Defense officials wanted to keep the effort bilateral.[69] The team ultimately decided to talk to Russia while avoiding multilateral negotiation, and instructions to that effect were cabled to the U.S. embassy in Moscow.[70] The Russian Ministry of Defense appeared disinterested.[71] Atomic Energy Ministry officials were hesitant and when pressed, said the issue should be handled by the Foreign Affairs Ministry.[72] That ministry said Russia was not interested in taking the material. When the issue was subsequently raised by Vice President Al Gore with Russian Prime Minister Viktor Chernomyrdin in June 1994, he confirmed that Russia was uninterested in the material and acquiesced to U.S. removal of it.[73]

The subsequent operation was kept as low profile as possible; hence most negotiations were conducted through Ambassador Courtney in Almaty rather than using outside negotiating teams.[74] In April 1994, Kazakhstani Atomic Energy Ministry Director Shkolnik visited Washington and engaged in preliminary negotiations on compensation.[75] The State Department initially decided it would not pay more than "market value" for the material, which it defined as the market value of the uranium contained in the fuel, ignoring the costs entailed in extracting it.[76] Shkolnik's response, according to one U.S. official, was to allude to the nuclear black market when he asked, "What market are you talking about?"[77]

U.S. officials acknowledged Shkolnik's point. As one official said, "Market value didn't seem quite right because they could have gotten much more from the bad guys."[78] And while some officials expressed concern that "everybody's going to try to dump uranium on us," other officials argued that given proliferation vulnerabilities, this might not have been such a

bad outcome.[79] Finally, U.S. officials also saw the project as an opportunity to engage Kazakhstan more broadly and transform the U.S.-Kazakhstani relationship.[80]

A U.S. government official closely involved with the operation indicated in an interview that the U.S. government offered $16,000 per kilogram and the Kazakhstanis initially asked for around $25,000 per kilogram, equivalent to a range of about $10 to $15 million for the total HEU.[81] Kazakhstan ultimately received an additional in-kind assistance package in the $20 million plus range and total compensation of $30 to $40 million, although the exact numbers have never been revealed by Washington, at the Kazakhstani government's request.[82] The Kazakhstanis changed their in-kind compensation demands while the packaging operation was in progress and negotiations did not conclude until after the material was moved, apparent evidence of good faith between the two countries.[83] Negotiations were finally concluded in spring 1995.[84] One official pointed out that much of the in-kind compensation was for efforts the United States intended to support independent of Project Sapphire and was tied to broader U.S. interests, such as increasing mobility for Kazakhstani security and border control forces.[85]

On October 8, 1994, more than a year after Kazakhstan had approached the United States, President Clinton gave final authorization for the operation.[86] Within hours, 31 scientists, engineers, and other personnel were en route to Ust-Kamengorsk on three Defense Department C-5 Galaxy cargo aircraft.[87] The team was led by Oak Ridge specialist Alex Riedy, and included nuclear, chemical, and industrial engineers, health physicists, industrial hygienists, packing experts, criticality safety engineers, maintenance technicians, a physician, and three Russian-speaking interpreters.[88] The aircraft also carried 130 tons of gear, including laboratory equipment, generators, satellite communications, and a maintenance depot.[89] The team's cover story for the operation: they were a group of American experts assisting Kazakhstan in preparing for its first full-fledged IAEA inspection following pending accession to the Nuclear Nonproliferation Treaty.[90]

Riedy and other Oak Ridge specialists had developed a plan for removing the material from its existing containers—which were not approved for transport on American aircraft—processing it, and repackaging it in U.S.-certified transport containers.[91] The team worked up to 14 hours per day, six days per week, to prepare the material for transport by mid-November.[92] The operation was characterized by technical surprises, stress, and tensions on the site between U.S. and Kazakhstani scientists that at one point required a visit by Ambassador Courtney to smooth over when it appeared the Energy Department might recall its personnel.[93]

On November 19 and 20, the material was trucked to the airport under Kazakhstani special forces guard.[94] The C-5s were loaded and flown to the United States with aerial refueling en route to avoid security and environmental regulation complications entailed in landing with the nuclear material on foreign soil.[95] Upon arrival in the United States, the material was loaded onto secure transports—trucks outfitted with "a veritable funhouse of violent tricks" to prevent theft—and transported to Oak Ridge for temporary storage.[96] It was later processed into LEU nuclear fuel under contract with a private firm.

Interagency tensions persisted throughout the effort. At one point there was apparent controversy over who would pay for the Defense Department-provided "meals-ready-to-eat" that were being provided to the Energy Department scientists at the site.[97] Concern was raised that the operation might become public after Energy Department officials worried about political controversy decided to brief the Tennessee government, state lawmakers, and candidates for electoral office without informing their tiger team colleagues, an action that infuriated at least one key official but did not result in any leaks.[98] The environmental assessment required under U.S. law was conducted on a classified basis, which later raised the ire of some environmental activists and government watchdog organizations.[99] And the U.S. Commerce Department at one point mistakenly accused the Kazakhstanis of dumping uranium on the U.S. market and demanded

a copy of their import license, according to one U.S. official.[100]

The interagency process began to break down at the end of the operation, according to one key official.[101] There was particular wrangling about funding and liability issues; the latter have consistently dogged U.S. efforts to address weapons of mass destruction material, facilities, and expertise abroad.[102] According to another official, in the final month senior policymakers seemed more focused on which agency would host the press conference than on substantive details.[103] The Defense Department apparently won that particular turf battle and on November 24, 1994, in a rare joint press conference, Defense Secretary Bill Perry, Secretary of State Warren Christopher, and Secretary of Energy Hazel O'Leary announced the operation's successful completion.[104] Perry emphasized at the press conference that the operation was unique and that further efforts were not planned.[105] Even as Perry was saying this, the U.S. government was aware that there were other caches of potentially vulnerable HEU still in Kazakhstan itself – at research facilities located in the Kazakh capital and near the Semipalatinsk test site. Most of those caches of HEU remain in Kazakhstan a decade later.

Although it did not lead to further near-term efforts to address nuclear material stockpiles, Project Sapphire had other long-term effects. It helped to create a critical mass of senior bureaucrats who had formed informal networks and subsequently worked together on related issues, such as the creation of the International Science and Technology Centers to employ former weapons of mass destruction scientists in Russia.[106] Slightly more formally, a key Sapphire participant notes that

> After Sapphire, OSD [Office of the Secretary of Defense] did organize a 'pre-emptive acquisition project.' The team consisted of [three officials], although the office was never given a formal structural existence. We did scour the world for proliferation threats, but not just uranium, also other WMD [weapons of mass destruction] materials, advanced conventional weapons, etc…[But] because OSD wouldn't formalize anything, we couldn't take the idea to [the White House National Security Council] to formalize a broader group in the [U.S. Government].[107]

Unfortunately, it appears that this effort to "scour the world for proliferation threats" did not lead to any additional removals of dangerous nuclear materials from vulnerable sites around the world.

The Sapphire precedent also likely motivated the newly independent state of Georgia to approach the United States about a fissile material stockpile that would be addressed in the next cleanout operation in 1998. And the Kazakhstani government had built up a relationship of trust with the United States and subsequently engaged with Washington to address its Stepnogorsk biological weapons production facility and Vozrozdeniye Island biological research and development site, which one U.S. official characterized as a direct result of Sapphire cooperation.[108]

Senator Richard Lugar (R-IN), concerned about the interagency wrangling over funding, subsequently spearheaded efforts to create a dedicated fund to meet urgent nonproliferation needs. The Nonproliferation and Disarmament Fund (NDF), housed in the State Department, has remarkable flexibility in allocating its modest annual budget and subsequently played a role in both the 1998 operation to remove material from Georgia and the 2002 operation in Yugoslavia, in addition to other nonproliferation efforts.[109]

## Operation Auburn Endeavor[110]

*Identified in the aftermath of Project Sapphire, this site was not addressed until several years later. Like Sapphire, the interagency effort was coordinated by the National Security Council and the Defense, Energy, and State Departments all playing key roles, although the effort lacked a strong proponent in government. After the Energy Department effectively ruled out the Sapphire option of taking material back to the United States and France declined to accept it, Britain played a key role by agreeing to receive the nuclear material. After Auburn Endeavor*

*was conducted, the Energy Department began slow-moving discussions with Russia and the IAEA on addressing the broader universe of civil sites with Soviet-origin nuclear materials.*

The research reactor at the Institute of Physics in Mtskheta, on the outskirts of Tbilisi, the capital of the former Soviet republic of Georgia, contained approximately 4.3 kilograms of fresh fuel. Most of that was HEU but the material also included a small amount of LEU fuel, as well as about 800 grams of HEU- and LEU-based spent fuel, according to U.S. officials. An additional 5.8 kilograms of LEU fresh fuel and 3.7 kilograms of LEU spent fuel were also eventually removed from the site, according to the British government.[111]

The light-water research reactor had been operational since 1959 and remained in operation until 1988.[112] The spent fuel was left over after a final shipment of fuel bound for a Russian nuclear facility in March 1991 could not accommodate five spent fuel rods.[113] The Soviet Union collapsed a few months later, leaving the institute with the spent fuel as well as 10 kilograms of HEU fresh fuel.[114] After a civil war that erupted in the aftermath of the Soviet Union's collapse eased, about 5 kilograms of HEU fuel was sent to a research reactor in Uzbekistan in August 1995.[115] The remaining fresh and spent fuel remained at the site.

Senior Georgian officials told the *New York Times* the material was virtually unsecured in the early 1990s while the civil war raged.[116] In fact, around this time several kilograms of HEU disappeared from another site near Sukhumi in the rebel-controlled Abkhazia region of the country. U.S. government officials with operational responsibility for nuclear nonproliferation efforts confirmed the apparent loss and indicated that to the best of their knowledge the material was never recovered, nor was it ever clear by whom or to where it was diverted.[117]

It is unclear when U.S. government officials first found out about the material at Mtskheta. Nongovernmental nonproliferation advocate William Potter had been raising the issue with officials since at least the mid-1990s.[118] And one participant in the 1994 Project Sapphire operation to remove HEU from Kazakhstan said that in the aftermath of that operation, attention had quickly focused on the material at Mtskheta.[119] Officials were concerned about physical security, particularly given what U.S. officials characterized as a "bad neighborhood" in the vicinity of Chechnya and Iran.[120] One official indicated that intelligence reports had indicated specific Iranian interest in the facility.[121] At the same time, a key National Security Council official explained the subsequent delay in addressing the site by saying that "nobody in the [U.S.] government saw this as a vital, pressing, urgent matter."[122]

A key Defense Department official countered that many officials did see the issue as urgent, but that "quick action was, bluntly, a casualty of interagency bureaucratic battling."[123] The official explained that "a key problem in Auburn was that the NSC refused (or at least didn't) appoint a lead agency. So all the agencies acted as leads in their areas, and it was a bit like having a coalition government try to develop an action plan."[124] According to the official, the State Department wanted to use the effort to highlight U.S.-Russian cooperation, the Energy Department wanted to run the effort itself but was concerned about bringing the material back to the United States, the Defense Department was impatient with the other agencies and thought the effort should highlight U.S.-Georgian cooperation, and the National Security Council was trying to keep the interagency bickering under control.[125] The official also noted that in intelligence estimates "the threat of diversion was never indicated…to be 'imminent,' which gave people the luxury…of being able to keep alive all these little disputes."[126] Interagency tensions persisted throughout. One official who recalled tensions between the Defense, Energy, and State Department officials working the effort noted that in particular, "DOD and DOE…they couldn't stand to be in the same room."[127]

