



TOM CLANCY MIGHT WELL HAVE crafted the story line for "Project Sapphire": 600 kilograms of weapons-grade uranium left over from a secret Soviet submarine program and then forgotten; the rediscovery of the material by Kazakhstani authorities at an ill-protected facility on the windswept steppes of Central Asia; a race against the onset of winter by a team of U.S. scientists and technicians who were preparing the sensitive cargo for airlift out of Kazakhstan; the discovery of empty canisters with Tehran addresses during the repacking of the uranium; and the successful removal of more than the declared inventory of highly enriched uranium from the vulnerable facility. Its resemblance to a Hollywood thriller notwithstanding, Project Sapphire was a real-world nonproliferation success story. Its outcome, however, was not preordained. The case shows both the opportunities and challenges of post-Cold War diplomacy and suggests possible lessons about the problems of and prospects for nonproliferation progress in the former Soviet Union.

At the time of its demise in December 1991, the Soviet Union maintained a vast complex of nuclear research, production, and storage facilities, in addition to an enormous stockpile of nuclear weapons. The complex included the massive Ulba Metallurgy Plant, located 20 miles outside the Kazakhstani city of Ust-Kamenogorsk. Set up in 1949 and known simply as "Mailbox 10" prior to 1967, the plant served a number of different functions over the years, including production of most of the uranium dioxide powder and fuel pellets fabricated in the Soviet Union.¹ The Ulba plant was also the Soviets' principal producer of dual-use, nuclear-related beryllium and of tantalum. Only recently was it learned that during the Brezhnev era, the facility acquired the additional military function of fabricating highly enriched uranium (HEU) fuel for Soviet naval-propulsion reactors as part of the secret Alfa nuclear submarine program.

It remains unclear precisely when the Ulba facility began or ceased to fabricate HEU. At a 23 November 1994 press conference, former plant director Vitalii Mette reported that the uranium airlifted from Ulba had been produced beginning in the 1960s and ending in 1976-1977.² U.S. analysis of the recovered HEU suggests that it was of more recent origin, however. Regardless, work with HEU appears to have ceased at the Ulba plant in the 1980s. But a large inventory of HEU - approximately 600 kilograms - remained at the plant into the 1990s, most likely forgotten by officials in Moscow after the Alfa program was abandoned.

It is doubtful that more than a handful of officials in the newly independent state of Kazakhstan were familiar with the cache either. In any case, little attention appears to have been paid to the significance of the HEU - if indeed anyone remembered that it existed - until Vladimir Shkolnik visited the site in 1992, after he was appointed director of Kazakhstan's Atomic Energy Agency. U.S. knowledge of and interest in the Ulba plant was very limited prior to Kazakhstani independence. The facility was best known as the site of a large explosion in September 1990 that dispersed large amounts of toxic beryllium into the air. By mid-1992, however, the United States may have begun to pay closer attention to Ulba's nuclear-related activities. There were news reports, for example, that in August 1992, the CIA learned of a visit by Iranian nuclear experts to the Ulba plant.³ There are also many media accounts of Iranian purchases of beryllium from Ulba in 1992 and 1993. Although those reports - denied by Kazakhstani authorities - are difficult to corroborate, there are multiple indications that Iran was interested in Kazakhstan's nuclear-related activities. By fall 1993, Iran had explored the possibility of opening a consulate at Aktau on the Caspian Sea - the location of Kazakhstan's sole nuclear power plant, a BN-350 liquid-metal fast-breeder reactor. It is also well documented that canisters with Tehran addresses were stored in the room next to the one containing the HEU at the Ulba plant.

Those particular canisters, probably filled with beryllium, were discovered in 1994 and were not exported. But it is uncertain whether there were other exports to Iran from Ulba. More recently, Ergali Bayadilov, director-general of the Kazakhstani Atomic Energy Agency, reportedly acknowledged that Iran had formally approached Kazakhstan in 1992-1993 to purchase low-enriched uranium and beryllium from the Ulba plant. The same report, based on a July meeting at the Institute of Nuclear Materials Management in Palm Springs, California, indicates that U.S. officials have confirmed an Iranian initiative in Kazakhstan but agree with Bayadilov that it was limited to an attempt to acquire low-enriched uranium.⁴

It is difficult to establish from the public record how much Iran knew about Ulba or whether it had actually succeeded in establishing trade relations with the Ulba plant. What is clear is that, at a minimum, Iran - and possibly other states - was familiar

with at least some of Ulba's nuclear history and was probing to learn more.