The White House press release following the operation indicated that the Georgian government had approached the United States seeking assistance in dealing with the material, but officials were unable to provide further details.[128] By 1996, the U.S. Energy Department was

helping to perform a "basic" security upgrade at the site, but even post-upgrade "it was by no means secure."[129] At around this time, department officials proposed removing the fresh HEU to the United States in a January 1996 letter to White House.[130] That proposal did not mention the spent fuel at the site, also a proliferation risk. And the Energy Department appears to have quickly backed off, because other officials recount the Department's reluctance to consider bringing the material to the United States as a subsequent stumbling block.[131]

One key Defense Department official explained that "DOE was filled with trepidation about the domestic politics," calling this "understandable" given other nuclear-related controversies with various states, the legal challenges to the prior Project Sapphire, the fact that processing the Sapphire material had led to a number of complications that made for poor public relations, and most importantly, the fact that the Georgian material contained about 800 grams of spent fuel "nuclear waste" that could not be imported into the United States absent a legal waiver.[132] Another former administration official explained that in 1996 the Energy Department "was in the midst of an intense political fight to get U.S. take-back of U.S.-supplied HEU restarted" and that "bringing in foreign material would have confirmed everyone's worst fears that this would become an unlimited flood of other countries' nuclear waste coming into the United States."[133]

The presence of the site and U.S. government interest in addressing it was far from secret. The vulnerable material was first mentioned in an April 1996 *New York Times* article by journalist Michael Gordon, who cited American officials as "worried" about the proliferation risk posed by the "small cache of enriched uranium" at the facility.[134] U.S. officials subsequently convinced Gordon and his editors not to run a longer story about the site, telling them an operation to address the material was in the works and promising the *Times* an exclusive.[135] After repeated operational delays, Gordon finally went ahead with an article January 5, 1997 that detailed both the material at the site and the diplomatic difficulties between the United States and Russia.[136] Gordon noted that "the United States had wanted to keep the operation secret" but also that Georgian officials, including President Eduard Shevardnadze, had discussed the issue with him. The *Times* published an editorial two days later detailing the state of negotiations and urging Russia to quickly accept the material.[137]

In a last-minute response to Gordon's article, a senior State Department official issued a statement saying efforts were continuing to try to move the material to "a secure facility in Russia," but that Russia continued to stymie that effort.[138] Some American officials involved condemned Gordon's reporting as "grossly irresponsible," but at least one official said it provided much needed pressure to resolve bureaucratic logjams within the U.S. government.[139]

The State Department and White House had initially decided that Moscow should be given a chance to resolve the issue itself and offered Georgia "market value" of about $100,000 for surrendering the material to Russia.[140] But Russia did not play ball. In fact, for the following year Russia consistently stalled efforts to move the project forward, although it remains unclear whether as a result of bureaucratic ineptness, willful obstruction, or some combination of the two. Russian delegates failed to show for an early summer 1996 meeting in Tbilisi they were due to attend with American and Georgian experts.[141] Vice President Albert Gore raised the issue with Russian counterpart Viktor Chernomyrdin at a meeting in Moscow, and the head of Russia's Ministry of Atomic Energy Viktor Mikhailov subsequently assured the United States that Russia would remove the material by the following August.[142] But August came and went with no visible progress.

Russia then indicated that the canisters in which the material was stored had to be approved by nuclear regulators prior to transport. Washington offered to provide canisters, an offer Russia declined, dropping that issue.[143] When Moscow expressed concern about funds, the U.S. government agreed to advance Russia $1 million, to be returned minus any packing and handling expenses, but Russia never took Washington up on the offer.[144] Russian officials then said that as a result of environmental laws nuclear waste

remaining once the spent fuel was processed would have to be returned to Georgia, since it was now a foreign country and Russia could not legally accept foreign nuclear waste.[145] Given Georgia's lack of nuclear waste storage areas, this was not a viable proposal.

In January 1997, Mikhailov announced at a news conference, "We are preparing for this operation. I think we will be able to withdraw this fuel in February or March."[146] But the minister also noted that "dozens of ministries are involved. We must clear all of these operations with them." And he failed to clarify whether Russia was sticking to its previous, untenable position of returning the nuclear waste to Georgia.

A February 1997 assassination attempt on Shevardnadze highlighted the urgency of addressing the site. Washington finally decided to press ahead with the operation without Russia, although it did inform Moscow.[147] The Americans initially asked the French to take the material, but they declined.[148] Eventually the British government agreed to accept the material following six months of consultation among British government departments and with the American government.[149] Prime Minister Tony Blair decided to accept the material February 2, 1998, making an exception to British regulations against accepting foreign nuclear material in light of the proliferation concerns, a decision he reaffirmed during a visit to Washington in early February 1998.[150]

In a last minute negotiation setback, Defense Department attorneys determined that funds could not be spent without a signed "implementing agreement."[151] But the Georgian government indicated such an agreement would require ratification by the Georgian parliament, delaying the planned operation to remove the material.[152] U.S. officials suggested bypassing the legal issues by terming the agreement an "implementing *sub*-agreement," and after reluctant approval was obtained from legal advisors on both sides, inked "sub" onto the formal documents in pen before they were signed.[153] U.S. officials were unwilling to provide specific cost or compensation breakdowns; the *New York Times* reported that Georgia was to be paid approximately $125,000 (U.S.) and the operational costs totaled about $2 million.[154]

The removal effort was directed by the White House National Security Council and implemented by the Defense, State, and Energy Departments.[155] The State Department negotiated all agreements and managed the policy issues in Georgia and Britain. The Defense Department, through its European Command, was responsible for logistics, transportation, and coordinating security with Georgia. The Energy Department was responsible for the repackaging effort and interfacing with the Georgian Institute of Physics and the British Nuclear Industries Directorate and Directorate of Civil Nuclear Security.[156] Defense Department Cooperative Threat Reduction monies funded both Defense and Energy Department activities, supplemented by some funds from the State Department's Nonproliferation and Disarmament Fund.[157]

The actual packaging effort was conducted by an interagency task force that included Energy Department officials and Defense Department military personnel under U.S. European Command; it was headed by senior State Department officials.[158] Equipment and the operational team were transported to Georgia on two U.S. Air Force C-5B Galaxy cargo planes, the largest aircraft in the U.S. fleet.[159] Most of the equipment was tied down to three long-bed tractor trailers, while additional tractor trailers were contracted in Georgia and a 70-ton crane was contracted from Georgian industry.[160] The technical team, led by Energy officials, consisted of HEU handling, packaging, and transportation experts from Oak Ridge's Y-12 Plant run by the private Lockheed Martin Energy Systems as well as spent fuel handling and transportation experts from the private NAC International in Norcross in the U.S. state of Georgia.[161]

The United States supplied transportation casks for both the fresh and the spent fuel.[162] The fresh fuel repackaging operation required five days to setup, perform, repack, and tear down.[163] The spent fuel repackaging, conducted in parallel, required four days.[164] The *Times* reported April 21, 1998, that the operation was going

ahead, as material was still being packaged for transport.[165] There were also apparently earlier reports in the Georgian press as a result of the hard-to-disguise presence of American transport planes and the evident flurry of activity at the site.[166] A Defense Department spokesman acknowledged the effort at an April 21 news briefing.[167] The *Times* bizarrely termed it "one of the most secretive" of such operations in an April 24 story after having featured it in multiple front-page stories and even an editorial.[168]

The transport operation took place April 24, 1998.[169] The nuclear material, support equipment, and team were taken to the airport under Georgian Security Forces protection, with additional protection from U.S. Marines, according to one U.S. official.[170] The material was loaded onto one aircraft and the remaining equipment and logistics gear was loaded onto the other.[171] The containers were transported from Tbilisi, Georgia to Kinloss Royal Air Force Base outside Inverness, Scotland, with two air-to-air refuelings enroute.[172] From there they were transported to Britain's Dounreay Nuclear Complex for interim storage and final disposition.[173] The British government announced that the bulk of the material would be used to produce medical isotopes for cancer diagnosis and treatment, with the total quantity of material sufficient for 5 million cancer treatments.[174]

An additional 9.5 kilograms of LEU accompanied the agreed-upon 4.7 kilograms, which helped fuel the controversy that resulted when the operation became public.[175] Following an outcry among political opponents, environmental groups, and Scottish interests, Prime Minister Blair was forced to publicly defend his decision.[176] But much of the outcry appeared to focus on secrecy rather than the fundamental issues involved, with members of Parliament disconcerted that the story broke in the *New York Times* without so much as notification from the prime minister's office. Nonetheless, U.S. officials appear to have concluded that Auburn Endeavor was a one-off and that they could not plausibly send additional nuclear material to Britain in future.

## Project Vinca[177]

*The Vinca site was pulled out of the larger U.S. Department of Energy-led joint effort with Russia and the IAEA, intended to address a broad array of sites with Soviet-origin fuel, by State Department officials who concluded that there was an opportunity to address the site directly. The operation was negotiated by relatively few officials, explicitly seeking to minimize interagency processes, although the operation sometimes fell low on the list of priorities. This was the first "cleanout" operation to send material to Russia. The effort required a unique funding mechanism involving the participation of the nongovernmental Nuclear Threat Initiative. There was post-operation controversy about whether the U.S. government had the authorities necessary to fund the entire effort, with some officials claiming the government had not required NTI's involvement.*

The Vinca Institute of Nuclear Materials outside Belgrade in the Serbian portion of the former Yugoslavia contained sufficient HEU for several nuclear weapons. The research center housed just over 48 kilograms of HEU distributed across 5,000 fresh fuel slugs weighing a total of about 800 kilograms.[178] In addition, the site contained about 13 kilograms of HEU in about 220 kilograms of irradiated fuel, about 6 kilograms of plutonium distributed in about 3,000 kilograms of irradiated LEU fuel and to a lesser extent in the irradiated HEU fuel, and high- and low-level nuclear waste.[179]

Extracting weapons-usable HEU from the fresh fuel would have required relatively rudimentary but labor-intensive chemical processing. Identical chemical processing would be needed to extract HEU from the irradiated fuel, which had been cooling for years and whose radiation was not sufficient to make it considered "self-protecting" from theft, but this processing would have required either personnel willing to absorb substantial radiation doses, or at least rudimentary radiation-protection arrangements. Recovering the plutonium from the irradiated LEU fuel would have involved similar requirements to deal with the radiation, and would have been more difficult and labor-intensive, because of the chemical similarities of uranium and plutonium, and the extremely small percentage of pluto-

nium in the fuel (6 kilograms in 3,000 kilograms of LEU fuel).

Located on a substantial campus in a rural area, the institute had modest physical security, including fences and controlled access points.[180] The most proliferation-usable fresh fuel was targeted by the IAEA in the late 1990s for security upgrades, such as a metal storage cage that would have hampered a casual effort at diversion.[181] The institute was also under IAEA safeguards, hence was visited on a monthly basis by inspectors who verified the presence of proliferation-vulnerable materials.[182]

A Defense Department official involved in the 1994 Project Sapphire cleanout operation reported learning about the existence of nuclear weapons-usable material at Vinca in late 1994 or early 1995.[183] An Energy Department official reported knowledge of the material within the Clinton administration in the late 1990s.[184]

U.S. officials indicated the material at Vinca was a proliferation concern, particularly with regard to non-state actor proliferation.[185] The officials gave various explanations for why the material was not initially dealt with. According to a former Energy Department official, the primary problem was finding a site to locate the material for subsequent neutralization.[186] The official indicated that the political ramifications of Project Sapphire and Operation Auburn Endeavor meant that the United States and Britain were no longer viable locations absent a critical proliferation emergency. As a result, the administration "vigorously" pursued the issue with Russia, whose officials declined to accept the material, due to the absence of national legislation providing a legal basis for the transfer, according to this account. According to a State Department official who raised the issue with colleagues in the 1990s, poor relations between Washington and Yugoslavia's Milosevic regime complicated efforts, particularly since officials were hesitant to give Belgrade a "bargaining chip."[187]

Milosevic stepped down in October 2000 and was taken into Serbian police custody in April 2001. Around that time, dealing with the fresh, unirradiated HEU at the Vinca site (but not the other materials) was incorporated into a diplomatic package to engage the newly cooperative Yugoslavia.[188] The decision to address the Vinca material was made by Debra Cagan, an office director in the State Department's Bureau of European and Eurasian Affairs known to "play above her pay grade."[189] Although officials explained the decision to address the Vinca material with regard to its proliferation threat, they emphasized that the sense of a limited "window of opportunity" was the primary driver for the decision to address the Vinca material at that time.[190]

Cagan convened the team of State Department officials that managed the day-to-day implementation of the effort. Cagan had William Severe transferred to her office in winter 2002 so that he could assume responsibility for day-to-day management and coordination. Allan Krass, a nuclear energy expert in the department's Nonproliferation Bureau, served as principal technical advisor. Cagan played a central role throughout, obtaining support from Deputy Secretary of State Richard Armitage, arranging to have the issue briefed to National Security Advisor Condoleezza Rice, managing intra-department dynamics, and facilitating Russian approval by leveraging a pre-existing relationship with a senior Russian Ministry of Atomic Energy (Minatom) official.[191] The ability to point to Rice's support helped Cagan overcome institutional resistance within the State Department, particularly when she later relied on an unconventional and controversial tactic by bringing the nongovernmental Nuclear Threat Initiative (NTI) on board as a funder of the effort.[192]

In the spring of 2001, Cagan brought the State Department's Nonproliferation and Disarmament Fund on board. Established in the aftermath of the 1994 Project Sapphire operation to fund unanticipated, unusually difficult, or high priority nonproliferation projects, the fund has a modest budget of about $15 million.[193] The fund operates outside the traditional stovepipes of the State Department, and enjoys tremendous autonomy, as its authorizing legislation gives it authority, with a few exceptions, to carry out actions "notwithstanding any other provision of law," allowing it to carry out operations that

would not otherwise be permitted, such as providing assistance to a state under sanctions.[194] This autonomy is constrained through oversight by a board of four assistant secretaries, and routine Congressional oversight.[195]

Cagan sought funding for the HEU removal from NDF. Director Steven Saboe raised the prospective operation with his review panel in May 2001 and received approval the following month.[196] Ray Smith, an NDF negotiator, came on board at this point and subsequently served as chief of delegation for the detailed negotiations required out to hammer out the various agreements for the operation.[197] Together with Severe and Krass, Smith formed the team responsible for day-to-day implementation of the effort.

Cagan decided early on to remove the Vinca material from ongoing efforts to address the broader problem of returning Soviet-era fuel to Russia; the Energy Department had the implementation lead on that effort.[198] State Department officials explained that the move was intended "to get the pace to go faster," since the Vinca material could be addressed outside the slow-moving negotiations intended to cover all Soviet-origin material of concern.[199]

State Department officials consciously kept the operation low-profile. U.S. embassy officials in Belgrade were regularly used in place of outside negotiating teams, interagency negotiations were minimized, the Energy Department was effectively kept out of the operational planning loop, and the Defense Department played no role at all.[200] There was also a conscious effort to keep the operation quiet, both because of proliferation concerns and because of its potential political volatility in Yugoslavia.[201]

Compensation for the nuclear material was a key issue. State Department officials offered payment—negotiated into the contract as expenses related to removal in order to avoid the precedent of actually paying for material, consistently a concern for officials implementing cleanout operations—equivalent to the market value of the HEU, ignoring extraction costs (extraction was actually more costly than the value of the fuel, making it essentially worthless from a commercial perspective).[202] But even early on it was clear that such compensation was unlikely to suffice. The Serbian officials made it clear they expected their spent fuel problem dealt with in exchange for cooperation on the fresh HEU fuel.[203] State Department officials at the time considered this "way beyond our mandate," although some now claim they could have funded that work.[204]

Cagan sought to break the stalemate by bringing the nongovernmental NTI on board as a funder for spent fuel remediation activities. NTI, founded by media magnate Ted Turner and former Senator Sam Nunn in January 2001 to address weapons of mass destruction threats, had previously expressed interest in dealing with the Vinca material directly.[205] In July 2001, Cagan contacted NTI Vice President Laura Holgate seeking $5 million for the project, asking for a response within the week due to an upcoming visit by the deputy prime minister of Yugoslavia.[206]

After NTI officials satisfied themselves that the government could not fund the work itself—a claim Cagan buttressed with a legal analysis that other officials involved do not recall—they committed to the project.[207] Undersecretary of State John Bolton resisted NTI's involvement, but Cagan was able to leverage support from Armitage and others.[208]

In early August 2001, State Department officials in Washington and Belgrade began a multi-pronged effort to raise the issue with Yugoslav and Serbian counterparts.[209] At around the same time, Cagan also made initial overtures to the Russian government.[210] There was consensus among implementing officials that as a result of the political controversy around prior operations, the material could not be taken to either the United States or another nation and had to be returned to Russia. Cagan contacted Mikhail Ryzhov, responsible for foreign cooperation at Minatom, and quickly secured his support.[211] Cagan was then able to leverage Ryzhov's support to engage directly with two semi-autonomous Minatom institutes who would ultimately do the work of packaging, transporting, and receiving

the material, thereby building Russian constituencies for the operation.

State Department officials characterized Russia as unusually cooperative, which they attributed to both a general desire to cooperate on terrorism after the September 11 attacks and a specific desire to address the Vinca site.[212] Officials also noted that the operation could help Russia establish the legitimacy of nuclear fuel imports, which it is seeking to conduct to raise revenue, and that Russia did receive compensation for its Vinca participation.[213]

Initial responses from the Yugoslav and Serbian governments were unclear, and in the aftermath of the September 11, 2001 terrorist attacks, Cagan focused on issues related to the run-up to the war in Afghanistan, and Project Vinca stalled.[214] Nunn called Armitage twice during this time to keep the issue on the State Department radar.[215]

After several months of little activity, negotiations began in earnest in February 2002, when Smith and Krass traveled to Belgrade to offer Serbian Science Minister Dragan Domazet $700,000 for the fresh fuel removal.[216] Smith and Krass were under "strict instruction not to discuss [the NTI funds] with the Serb[ian]s" as a result of divisions within the State Department over NTI's involvement.[217] But Yugoslav officials had previously been presented with a package that included the NTI funds for spent fuel remediation and continued to expect a substantial quid pro quo in exchange for agreeing to remove the spent fuel, so early negotiations quickly bogged down.[218]

Around this time, the U.S. embassy in Belgrade contacted Holgate, then in Moscow, and asked her to explain NTI's potential role in the deal to Domazet via telephone.[219] Holgate instead decided to visit Belgrade in person, and subsequently met with Domazet along with Severe.[220] When "agreement in principle" was quickly reached, support was obtained from Armitage to keep Bolton, who had previously been resisting and undermining NTI involvement, "out of the picture," according to one State Department official.[221]

In subsequent negotiations, Yugoslav officials tried to explicitly link the U.S. operation to remove the fresh fuel with the spent fuel remediation to be funded by NTI. But the U.S. government was reluctant to formally tie the private NTI into the government-to-government arrangement; hence the two sides eventually agreed on a more informal process in which roughly parallel agreements were negotiated at each stage.[222]

NTI began assessing how it would contract for the spent fuel remediation and decided that considerations related to liability, accountability, and expertise made the IAEA the best implementing agent.[223] NTI's previous financial support for the agency facilitated collaboration to address Vinca, and IAEA pledges to rely on institute staff, to procure materials locally where possible, and to supplement NTI's $5 million with approximately $2 million of IAEA funds sealed the deal.[224]

In May and June 2002, Smith traveled to Moscow for "businesslike" negotiations with two Russian institutes that ultimately transported and processed the Vinca fresh fuel.[225] The project scored a coup when an ongoing Energy Department effort, the Materials Consolidation and Conversion program to consolidate and blend down Russian nonweapons-origin HEU, was integrated. Program Director Tom Wander had contacted State Department officials after learning about Project Vinca.[226] The program's incorporation reduced the funds Russia charged for the processing and downblending, saved the State Department additional funds by shifting some expenses to the Energy Department, and allowed the effort to take advantage of preexisting oversight and security arrangements.[227] Although the State Department had consciously kept the Energy Department largely out of the loop in preparation for Vinca, once the focus was on processing the material after it arrived in Russia both State and Energy Department officials characterized the degree of cooperation between their departments as unusual and remarkable.[228]

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.[229] U.S. officials were eager to move the material the following month; negotiations intensified in mid-July.[230] As negotiations became increasingly confrontational, U.S. officials began to make reference to unrelated aid, according to one observer.[231] They also arranged two additional concessions. The United States pledged to organize an international donors' conference to help fund spent fuel and nuclear waste cleanup, expected to require more than the funds that NTI and the IAEA had pledged. And Washington agreed to facilitate visits to the United States by Vinca scientists as part of an effort to find new missions for the institute.[232] The final agreement was hammered out July 15, in a late-night session over what was intended to be a celebratory post-negotiation dinner.[233]

The operation to remove the fresh HEU fuel was conducted in a few short weeks. Beginning August 15, Vinca scientists began packaging the material for transport, working in multiple-person operations with egress points guarded and a metal detector installed at the work area entry to reduce the risk of theft.[234] Two IAEA safeguards inspectors oversaw the process, as did several U.S. Energy Department scientists.[235]

On August 21, the transport containers were loaded onto a truck.[236] Late that night the material was transported to the airport, while two decoy convoys took alternate routes.[237] The operation was secured by 1,200 armed guards, including tactical units escorting the material, rooftop snipers, helicopter escorts, and uniformed police at every intersecting roadway.[238] Yugoslav nuclear scientists equipped to deal with unexpected contingencies, as well as U.S., Russian, and IAEA officials, accompanied the transport.[239] Some involved criticized the security as excessive.[240] Others argued that a loss of tactical surprise as a result of articles published in Belgrade newspapers and concern over protesters justified the effort.[241]

The material was loaded onto the transport plane, which departed on the morning of August 22 with an escort of two Yugoslav combat aircraft.[242] The transport plane landed in Ul'yanovsk, Russia, and the shipment was transported via truck to the processing facility, where its arrival was eventually verified by Russian and Energy Department representatives.[243]

As of this writing, the IAEA has begun to address the spent fuel problem at Vinca.[244] But even if the material can be analyzed and stabilized sufficiently to allow transport—a significant technical challenge—it is not clear when it might be removed. The material—which still contains 13 kilograms of irradiated HEU, which is not radioactive enough to be self-protecting against theft, along with a large quantity of LEU—is not considered a proliferation priority by U.S. officials (though some other experts consider it one) and Washington remains unwilling to fund the full spent fuel removal.[245] The donors' conference now appears unlikely to take place, although funding is likely to be sought through a broader "Global Threat Reduction Initiative Partners' Conference" announced for 2004 by U.S. Energy Secretary Abraham;[246] indeed, GTRI itself may in the end pay for shipping at least the HEU to Russia, as Secretary Abraham has said that GTRI will "work in partnership with Russia to repatriate all fresh and spent Russian-origin nuclear fuel that currently resides at research reactors around the world."[247] U.S. officials have also encouraged the Yugoslavs to seek funding from European countries.[248]

Back in Washington, there has been post-operation debate about whether NTI's participation was necessary or whether the U.S. government could have funded the operation itself. At the time of the operation, the State Department announced that "the U.S. Government lacks the authority to fund this critical element of the project."[249] But when the issue was raised by members of Congress concerned about the need to rely on a private organization to address a proliferation threat, assistant secretary-level officials from both the Energy and State Department claimed they had all the authority and funding they needed.[250] Whether accurate or not, such statements have hampered efforts by global cleanout proponents to prod Congress to provide additional authorities or even clarify existing ones.