THE KAZAKHSTANI OVERTURE

In February 1993, the International Atomic Energy Agency (IAEA) made a "pre-safeguards" visit to the Ulba plant. Although there are no clear indications that the IAEA discovered the presence of HEU at Ulba during its visit, Shkolnik must have understood that Kazakhstan would have an obligation to declare all of its nuclear holdings once it acceded to the Nuclear Nonproliferation Treaty, an action that was not the subject of much debate in Kazakhstan after May 1992.

1 For a more detailed description of Kazakhstan's nuclear heritage, see Oleg Bukharin and William Potter, "Kazakhstan - A Nuclear Profile," *Jane's Intelligence Review*, April 1994, pp. 183-187.

2 See Steve Erlanger, "Kazakhstan Thanks U.S. for Moving Uranium," *The New York Times*, 25 November 1994.

3 See Andrew Higgins, "Kazakhs Tell Us How the U.S. Flew Out Uranium," *The Independent*, 26 November 1994.

4 See Mark Hibbs, "Kazakhs Say Iran Sought LEU for VVER Fuel, Not 'Sapphire' HEU," *Nuclear Fuel*, 17 July 1995, pp. 11-12.

By mid-1993, Kazakhstan's leadership appears to have decided that it would be prudent either to upgrade national safeguards at Ulba or, alternatively, to remove the HEU from the plant. Having reached that conclusion, President Nursultan Nazarbaev authorized the communication of information to the United States about the existence of weapons-grade nuclear material at Ulba. That information was passed on to U.S. Ambassador to Kazakhstan William Courtney. That same month, the U.S. Department of State sought confirmation from Russia about the disclosure. Whether due to duplicity, ignorance, or a lapse of institutional memory, none of the Russian ministries that were contacted, including the ministries of Nuclear Energy and Foreign Affairs, acknowledged the existence of HEU at Ulba. In October 1993, Courtney obtained more details from senior Kazakhstani officials about the situation at Ulba. Kazakhstan conveyed its concerns about its ability to adequately safeguard the nuclear material and sought assistance from the United States in protecting the nuclear stocks. Kazakhstani officials did not specifically request that the HEU be sent to the United States, but they indicated that it should be removed from Kazakhstan and placed under IAEA safeguards.

It remains open to question whether or not the United States was the first or only state approached by Kazakhstan regarding the HEU at Ulba. According to most U.S. officials involved in Project Sapphire, Kazakhstan was not anxious for Russia to learn of the situation at Ust-Kamenogorsk and feared that Moscow might try to block its safeguards initiative. The principal U.S. players in the operation also cannot recall any indication that Kazakhstani officials offered the HEU to Russia - or any other state - before an overture was made to the United States. That information is at odds with a number of Kazakhstani and Russian public statements made after the completion of the airlift, however. Mette, for example, has been quoted as saying at a press conference, "We offered to give [the HEU] to Russia, but Russia refused."⁵ A spokesperson from the Russian Ministry of Nuclear Energy is also reported to have claimed that Kazakhstan first offered to sell a large quantity of uranium-beryllium alloy and uranium dioxide to Russia. "We didn't want this material," he maintained. "We produce enough of it ourselves."⁶ Those varying accounts are not easy to reconcile. What does appear clear is that if Moscow was approached first, it showed no interest in the HEU and most certainly was not prepared to pay Kazakhstan for its relocation.

THE U.S. RESPONSE

Courtney's deliberations with senior Kazakhstani officials in October 1993 set in motion U.S.-Kazakhstani cooperation to remove the HEU. A number of important issues had to be resolved before any concrete action could be taken. On the U.S. side, for example, it was necessary to confirm that the material in question was indeed HEU; decide whether to remove the material or to assist Kazakhstan in upgrading safeguards at the plant; determine the Russian reaction to alternative scenarios; reach agreement with Kazakhstan about compensation for the material if it were to be removed; and reach interagency agreement on

the final disposition of the material - an issue that was not without potential political ramifications at home.