## The Romania Operation[251]

*The Energy Department's "slow-and-steady" approach bore fruit for the first time as the Department collaborated with the IAEA and Russia in the first operation to break the one-every-four-years cycle. The operation was planned and implemented by the Energy Department, with modest reliance on the State Department for diplomacy and some technical expertise and with State Department officials clearly subordinate to the Energy Department. Negotiations were conducted through the IAEA and were considered straightforward. However, the spent fuel at the site will not be dealt with until Russia can overcome bureaucratic hurdles primarily related to environmental impact assessment.*

The Pitesti Institute for Nuclear Research west of Bucharest, the capital of Romania, had both Russian- and U.S.-origin research reactors. After the collapse of the Soviet Union, the facility remained in possession of Soviet-origin fresh and spent fuel as well as U.S.-origin spent fuel, which made it a "complicated and interesting case" for cleanout, according to a U.S. State Department official.[252] The Soviet-origin reactor was shut down in December 1997, while the U.S.-origin reactor remains in operation.[253]

The facility had approximately 14 kilograms of fresh, Soviet-origin 80-percent enriched HEU fuel,[254] insufficient material for the sort of primitive nuclear device terrorists could most readily build, but possibly sufficient for a relatively efficient implosion-type device. The quantity of material and the ease with which the fresh and hence minimally radioactive fuel could have been transported once stolen raised proliferation concerns in the U.S. government, U.S. officials told the *Washington Post*.[255] The facility appears to have had basic security measures in place. After the *Post* described the facility as "insecure," Romania's ambassador protested that the fuel had been securely stored until its removal and cited an Energy Department press release stating that the fuel was stored in a "secure location."[256] A U.S. official buttressed that conclusion, saying basic physical protection measures were in place.[257]

The site had been on U.S. officials' radar since at least 1999, when Energy Department officials "started to look at…where there were gaps of material we weren't currently addressing" and decided to begin targeting Soviet-origin research reactors with HEU fuel to supplement ongoing efforts to address U.S.-origin nuclear material.[258] Around that time, the Energy Department started "Tripartite Initiative" talks with Russia and the IAEA aimed at addressing these facilities, which numbered 20 to 25 sites spread across 17 countries, according to one key Energy Department official and Department documents.[259] (Another two countries, China and North Korea, also have Soviet-origin material but are not currently being addressed, the former because it is a nuclear-weapons state and the latter because of the lack of U.S.-North Korean diplomatic relations.)[260] Of those, six countries had more proliferation vulnerable fresh fuel (some in addition to spent fuel), the remainder less proliferation vulnerable spent fuel.[261] Three of the countries with fresh fuel—Bulgaria, Romania, and Libya—have since been targeted for cleanout operations—leaving only three, which have been "targeted" by the program, according to the official.[262] Additional countries have spent HEU fuel and officials plan to eventually address them as well.[263] Indeed, Secretary Abraham has indicated that under the GTRI, the Energy Department hopes to return all Soviet-supplied irradiated HEU to Russia by the end of 2009.[264]

In 2000, the IAEA director general sent a letter to eligible countries soliciting participation in the program.[265] Participation required agreeing to give up fresh HEU fuel and to either convert reactors to LEU fuel when it became available or shut them down entirely.[266] Both Romania and Bulgaria quickly expressed interest.[267] The two sites were included in the 24 (now apparently 20-25) identified by the United States as priorities after the completion of the 2002 Project Vinca.[268] A U.S. official emphasized that opportunity, rather than the urgency of the proliferation threat, was the key variable in the timing of the operations to address the two sites.[269] Another official explained that the countries were "easy targets: they were agreeable…they worked with us on an expedited basis."[270] The current

U.S. strategy, one official explained, is "picking the ripe fruit" and "doing shipments…where we can find them."[271] The Romania operation advanced to the head of the list after new Russian legislation that requires an environmental impact statement prior to the import of spent nuclear fuel led the Energy Department to focus its efforts on fresh fuel stockpiles, an official indicated.[272]

Romania's nuclear materials had been on the U.S. government radar for some time. The two countries had been discussing Romania's U.S.-origin reactor, which the country had begun converting from HEU to LEU fuel, a project it could not afford to complete, for fifteen years prior to the recent removal operation.[273] The United States had expressed willingness to assist but was unwilling to put up the several million dollars required to purchase the necessary LEU fuel.[274] A U.S. official explained that the only way the expense could be justified was to make it part of a package deal that addressed all of the materials of concern in Romania and hence had significant nonproliferation benefits.[275]

Efforts to address the site made progress as the United States and Russia moved to finalize an arrangement to address a wide array of Soviet-origin reactor fuel. In the summer of 2003, the White House approved the Energy Department's action plan for addressing Soviet-origin sites under the Tripartite Initiative.[276] The Romania operation was heralded as the first under what is now termed the Russian Research Reactor Fuel Return program.

In June 2003, the U.S. Energy and State Department representatives proposed a package deal to Romania.[277] The subsequent negotiations with Romania and other parties, including a French fuel fabrication company, were facilitated by the IAEA and were "very straightforward," according to one official.[278] In fact, the official emphasized that negotiations with all parties were notably smooth, highlighting in particular the Russian shipping company that has been involved with efforts since Project Vinca. The official attributed this to lessons learned from previous operations.

The Russian government has also been increasingly supportive, the official noted.[279] And multiple officials highlighted the vital facilitative role played by the IAEA.[280] Officials also noted that interagency relations between the Energy and State Departments were becoming smoother, which appears to be rooted in developing interpersonal relationships between key officials.[281] The Energy Department was the lead agency in the Romania operation, providing both the programmatic home and the funding. State Department officials provided substantial assistance, but carefully couched in an "advisory" or "supporting" capacity.[282] As one official explained, "everybody wants to keep it very clear, this is a DOE program."[283] The U.S. embassy in Romania was also used for some communications.

The final deal involved the United States purchasing LEU fuel for the U.S.-origin reactor, Romania agreeing to send the fresh HEU fuel to Russia, and the eventual shipment of the Soviet-origin spent fuel to Russia and U.S.-origin spent fuel to the United States. But an official emphasized that the spent fuel will be dealt with at some point in the future and will require further negotiation.[284]

According to one administration official, the United States will spend approximately $3.5 million to purchase the LEU fuel.[285] The United States apparently insisted that the Romanian government make a substantial contribution toward the fuel.[286] The United States also agreed to pay Russia between $300,000 and $500,000 for the transport of the material.[287] Unlike in Project Vinca, Russia took the material without charge, since its physical characteristics meant it could be profitably downblended into nuclear power plant fuel.[288] (The Vinca fuel was in a particularly difficult-to-extract form and hence not cost effective to extract.) Other U.S. officials declined to provide or confirm specific figures for either the compensation or the cost of carrying out the operation.[289]

The contracting was carried out by the IAEA because the government-to-government agreement between the United States and Russia had yet to be finalized.[290] (A U.S.-Russian govern-

ment-to-government agreement providing a legal umbrella for such cooperation on fuel returns to Russia was finally signed by Washington and Moscow on May 27, 2004.)[291] Although U.S. officials characterized the IAEA as "very helpful," they also noted that its participation invariably adds implementing complications that delay operations.[292] The fresh fuel was loaded into eight Russian transport containers by Romanian scientists and technicians the day before it was due to be shipped.[293] IAEA safeguards inspectors and U.S. Energy Department technical experts monitored the process.[294] On September 21, 2003, the material was transported to the Bucharest airport, loaded onto a Russian IL-76 cargo plane, and flown to Novosibirsk in Siberia, Russia.[295] From there it was transported to the Novosibirsk Chemical Concentrates Plant run by Russia's Minatom, where it will be down-blended and used for nuclear power plant fuel fabrication.[296]

According to a U.S. official, the Romanian government has expressed satisfaction with the outcome, although like Project Vinca, that is likely contingent on additional promised steps being taken by the United States and Russia.[297] The shipment of the Soviet-origin spent fuel awaits Russia's completion of an environmental review, while the U.S.-origin material will eventually be repatriated but for now remains at the site.

## The Bulgaria Operation

*Negotiated at the IAEA as part of the same process that produced the previous Romania operation, the Bulgaria initiative was similar to the Romania effort and is an additional sign that the Energy Department's efforts are finally bearing fruit. As was the case with Romania, the operation was planned and implemented by the Energy Department, with modest reliance on the State Department. Negotiations were conducted through the IAEA and considered straightforward. Energy Department officials expect similar operations to take place in the coming months and years.*

The Institute of Nuclear Research and Nuclear Energy in Sofia, Bulgaria, housed a Soviet-origin research reactor and 17 kilograms of Soviet-origin 36 percent enriched HEU fuel.[298] The institute's reactor had been built in 1959, fueled in the early 1960s, and was shut down in 1989.[299]

The fuel, on the low end of the HEU enrichment spectrum, could have been used in the construction of a nuclear weapon, but a far larger quantity would have been required. Alternately, the material could have been further enriched, particularly by a proliferant state like Iran that possessed enrichment technology. A U.S. official cited the non-irradiated character of the material as a concern, since this would make its transportation following theft relatively easy.[300] A key Energy Department official said the facility provided "adequate physical protection" of the material but that storage arrangements were "just a temporary solution."[301] It is unclear when U.S. officials first found out about the facility and its material.

The cleanout effort was the second under the Energy Department's Russian Research Reactor Fuel Return Initiative, the name used for the U.S. contribution to the U.S.-Russia-IAEA "Tripartite Initiative." As noted earlier, the Energy Department has the negotiation and implementation lead on that program, while the State Department plays a supporting role. After negotiations at the IAEA, much as was the case for the previous cleanout operation in Romania, a contract was concluded in early December between Bulgaria—represented by Institute of Nuclear Research and Nuclear Energy personnel—the United States, the Russian firm that was contracted for the transport, and the IAEA.[302]

As with the prior operation in Romania, U.S. government officials declined to provide details of the compensation package or the expense of the operation itself.[303] The *Washington Post* reported that it had cost $400,000 while the *New York Times* reported $440,000, but neither specified whether this was compensation to Romania, the cost of carrying out the operation, or the total expense of the project.[304]

The material packaging and transport was implemented within the scope of a regional IAEA technical cooperation project in which Bulgaria is engaged.[305] The actual packaging and

transport required 48 hours to complete.[306] The operation began when an IAEA team, accompanied by American and Russian nuclear engineers, removed storage cask seals and verified the materials' quantities and characteristics.[307] The IAEA safeguards inspectors and the other nuclear engineers then monitored the process of loading the fuel into four fresh fuel transportation canisters provided by Russia.[308]

The material was removed from Bulgaria on December 23, 2003.[309] The transport from the reactor site to the Gorna Oryahovista airport, 100 miles to the northeast, was guarded by special units of the Bulgarian police.[310] At the airport, the casks were loaded onto a Russian AN-12 cargo plane and flown to Dmitrovgrad, Russia, where the material will be downblended to commercial nuclear reactor fuel.[311] The reactor will eventually be reconstructed to utilize LEU fuel and will be used by Bulgaria primarily for education and training purposes.[312]

# Imagining Worst and Best Outcomes

The previous analysis has outlined the threat posed by civil nuclear materials and the inadequate, haphazard efforts made to date to address it. One useful exercise is to consider best and worst case scenarios. What outcome would have represented a true policy failure? What outcome would have represented a clear policy success? The absence of these outcomes—and particularly the worst-case outcome—may be due more to providence than policy, but that makes their contemplation all the more important.

## Policy Failure

Imagine a worst case: In the early 1990s, impoverished nuclear technicians in Kazakhstan are contacted by a middleman offering to pay top dollar for fissile material. The technicians negotiate a compensation package that includes tens of millions of dollars (U.S.) in cash as well as promises of assistance leaving the country after the deal goes through. The middleman obtains sufficient HEU for several primitive nuclear bombs; the bodies of the technicians are found in an abandoned safe house weeks later.

Although the theft is detected a few days after it occurs during a routine patrol, embarrassed Kazakhstani authorities spend several additional days fruitlessly trying to track the material down before informing the United States. By the time a full-fledged response that includes U.S. interdiction assistance has been mobilized, the material is well on its way to Taliban-controlled Afghanistan, host to terrorist group Al Qaeda. Its minimal radioactivity makes it very difficult to detect, even with the costly portable radiation detectors the United States recently provided to Kazakhstani border guards, and also means that it can be transported with little risk to those who have stolen it.

Initially the lost material remains high on the U.S. national security agenda. But authorities are unable to tie prime suspect Iran to the theft and after several years of little progress, the issue gradually leaves the spotlight as the United States focuses on other priorities. In the interim, Western-trained Pakistani technicians with experience in metallurgy, conventional explosives, and electronics spend a few months helping Al Qaeda construct several primitive nuclear devices in an industrial workshop housed in one of the many caves in northern Afghanistan. The devices, each weighing almost a ton and the size of a large home refrigerator, are eventually smuggled into the United States in ship-borne containers filled with dense metal components: extra insurance in case the containers are among the few percent of incoming shipments subject to X-ray inspection. The containers are rigged so that the inspection that would follow a suspicious X-ray result would detonate the weapons. But the bombs are not detected. The containers are loaded onto flatbed trucks which are driven to several rented warehouses. Late at night on September 10, 2001, the trucks depart the warehouses.

On the morning of September 11, 2001, a series of nuclear explosions levels the White House and surrounding executive branch office buildings, the Pentagon, and much of central Manhattan. Areas not directly devastated by the attack are

subject to intensely radioactive fallout tens of kilometers downwind from the blasts. Hundreds of thousands are killed instantaneously, additional thousands overwhelm hospitals, and anarchy breaks out on the nation's highways as millions attempt to evacuate the stricken areas.

Although President George W. Bush is not at the White House and hence survives the attack, the nation's government is thrown into disarray. Relative order is restored within days, although decontamination and reconstruction of the attack sites will take years. The attacks trigger a deep economic recession in the United States. A global chain reaction follows, triggering recessions in already fragile economies around the globe. The short-term death toll is 500,000, with many more seriously injured; including those who will die of various cancers in the following years as a result of radiation exposure, it exceeds one million.

### Policy Success

Now imagine a best case: In 1992, early in the Clinton administration, as the magnitude of the potential nuclear hemorrhage from the former Soviet Union becomes clear, the president asks for a prioritized assessment of the nuclear threat to the United States and a prioritized action plan for addressing it. Civil nuclear material ranks high on the list and the president orders a program to be established within the next budget cycle to address it. Administration officials work with Congress to establish a dedicated office in the Energy Department, generously funded through the defense authorization and appropriation bills and with the full backing of the president and senior administration officials. The program's administrators are empowered with an unprecedented degree of flexibility, with oversight from both high-level executive branch officials and Congress.

By 1993, countries known or suspected to have nuclear material are being contacted directly, unearthing material in places where the United States did not know it existed, such as Kazakhstan. The administration's public championing of successful operations leads additional countries to come forward in 1993 and 1994, motivated both by the available compensation and by a desire to reap some of the evident global goodwill associated with the effort.

Efforts to denuclearize former Soviet republics and to address weapons and weapons-origin fissile material in Russia and other newly independent former Soviet states proceed apace, but they are complemented by a comprehensive "global cleanout" effort to address the civil nuclear material threat. By the end of 1996, a combination of carrots and sticks has allowed the United States to remove nuclear material from the vast majority of sites and to dramatically upgrade security at most of the relatively few sites where removal is not feasible. Some material is taken to the United States, some to Russia, and some to a small group of cooperating states that includes Britain, Canada, and France. The United States and its allies are manifestly safer. The president has managed to leave a defining legacy by the end of his first term in office. Total cost, including compensation to target countries and the cost of implementing operations: less than $400 million, or one tenth of one percent of the current annual defense budget of the United States.[313]

## Patterns from the Cases

The cases highlight a remarkably consistent pattern of passivity in site identification; incoherence in site selection; sluggish implementation; allowing Russia to stymie progress; and failure to productively engage third-parties.

### Passivity in Site Identification

The process by which the U.S. government identified candidate sites for "cleanout" operations is characterized by remarkable passivity. In each case, sites were discovered accidentally or arose on the agenda haphazardly. Throughout the cases there is no evidence of any systematic U.S. government effort to identify sites with dangerous materials or to conduct a "vulnerability assessment" of sites that have already been identified. All the officials interviewed stated that such an assessment had not been conducted, although some speculated that the relevant

information might have been obtained but not shared by the U.S. intelligence community.

## Incoherence in Site Selection

Operations occurred only when foreign countries contacted the United States to express their desire to have material removed or when officials within the U.S. government identified and pursued specific sites. In the latter cases, these officials consistently viewed the efforts they spearheaded as one-offs, with the modest exception of the two most recent operations, which are part of a larger effort to address Soviet-origin material. To the extent that prioritization is evident in the selection of the sites targeted in the two most recent operations, it is prioritization according to the ease with which the sites could be addressed rather than the proliferation threat they posed. As one U.S. official explained with reference to the two most recent operations, the current strategy is "picking the ripe fruit," hence opportunity rather than urgency of proliferation threat is the key variable in explaining the operations that have been conducted.[314] Another official made the point in a striking fashion by explaining that Romania had advanced to the head of the list *not* because of the proliferation vulnerability of the substantial amount of fresh HEU it possessed, but because newly passed Russian legislation had complicated dealing with sites that had less proliferation vulnerable spent fuel.[315] The ease with which a site can be addressed is surely a relevant factor, but the notion that it should form the core strategy appears flawed. Prioritization is vital *despite* the fact that other factors will inevitably influence whether and when an operation is conducted.

## Sluggish Implementation

Even once sites had been identified and selected for "cleanout," implementation required months and more often years. In contrast, the actual operations to package and remove material required only days or weeks. The sources of delay include intra- and interagency dynamics within the U.S. government, negotiations with the target country, and engagement with Russia, which played a role in every case, whether it was part of the final solution or not. Given the parallel nature of these processes, it is difficult to be specific about their individual contribution to the delay observed in each operation, but the cases make clear that they are all significant factors. Internal U.S. government-generated delay and external U.S. government-target country delay have a similar source and are discussed in this section. Russia's role deserves special discussion and is dealt with in a subsequent section.

Internal and external delay were due to the ad hoc nature of operations, the absence of clear lines of authority, and insufficiently empowered implementing officials, all of which stem to some degree from a lack of high-level awareness and support.

Because each operation was ad hoc, officials had to "reinvent the wheel" for each successive effort rather than developing standard operating procedures that could be rapidly implemented. Formally, this applies to legal procedures such as contracts. Liability, for example, was repeatedly an issue, as it has been for a range of U.S. threat reduction efforts.[316] More informally, it applies to the intra- and interagency and external relationships that expedite efforts. Informal relationships are at least as important as formal ones; perhaps more so. In those cases where informal relationships had a chance to develop, they substantially facilitated the implementation of subsequent operations. Hence the Russian shipping company that has been involved in the three most recent operations is becoming notably adept at interacting with U.S. and other officials.[317] And Energy and State Department officials appear to be developing interagency working relationships that have facilitated the most recent two operations. (Negative informal relationships can also play a role: the tensions between Energy and Defense Department officials during Project Sapphire, for example, probably played a role in the difficult interagency process that characterized Operation Auburn Endeavor.)

The cases highlight the extent to which clear lines of authority between officials and agencies expedited implementation. This lesson may have been at least partially internalized by U.S.

government actors, since the cases demonstrate progressively more clear-cut organizational approaches. In Project Sapphire and Auburn Endeavor, in which the agencies were roughly on par, interagency cooperation was ultimately effective but enormously cumbersome and time consuming. Cooperation in the case of Vinca was relatively smooth, with the State Department as clear lead and Energy playing a subordinate role, although less by institutional design than because lead actor Debra Cagan decided to effectively sideline the Energy Department. Cooperation in the two most recent operations, in which the Energy Department was the clearly designated lead agency, appears to have been substantially smoother. A clear understanding of who is in charge and what each player's responsibilities and authorities are appears to facilitate efforts, while lack of clarity on these points impedes them.

The lack of empowerment of implementing officials is notable. The exception to the rule may be Project Sapphire, but the number of officials engaged in the process and what appears to have been a consensus-based approach more than outweighed any efficiency gains from empowered implementing officials. The Vinca effort provides the most striking example. The lead official, Debra Cagan, had to engage in extraordinary bureaucratic tactics, most notably the unprecedented step of bring the nongovernmental NTI in to help fund the effort. Cagan, like other officials, was not empowered to prioritize speed and effectiveness over what were ultimately small amounts of money. In every operation, the United States engaged in lengthy negotiations with target countries over compensation. If the materials in question had leaked and sparked a burst of proliferation, the United States would have spent billions or even trillions of dollars attempting to neutralize the threat.[318] If speed is a priority, dollars must become less of one. Of course the United States must be careful not to excessively bid up the price of nuclear materials, but Washington brings substantial external leverage to the table to ensure that this does not occur, and modest differences in cost are a relatively minor concern compared to the proliferation risk posed by needlessly slow implementation.

All of these problems stem substantially from a lack of high-level awareness and support. This lack of support is clear throughout the cases. Again the exception is Project Sapphire, in which the most high-level officials, including the Vice President, were personally engaged and whose slow implementation is due to other factors. Operation Auburn Endeavor floundered because it lacked a patron in government. Project Vinca occurred thanks to the efforts of an official seven layers down in the State Department bureaucracy who "played above her pay grade" and successfully lobbied senior State Department and White House officials. And the two most recent operations were the culmination of a multi-year process precisely because senior officials failed to make them a priority.

## Varying Incentives Needed to Convince Facilities to Give Up Material

In most of the cases considered here, substantial incentives were needed to convince facilities and the states where they were located to allow the HEU at the sites to be removed. The incentives required in each of these cases were quite different. In Project Sapphire, the incentives included both assistance to the facility from which the HEU was being removed and funding for cooperative projects not directly related to the facility or its HEU. In the case of Project Vinca, funding for dealing with the site's spent fuel and radioactive wastes was essential to sealing the deal. In the Romanian operation, U.S. agreement to fund the purchase of an LEU core for the U.S.-supplied Romanian reactor was critical to getting Romanian agreement to give up the Soviet-supplied HEU. Since these cases were explicitly selected as ones where there was an opportunity to remove material without great difficulty, future cases involving facilities that have been far more reluctant to give up their HEU are even more likely to require substantial incentives—and given the wide variation in the operations that have already occurred, it is difficult to predict exactly what incentives will be needed in the future.

### Allowing Russia to Stymie Progress

Russia was a player and a central obstacle in every operation, including those cases in which it was not part of the final solution and those in which it played a central role. Although it is possible that at times U.S. officials blamed Russia for delays for which it was not responsible, officials also appear to have found dealing with Russia genuinely frustrating as they attempted to implement cleanout projects. In Project Sapphire, Russia's failure to coherently interact with the United States appears to have been a function of genuine internal disorder. In the subsequent Operation Auburn Endeavor, Russia's unwillingness to move forward constructively was likely motivated at least in part by its complicated relationship with the former Soviet republic of Georgia, and its desire not to encourage U.S. meddling in its "sphere of influence"—although as with Sapphire, a degree of incompetence cannot be ruled out as a causal factor.

Project Vinca highlighted substantially improved U.S.-Russian collaboration, in large part because implementing official Cagan was able to leverage a pre-existing relationship with a senior Russian policymaker. And in the two most recent operations Russia appears to be playing an increasingly constructive role, although the negotiations necessary to reach that level of cooperation required several years to conduct. A former U.S. official involved with cooperative threat reduction efforts indicated that Russian officials diagnose the primary problem as a lack of high-level engagement and pressure to spur a reluctant bureaucracy to action.[319] Senior Russian officials place little priority on threat reduction efforts, and therefore are only willing to undertake projects when the United States not only pays their full cost but also compensates Russia for its involvement, the official observed.[320]

### Failure to Effectively Engage Third Parties

Several of the cases demonstrate a failure to effectively engage third parties. In Auburn Endeavor, other potential recipients of the nuclear material waffled until Britain agreed, after six months of negotiation, to take it. In no other case did the United States seriously pursue sending material to another country. Nor did it seek to engage other countries in negotiating, financing, or carrying out operations, despite the inherently global nature of the civil nuclear material threat. (The Global Threat Reduction Initiative Partners Conference proposed by Energy Secretary Abraham is intended to address this concern.) And although Project Vinca demonstrates innovative engagement of a nongovernmental organization, engaging either commercial or non-profit nongovernmental actors does not appear to have been considered in any of the other cases, despite the expertise and funds potentially available from these sources. That said, the evident complications entailed in dealing with third parties—particularly Britain but also the IAEA and perhaps NTI—may have motivated officials to minimize their participation in an effort to streamline implementation.

## The Solution: A Comprehensive, Prioritized, Empowered Program

The weaknesses of current efforts identified above call for specific solutions. The passivity in site identification calls for a comprehensive threat assessment. The incoherence in site selection calls for a prioritized implementation plan based on that threat assessment. Sluggish implementation requires a coherent program with clear lines of authority and empowered officials, none of which are possible without increased awareness and support from senior policymakers. The need for a variety of incentives to convince facilities to give up their material requires flexible legal authority to offer a wide range of inducements and political instructions to use it. Russian reluctance or passivity requires diplomatic engagement at the highest levels. And the failure to effectively engage third parties can be remedied by diplomacy aimed at countries that have so far been rhetorically supportive of threat reduction but demonstrated

relatively little engagement, as well as exploring possible efforts in collaboration with non-governmental entities.[321]

## Comprehensive Global Threat Assessment

Currently there exists no comprehensive list of all sites with weapons-usable nuclear materials—or even a comprehensive list of all non-military sites holding such materials. Resolving this deficiency is a necessary condition for any viable large-scale cleanout initiative. Officials involved with operations to date admitted they had access to no such list, although some speculated that the information likely resided within the intelligence community. But to the extent that it does exist and is not shared with the policymakers who work on this issue, the information might as well not have been compiled. A comprehensive threat assessment would include, for each site, specifics on the quantities and characteristics of the nuclear materials present there, the current level of security at the site, a threat assessment that incorporated relevant terrorist or other activity in the region or specific location, and opportunities to engage specific sites by meeting anticipated or enunciated needs. A combination of U.S. government information from multiple sources and IAEA databases, supplemented by a modest amount of targeted collection, should be sufficient to compile such a list. For the most part, targeted collection can consist of contacting countries to confirm stockpiles or conducting nuclear audits, perhaps in collaboration with the IAEA. Matthew Bunn refers to this form of less-than-glamorous but often surprisingly effective intelligence-gathering as "ASKINT."[322] A task force within the Energy Department has been tasked with conducting such a threat assessment, which is being integrated into the GTRI initiative.

## Prioritized Global Implementation Plan

With a comprehensive threat assessment in hand, a prioritized, global implementation plan must be developed. That plan should allow particularly high-risk sites (based on a combination of the characteristics of the materials located there, the level of security at the site, and the stability of the region) to be addressed in an expedited manner, and should allow the U.S. government to prioritize its overall approach to the global cleanout challenge. The ease of conducting particular operations should figure into the order in which they are undertaken, but is not in its own right a coherent guiding metric for a cleanout effort aimed at keeping nuclear materials away from terrorists and hostile states. The implementation plan should be comprehensive: all potentially threatening nuclear materials must be covered where feasible, regardless of their country of origin (primarily U.S. and Soviet but including a few other countries), their physical characteristics (including more esoteric nuclear fuels), and other factors (e.g. political relations with the target country). In principle, the GTRI now has the task of preparing such a global implementation plan.

## Coherent Program with Adequate Resources

The cases make clear that a single office is needed within the U.S. government with the resources, authority, expertise, and flexilibility needed to implement a cleanout agenda. This is the stated purpose of the GTRI. Rapid, comprehensive, and flexible implementation—which can only be accomplished with the sustained support of senior officials—will be essential for GTRI to achieve its goals. Past efforts were fragmented across offices and agencies. The GTRI office must be given a clear leadership role on the issue and adequate resources and must be able to draw on the expertise and resources of other agencies when needed. All of this will require high-level administration and Congressional engagement and leadership. Engagement is easy to call for but difficult to achieve; policymakers have their own priorities and to date, "global cleanout" has not ranked high on those lists. Studies such as this one can go some way towards raising the issue's profile by enunciating a coherent case for a global cleanout initiative.

Resources adequate to get the job done will be critical to success. The funds requested for the various component parts of GTRI related to removals of HEU in the Bush administration's

fiscal year (FY) 2005 budget request amount, in total, to some $24.75 million.[323] Simply continuing the previously planned budgets for these programs is clearly not sufficient: if the effort is to expand to cover additional materials (such as the two-thirds of the U.S.-supplied HEU abroad that was not previously covered by the U.S. take-back effort), additional facilities (such as critical assemblies, pulsed power reactors, HEU-fueled icebreakers, and more, none of which were adequately covered by the previous programs) and additional incentives for facilities to give up their HEU, more funding will be needed.[324] By one independent estimate, a funding level of some $50 million per year would be sufficient for the part of GTRI focused on high-priority removals of HEU from vulnerable nuclear facilities.[325] As Congress considers the Energy and Water appropriations bills for FY 2005, it should consider increasing the resources available for this high-priority effort to keep the essential ingredients of nuclear weapons out of the hands of terrorists and hostile states.

## Flexibility to Target Incentives as Needed

One critical lesson of the cases is that to rapidly remove vulnerable nuclear material around the world, it will be necessary to offer generous incentives targeted to the needs of each facility—and the states where these facilities are located—to convince them to agree to the removal of their nuclear material. Given the wide range of incentives that have been needed in the past, it is very difficult to predict exactly what kinds of incentives will be needed in the future. Hence, it is absolutely critical that those charged with implementing GTRI be given flexible authority (including both unambiguous legal mandates and instructions to use them fully) to negotiate incentives as required in each case. As the previously mentioned Domenici-Feinstein amendment authorizing a global HEU removal effort is discussed in the House-Senate conference committee, the committee members should work with the administration to ensure that adequate flexibility is provided.

## Diplomatic Engagement with Russia

Whether due to intransigence or disinterest, Russia has substantially slowed a number of these past efforts. But simply bypassing Russia is in most cases not an effective strategy. Much of the nuclear material of greatest concern is of Soviet origin. Hence Russia feels a sense of ownership and almost certainly has a legal say over its final disposition. It is particularly likely to invoke the latter in those cases where material, because of the ease with which valuable HEU can be extracted from it, has substantial economic value. Countries possessing much of the material of concern are in Russia's traditional "sphere of influence," meaning that attempts to bypass Russia would risk diplomatic affront (although sometimes that may be worth risking). And it is far easier from both a regulatory and a public relations perspective to take Soviet-origin material to Russia than it is to ship it to the United States or another country, particularly if spent fuel (seen by some as "nuclear waste") is included in the package. Hence the United States *must* engage Russia more effectively. President Bush should communicate to his counterpart Vladimiar Putin that securing vulnerable nuclear material is a priority of the United States government. Russia needs to assume legal and moral responsibility for Soviet-origin nuclear materials. Moscow should be encouraged to act in a "swords to plowshares" manner, applying the facilities and expertise developed to support the Cold War superpower standoff to reducing the threat posed by vulnerable nuclear materials.

## Engaging Third Parties

Nuclear materials are a global threat; hence a comprehensive solution must be global in character. The United States should encourage other countries to take on key challenges, facilitating those efforts and then engaging to address gaps not covered by other countries. This is not a call for formal multilateralism; instead, a range of bilateral or trilateral operations can be undertaken with a variety of different "coalitions of the willing." A number of developed countries have the capability to store and process nuclear material, strongly support nonproliferation efforts (at least rhetorically if not always through action),

and likely have more political credibility in countries where the motivations of the hegemonic, nuclear-capable United States may be viewed skeptically. Canada, for example, has both the facilities and expertise to deal with nuclear materials and would be viewed with far less suspicion by some countries with nuclear material. And the Project Vinca collaboration with the nongovernmental NTI highlights the constructive role nongovernmental actors can play. For example, fresh HEU often has economic value, making private transactions (under national and international safeguards) to remove and convert the material feasible. At a minimum this possibility deserves further exploration.

# Conclusions

Current U.S. President George W. Bush's rhetoric is heartening. For example, the White House's 2002 National Security Strategy states,

> 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.[326]

But the president and senior administration officials need to back rhetoric with action; if and when they do so, Congress must support them. As this study makes clear, securing bomb-usable nuclear material is eminently feasible from a diplomatic, technical, and financial perspective, and would leave a lasting legacy in the form of a world in which nuclear terrorism and nuclear proliferation to states were far less likely to occur.

The efforts announced by the U.S. government in spring 2004 offer the potential for the kind of comprehensive, prioritized, and accelerated effort that is urgently needed. To fulfill that promise will require sustained high-level engagement informed by the lessons of past efforts. Speed is of the essence. As former Senator Sam Nunn has observed: "We are well past the time where we can take satisfaction with a step in the right direction. A gazelle running from a cheetah is taking a step in the right direction. But it's not just a question of direction; it's a matter of speed."[327] The stakes are high. Some proponents of cooperative efforts to reduce weapons of mass destruction threats ask: The day after a nuclear September 11th, what will U.S. officials wish they had done?[328] If Washington fails to seriously address the global cleanout challenge, neutralizing the proliferation threat posed by a vulnerable civil nuclear material stockpile may be the rueful answer to that question.

# Notes

[1] Philipp C. Bleek, "Project Vinca: Lessons for Securing Civil Nuclear Material Stockpiles," *Nonproliferation Review* 10 (Fall-Winter 2003), pp. 1-23.

[2] As this study was being finalized, a sixth "cleanout" operation was conducted to remove 16 kilograms of 80 percent enriched HEU from Libya. The IAEA announced March 8, 2004, that the Soviet-origin material had been returned to Russia under the U.S.-Russia-IAEA Tripartite Initiative (for more information on the initiative, please see the case studies below of the Romania and Bulgaria operations). (See, for example, "U.S., Russia Receive Last of Libya's Nuclear Material," *Nuclear Weapons and Materials Monitor,* March 9, 2004, pp. 5-6.) In addition to these cases relating to Soviet-supplied HEU, the U.S. program to take back U.S.-supplied HEU from facilities around the world has been proceeding, but is not documented in this study. By October 2003, 1.1 tons of U.S.-supplied HEU had been returned to the United States from research reactors around the world since the restart of the take-back effort in 1996 (out of some 17.5 tons of U.S.-supplied HEU abroad as of 1996); in some cases, these shipments resulted in all HEU being removed from particular sites. As of early 2004, however, more than 12 tons of U.S.-supplied HEU was not covered by this take-back program. See U.S. Department of Energy, Office of Inspector General, *Audit Report: Recovery of Highly Enriched Uranium Provided to Foreign Countries,* DOE/IG-0638 (Washington, D.C.: DOE, February 2004; available as of July 8, 2004 at <http://www.fas.org/irp/agency/doe/ig-heu.pdf>).

[3] The Nuclear Threat Initiative deserves credit for this way of framing the weapons of mass destruction nonproliferation imperative.

[4] 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 Matthew Bunn, Anthony Wier, and John P. Holdren, *Controlling Nuclear Warheads and Materials* (Washington, DC: Nuclear Threat Initiative and Managing the Atom Project, Harvard University, March 2003), p. 9.

[5] David Albright, "Al Qaeda's Nuclear Program: Through the Window of Seized Documents" *Policy Forum Online* Special Forum 47 (Berkeley, CA: The Nautilus Institute, November 26, 2002). Available as of January 26, 2004 at <http://www.nautilus.org/fora/Special-Policy-Forum/47_Albright.html>.

[6] Bunn et al., *Controlling Nuclear Warheads and Materials,* pp. 15-16.

[7] The phrase "nuclear blackmail," used by current National Security Advisor Condoleezza Rice, among others, frequently in the context of justifying U.S. national or global missile defense deployment, effectively appears to denote deterrence exercised against the United States.

[8] The vulnerabilities of the Russian nuclear complex have been extensively documented. See, for example, Matthew Bunn, "The Threat in Russia and the Newly Independent States," available as of July 8, 2004 at <http://www.nti.org/e_research/cnwm/threat/russia.asp>; and Matthew Bunn and Anthony Wier, "Anecdotes of Insecurity," available as of July 8, 2004 at <http://www.nti.org/e_research/cnwm/threat/anecdote.asp>.

[9] There is some debate about the quantities of fissile material necessary to construct a nuclear bomb. The generally accepted minimum quantities are 4 kilograms of plutonium or 12-15 kilograms of HEU enriched to 90 percent U-235 or greater, the former figure based on declassified U.S. government information. Constructing weapons with such small quantities of material would require relatively efficient "implosion" designs, which would be quite challenging for a terrorist group to construct. (More sophisticated implosion designs would reportedly require somewhat less.) The sort of primitive and hence inefficient gun-type design terrorists might attempt with stolen HEU would require approximately 50 kilograms of very highly enriched material or greater quantities of material of lesser enrichment.

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

[11] Manhattan Project scientists had sufficient confidence in their conservative design that the gun-type device the United States dropped on Hiroshima was never tested. South Africa based its nuclear program on a similar design and appears to have had confidence in its arsenal absent testing, although the country may have conducted a clandestine test in 1979.

[12] Matthew Bunn and Anthony Wier, *Securing the Bomb: An Agenda for Action* (Cambridge, MA: Harvard University, May 2004), p. 38.

[13] Matthew Bunn, written communication, August 13, 2003.

[14] 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. (Frank von Hippel, Princeton, New Jersey, written communication with author, August 8, 2003 and David Albright, Frans Berkhout, and William Walker *Plutonium and Highly Enriched Uranium, 1996: World Inventories, Capabilities and Policies* (Solna, Sweden: SIPRI, 1997).

[15] Treaty on the Non-Proliferation of Nuclear Weapons (NPT), Article V, available as of July 14, 2004 at <http://disarmament2.un.org/wmd/npt/npttext.html>.

[16] The 20 tons figure is from Albright, Berkhout, and Walker, *Plutonium and Highly Enriched Uranium, 1996,* op. cit., p. 253. But the U.S. Department of Energy estimates that there are 40 tons of HEU or separated plutonium at civilian facilities in Russia and the other states of the former Soviet Union (of which more than 95% is in Russia); the majority of this material is likely to be HEU. Indeed, DOE estimates that 29 tons of HEU (primarily, though perhaps not exclusively, from civilian facilities) in the former Soviet states is available for downblending to LEU. See U.S. Department of Energy, *FY 2004 Detailed Budget Justifications—Defense Nuclear Nonproliferation* (Washington, D.C.: DOE, 2003; available as of June 29, 2004 at <http://www.mbe.doe.gov/budget/04budget/content/defnn/nn.pdf>), p. 644 and p. 647).

[17] See International Atomic Energy Agency, *Nuclear Research Reactors of the World* (Vienna, Austria: IAEA, September 2000), supplemented with personal communications to Matthew Bunn by James Matos, Argonne National Laboratory, and Iain Ritchie, International Atomic Energy Agency, 2002.

[18] Matthew Bunn, interview, March 29, 2004.

[19] Ibid.

[20] Ibid., and Bunn et al., *Securing the Bomb,* p. 142.

[21] After the September 11, 2001 terrorist attacks, "Bush ordered his war counsel to give nuclear terrorism priority over every other threat to the United States," James Lindsay and Ivo Daalder write in the recently published *America Unbound*. That directive translated into efforts to better screen cargo coming into the United States, bolster last-minute interdiction and post-attack response capabilities, and the launch of a preventive war against Iraq. It does not appear to have translated into increased support for the first and arguably most important line of defense, efforts to secure the vulnerable nuclear materials without which nuclear terrorism would be infeasible. (James Lindsay and Ivo Daalder, *America Unbound* (Washington, DC: Brookings Institution, 2003), p. 119.)

[22] For a comprehensive discussion of what remains to be done, see Bunn and Wier, *Securing the Bomb,* op. cit. For an assessment of current efforts from a long-time advocate of threat reduction efforts, see Richard Lugar, "Eliminating the Obstacles to Nunn-Lugar," *Arms Control Today* 34, March 2004.

[23] Former U.S. Department of Defense official, interview, March 25, 2004.

[24] For important early discussions of the need for an expanded and accelerated effort to remove HEU from vulnerable sites, see Bunn, Wier, and Holdren, *Controlling*

*Nuclear Weapons and Materials,* op. cit.; Matthew Bunn, John P. Holdren, and Anthony Wier, *Securing Nuclear Weapons and Materials: Seven Steps for Immediate Action* (Washington, DC: Nuclear Threat Initiative and Managing the Atom Project, Harvard University, May 2002); and Robert L. Civiak, *Closing the Gaps: Securing High Enriched Uranium in the Former Soviet Union and Eastern Europe* (Washington, D.C.: Federation of American Scientists, May 2002).

[25] "Global Threat Reduction Initiative Highlights" Fact Sheet, Department of Energy, May 26, 2004.

[26] Ibid.

[27] "Senate Approves Domenici-Feinstein Amendment Seeking to Prevent Terrorists from Obtaining Nuclear Materials" Press Release, Office of Senator Dianne Feinstein, May 19, 2004.

[28] As noted earlier, a sixth removal, from Libya, was completed as this study was being finalized.

[29] 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), p. 345.

[30] Ibid., p. 346. Its use for submarine fuel arguably made this the material "military" rather than "civil." That said, at the time of the operation the Kazakhstani government had assumed control of the facility and its material, and it was no longer being used for military purposes; hence it is classed here as civil rather than military nuclear material.

[31] Ibid., p. 346.

[32] U.S. Department of Defense official, interview, June 26, 2003 and U.S. Department of Defense official, interview, July 24, 2003.

[33] U.S. Department of Defense official, interview, July 24, 2003.

[34] U.S. Department of Defense official, interview, June 26, 2003.

[35] Potter "Project Sapphire," p. 347.

[36] Ibid., p. 347.

[37] Ibid.

[38] U.S. Department of Defense official, interview, June 26, 2003.

[39] U.S. Department of Defense official, interview, July 24, 2003 and U.S. Department of Defense official, interview, June 26, 2003.

[40] U.S. Department of Defense official, interview, July 24, 2003.

[41] U.S. Department of Defense official, interview, June 26, 2003 and Potter, "Project Sapphire" p. 349.

[42] U.S. Department of Defense official, interview, July 24, 2003 and Potter, "Project Sapphire," pp. 348-349.

[43] Potter, "Project Sapphire," pp. 349-350.

[44] Ashton B. Carter and William J. Perry, *Preventive Defense* (Washington, DC: Brookings Institution, 1999), p. 67.

[45] Potter, "Project Sapphire," p. 349.

[46] Ibid.

[47] Ibid.

[48] Ibid.

[49] Ibid., p. 350.

[50] Potter, "Project Sapphire," p. 350 and Department of Defense official, written communication, March 29, 2004.

[51] U.S. Defense of Defense official, written communication, March 29, 2004. In his account ("Project Sapphire"), Potter apparently erroneously states that this meeting took place in March.

[52] Ibid.

[53] Potter, "Project Sapphire" p. 351 and U.S. Department of Defense official, interview, July 24, 2003.

[54] U.S. Department of Defense official, interview, July 24, 2003.

[55] U.S. Department of Defense official, written communication, March 29, 2004. In his account ("Project Sapphire") Potter apparently erroneously says the first meeting took place in March.

[56] U.S. Department of Defense official, written communication, March 29, 2004.

[57] U.S. Department of Defense official, interview, June 26, 2003.

[58] Ibid.

[59] U.S. Department of Defense official, interview, July 24, 2003.

[60] Ibid., and U.S. Department of Defense official, interview, June 26, 2003.

[61] U.S. Department of Defense official, interview, July 24, 2003 and Potter, "Project Sapphire," p. 351.

[62] U.S. Department of Defense official, interview, July 24, 2003.

[63] Ibid.

[64] Ibid.

[65] Ibid.

[66] Potter, "Project Sapphire," pp. 352-354.

[67] Ibid., p. 352.

[68] Ibid.

[69] U.S. Department of Defense official, interview, July 24, 2003.

[70] Potter, "Project Sapphire," p. 353.

[71] Ibid., p. 353.

[72] Ibid.

[73] Ibid., p. 353-354.

[74] Ibid., p. 354.

[75] U.S. Department of Defense official, interview, June 26, 2003.

[76] Ibid.

[77] Ibid.

[78] U.S. Department of Defense official, interview, July 24, 2003.

[79] Ibid.

[80] Ibid.

[81] U.S. Department of Defense official, interview, July 24, 2003.

[82] Ibid.

[83] Potter, "Project Sapphire," p. 358.

[84] Ibid.

[85] U.S. Department of Defense official, interview, July 24, 2003.

[86] Potter, "Project Sapphire," p. 355.

[87] Ibid.

[88] Ibid., p. 355.

[89] Ibid.

[90] U.S. Department of Defense official, interview, July 24, 2003.

[91] Ibid., and Potter, "Project Sapphire," p. 355.

[92] Potter, "Project Sapphire," p. 357 and U.S. Department of Defense official, interview, June 26, 2003.

[93] U.S. Department of Defense official, interview, June 26, 2003.

[94] Ibid.

[95] Potter, "Project Sapphire" p. 357.

[96] Carter et al., *Preventive Defense* p. 66.

[97] U.S. Department of Defense official, interview, June 26, 2003.

[98] U.S. Department of Defense official, interview, July 24, 2003.

[99] U.S. Department of Defense official, interview, June 26, 2003.

[100] Ibid.

[101] U.S. Department of Defense official, July 24, 2003.

[102] Ibid., and Potter, "Project Sapphire," p. 352. For a comprehensive discussion of liability issues as they relate to threat reduction programs in Russia, see R. Douglas Brubaker and Leonard S. Spector, "Liability and Western Nonproliferation Assistance to Russia: Time for a Fresh Look?" *Nonproliferation Review* 10 (Spring 2003), pp. 1-39.

[103] U.S. Department of Defense official, interview, June 26, 2003.

[104] Carter et al., *Preventive Defense*, p. 67

[105] Jim Adams, "U.S.-Kazakhstan Uranium Deal May Be One of A Kind," *Reuters* November 24, 1994.

[106] U.S. Department of Defense official, interview, July 24, 2003.

[107] U.S. Department of Defense official, written communication, June 21, 2004.

[108] Ibid.

[109] For a detailed discussion of the Operation Auburn Endeavor effort to remove nuclear material from Georgia, please see pages 15-21. For a detailed discussion of the Project Vinca operation to remove nuclear material from Yugoslavia, please see pages 21-29.

[110] This operation was given various names: The White House called it "Operation Auburn Endeavor," U.S. military personnel and called it "Auburn Endeavor," the U.S. Energy Department called it "Project Partnership," Oak Ridge National Laboratory personnel called it "Project Olympus," and the Georgians called it "Program Export." Source: NTI "Georgia: Operation Auburn Endeavor" Available as of April 27, 2003 at <http://www.nti.org/db/nisprofs/georgia/auburn.htm> and "Operation Auburn Endeavor" The White House Office of the Press Secretary, April 24, 1998.

[111] NTI, "Georgia: Operation Auburn Endeavor."

[112] Thomas A. Shelton, James M. Viebrock, Alexander W. Riedy, Stanley D. Moses, and Helen M. Bird, "Multilateral Nonproliferation Cooperation: U.S.-Led Effort to Remove HEU/LEU Fresh and Spent Fuel from the Republic of Georgia to Dounreay, Scotland (Auburn Endeavor/Project Olympus" Presented at the 1998 International Meeting on Reduced Enrichment for Research and Test Reactors, Sao Paulo, Brazil, October 18-23, 1998, p. 2.

[113] Michael R. Gordon, "Russia Thwarting U.S. Bid to Remove a Nuclear Cache," *New York Times,* January 5, 1997, Section 1, p. 1.

[114] Ibid.

[115] Ibid.

[116] Ibid.

[117] U.S. National Security Council official, interview, July 21, 2003; U.S. Department of Energy official, interview, January 30, 2004; and U.S. Department of Energy official, interview, June 26, 2003.

[118] William Potter, interview, June 25, 2003.

[119] U.S. Department of Energy official, interview, June 26, 2003.

[120] Michael R. Gordon, "Russia Thwarting U.S. Bid to Remove a Nuclear Cache," *New York Times,* January 5, 1997, Section 1, p. 1 and former U.S. Department of Energy official, interview, January 30, 2004.

[121] Former U.S. Department of Energy official, interview, January 30, 2004.

[122] Former U.S. National Security Council official, interview, July 21, 2003.

[123] U.S. Department of Defense official, written communication, March 29, 2004.

[124] U.S. Department of Defense official, written communication, June 21, 2004.

[125] U.S. Department of Defense official, written communication, March 29, 2004.

[126] Ibid.

[127] U.S. administration official, interview, July 23, 2003.

[128] "Operation Auburn Endeavor," The White House Office of the Press Secretary, April 24, 1998.

[129] U.S. Department of Energy official, interview, January 30, 2004.

[130] Michael R. Gordon, "Russia Thwarting U.S. Bid to Remove a Nuclear Cache," p. 1.

[131] U.S. National Security Council official, interview, July 21, 2003 and U.S. Department of Defense official, interview, June 26, 2003

[132] U.S. Department of Defense official, written communication, March 29, 2004.

[133] U.S. administration official, written communication, June 7, 2004.

[134] Michael R. Gordon, "Nuclear Insecurity—A Special Report; Russia Struggles in Long Race to Prevent an Atomic Theft," *New York Times,* April 20, 1996, Section 1, p. 1.

[135] Former U.S. administration official, interview, undated.

[136] Gordon, "Russia Thwarting U.S. Bid to Remove a Nuclear Cache," p. 1.

[137] "Insecure Nuclear Materials," (editorial) *New York Times,* January 7, 1997 p. A16.

[138] Gordon, "Russia Thwarting U.S. Bid to Remove a Nuclear Cache," p. 1.

[139] Former U.S. administration official, interview, July 23, 2003 and former U.S. administration official, interview, undated.

[140] Gordon, "Russia Thwarting U.S. Bid to Remove a Nuclear Cache," p. 1.

[141] Ibid.

[142] Michael R. Gordon, "Russia Vows to Remove Georgia Nuclear Fuel," *New York Times,* January 14, 1997, p. A8.

[143] Gordon, "Russia Thwarting U.S. Bid to Remove a Nuclear Cache," p. 1.

[144] "Insecure Nuclear Materials," (editorial), *New York Times,* January 7, 1997, p. A16.

[145] Ibid. and Scott Parrish and Emil Danileyan, "Russia Ready to Accept Uranium from Georgia," *OMRI Daily Digest*, January 13, 1997.

[146] Gordon, "Russia Vows to Remove Georgia Nuclear Fuel," p. A8.

[147] Michael R. Gordon, "U.S. and Britain Relocate a Cache of Nuclear Fuel," *New York Times,* April 21, 1998 p. A1.

[148] NTI, "Georgia: Operation Auburn Endeavor."

[149] Select Committee on Trade and Industry Minutes of Evidence, "Examination of Witness, Mr. D. Henderson (Questions 243-259)," July 1, 1998, United Kingdom Parliamentary Website, Accessed January 22, 2004 at <http://www.parliament.the-stationery-office.co.uk/pa/cm199798/cmselect/cmtrdind/815/80701p03.htm>

[150] Ibid., and Gordon, "U.S. and Britain Relocate a Cache of Nuclear Fuel," p. A1.

[151] U.S. Department of Defense official, interview, June 26, 2003.

[152] Ibid.

[153] Ibid.

[154] Gordon, "U.S. and Britain Relocate a Cache of Nuclear Fuel," p. A1.

[155] Shelton et al., "Multilateral Nonproliferation Cooperation," p. 3.

[156] Ibid., p. 4.

[157] U.S. Department of Defense official, interview, June 26, 2003 and U.S. Department of Energy official, interview, January 30, 2004.

[158] Shelton et al., p. 2.

[159] Ibid., p. 6.

[160] Ibid.

[161] Ibid., p. 2.

[162] Ibid.

[163] Ibid., p. 6.

[164] Ibid., pp. 6-7.

[165] Gordon, "U.S. and Britain Relocate a Cache of Nuclear Fuel," p. A1.

[166] Ibid.

[167] Captain Mike Doubleday, "DOD News Briefing," April 21, 1998.

[168] Stephen Kinzer, "U.S. Agents Whisk Atom Bomb Material From an Ex-Soviet Land," *New York Times,* April 24, 1998, p. A7.

[169] "Operation Auburn Endeavor," The White House, Office of the Press Secretary, April 24, 1998, and Stephen Kinzer, "U.S. Agents Whisk Atom Bomb Material From an Ex-Soviet Land," *New York Times,* April 24, 1998, p. A7.

[170] U.S. Department of Defense official, interview, June 26, 2003.

[171] Shelton et al., p. 7.

[172] Ibid., pp. 2, 7.

[173] Ibid., pp. 2, 7.

[174] "Nuclear Material (Reprocessing)," Statement by Foreign Office Minister of State, Mr. Doug Henderson, House of Commons, April 22, 1998. Accessed January 22, 2004 at <http://www.parliament.the-stationery-office.co.uk/pa/cm199798/cmhansrd/vo980422/debtext/80422-22.htm>.

[175] Select Committee on Trade and Industry Minutes of Evidence, "Examination of Witness, Mr. D. Henderson (Questions 243-259)."

[176] Warren Hoge, "Blair Defends His Decision to Accept Atom Material," *New York Times*, April 23, 1998, p. A6.

[177] An expanded version of this case was previously published by the author as "Project Vinca: Lessons for Securing Civil Nuclear Material Stockpiles," *Nonproliferation Review* 10 (Fall-Winter 2003), pp. 1-23.

[178] 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.

[179] Ibid.

[180] Laura Holgate, interview, June 16, 2003.

[181] Hopwood et al., "Cooperative Efforts," p. 2 and William Hopwood, interview, July 3, 2003.

[182] International Atomic Energy Agency official, interview, July 7, 2003.

[183] U.S. Department of Defense official, interview, July 24, 2003.

[184] Rose Gottemoeller, interview, June 26, 2003.

[185] U.S. Department of State official, interview, July 3, 2003; U.S. Department of State official, interview, June 25, 2003; and U.S. administration official, interview, July 8, 2003; and U.S. Department of State official, interview, June 20, 2003.

[186] Gottemoeller, interview, June 26, 2003.

[187] U.S. Department of State official, interview, June 20, 2003.

[188] 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.

[189] Holgate, interview, June 16, 2003.

[190] 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.

[191] 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 Holgate, interview, June 16, 2003. The Ministry of Atomic Energy has since been reorganized and renamed the Federal Agency for Atomic Energy.

[192] U.S. Department of State official, interview, June 25, 2003.

[193] For more information, see the initial discussion of the Nonproliferation and Disarmament Fund on page 18.

[194] Nonproliferation and Disarmament Fund, "Mission Statement," available as of June 1, 2004 at <http://www.ndf.org/html/goalsobj.html>.

[195] U.S. Department of State official, interview, June 25, 2003 and U.S. Department of State official, interview, July 3, 2003.

[196] U.S. Department of State official, interview, June 25, 2003.

[197] U.S. Department of State official, interview, July 3, 2003.

[198] Holgate, interview, June 16, 2003, and Matthew Bunn, written communication, October 5, 2003.

[199] U.S. Department of State official, interview, July 3, 2003 and U.S. Department of State official, interview, June 20, 2003.

[200] 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; Holgate, interview, June 16, 2003; U.S. Department of Defense official, interview, July 24, 2003; and U.S. Department of Defense official, interview, June 26, 2003.

[201] U.S. Department of State official, interview, June 20, 2003 and U.S. Department of State official, interview, June 25, 2003.

[202] U.S. Department of State official, interview, June 20, 2003 and U.S. Department of State official, written communication, July 21, 2003.

[203] Holgate, interview, June 16, 2003; U.S. Department of State official, interview, July 3, 2003; and U.S. administration official, interview, July 8, 2003.

[204] U.S. Department of State official, interview, July 3, 2003 and U.S. Department of State official, interview, June 20, 2003.

[205] Holgate, interview, June 16, 2003 and Charles Curtis, interview, June 16, 2003.

[206] Holgate, interview, June 16, 2003.

[207] Holgate, interview, June 16, 2003 and Brooke Anderson, Catherine Gwin, and Holgate, written communication, August 8, 2003.

[208] U.S. Department of State official, written communication, July 21, 2003; U.S. Department of State official, written communication, July 21, 2003; and Holgate, interview, June 16, 2003.

[209] U.S. Department of State official, written communication, September 8, 2003; U.S. Department of State Office of the Spokesman, "Daily Appointments Schedule: August 2, 2001" and U.S. Department of State official, interview, June 20, 2003 and U.S. Department of State official, interview, June 25, 2003.

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[318] Steven Miller deserves credit for this observation.

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[321] This section draws in part on the suggestions for a "global cleanout" effort made by Matthew Bunn and his co-authors, who coined the term. See, for example, Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Matierals,* op. cit., pp. 115-118, and also pp. 112-113 relating to the need for a comprehensive database and threat assessment for sites with nuclear materials worldwide; see also the previous volume from the same authors, *Securing Nuclear Weapons and Materials,* op. cit.

[322] Bunn's term plays off technical terms for various types of intelligence, such as "SIGINT" for signals intelligence and "HUMINT" for human intelligence.

[323] This includes $4.918 million for DOE's take-back program for U.S.-supplied HEU, $9.965 million for the Reduced Enrichment for Research and Test Reactors (RERTR) program, and $9.866 million for the Russian Research Reactor Fuel Return program. Anthony Wier, personal communication, June 2004.

[324] For discussions of these gaps in past U.S. efforts, see Bunn and Wier, *Securing the Bomb,* op. cit., pp.58-59, and Frank von Hippel, "What We Are *Not* Doing With Regard to Highly Enriched Uranium (HEU) Reactor Fuel," presentation to University of Chicago Advisory Committee on Nonproliferation, May 27, 2004.

[325] See Bunn et al., *Controlling Nuclear Warheads and Materials,* op. cit., p. 115.

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