The United States treated the information that had been conveyed to Courtney seriously, and the State Department's Office of Politico-Military Affairs was asked to pursue the matter. But the issue had to compete with a number of more public proliferation challenges, most notably those posed by North Korea's refusal to comply with IAEA safeguards and Ukraine's reluctance to surrender strategic nuclear weapons. As a consequence of that preoccupation with other proliferation threats and of the need to assemble, essentially from scratch, information and expertise relevant to the Kazakhstani issue, the United States was unable to obtain firsthand confirmation of the Ulba situation until late February 1994, when Elwood Gift, a nuclear engineer from the Y-12 plant at Oak Ridge National Laboratory in Tennessee, was sent on a one-man reconnaissance mission to Ulba.

The Kazakhstani authorities allowed Gift to examine the physical layout of the Ulba plant and discern how the material in question was stored and protected in three different vaults. He was also given 15 samples of the material, four of which were dissolved in nitric acid at the plant's lab in his presence. The mass spectroscopy analysis of the samples, observed by Gift, revealed assays of U-235 of approximately 90 percent - weapons-grade material.

An additional 11 samples of material were transported back to the United States for further analysis. The preliminary findings obtained on site by Gift, however, were sufficiently worrisome to prompt the United States to accelerate its response.

After an early March 1994 meeting of the three senior U.S. nonproliferation officials - Robert Gallucci from the State Department, Ashton Carter from the Defense Department, and Daniel Poneman from the National Security Council - a decision was made to have the Defense Department take the lead in coordinating U.S. efforts to secure the Ulba fissile material. An interagency "Tiger Team," chaired by the Defense Department's Jeff Starr, was set up, and at about the same time, the mission was dubbed "Project Sapphire." (The name was coined by an Oak Ridge scientist and had no special significance other than to connote that the object in need of safeguarding was valuable; it was proposed after the scientist noticed other government officials carrying folders conspicuously labeled "Kazakh HEU.")

5 Higgins, "Kazakhs ..."

6 Vitalii Nasonov cited by Barry Schweid, AP, 23 November 1994.

The Tiger Team was usually composed of representatives of the departments of State, Defense, and Energy, the National Security Council, the Joint Chiefs of Staff, the intelligence community, and other relevant agencies, depending on the focus of the particular meeting. It reported to a higher-level interagency group chaired by Rose Gottemoeller at the National Security Council. The team held its first meeting on 25 March 1994.

Most of the first meeting was devoted to the practical problems associated with getting the HEU out of Kazakhstan. Those problems included compensation for Kazakhstan and coordination with Russia.

The Tiger Team agreed from the outset that Kazakhstan should be given fair and appropriate compensation for the HEU. There was considerable interagency wrangling, however, over who should foot the bill. Unfortunately, Presidential Decision Directive-13 of September 1993, which authorized the United States to purchase nuclear material at the market rate when it would serve U.S. non-proliferation interests, offered little guidance. Although the Defense Department was anxious to tap into Cooperation Threat Reduction (CTR) funding for the mission, it was not clear if some of the items requested by Kazakhstan for compensation - hospital supplies and medical assistance, for instance - could be funded legitimately under the CTR's terms. Although there was never any question about the compatibility of the objectives of Project Sapphire and the CTR, a lack of consensus within the Defense Department over what were appropriate CTR expenditures led the department to seek contributions from other agencies. As a result, an interagency debate over how to pay for Project Sapphire ensued in tandem with U.S.-Kazakhstani deliberations about the size and composition of the compensation package.

A debate over whether to discuss the matter with Russia coincided with the interagency debate in early spring 1994. The Russia debate revolved around a number of thorny issues, including Kazakhstani concerns that Almaty not get involved in a trilateral negotiation in which Moscow might make demands for compensation for "its HEU." The Tiger Team as a whole was wary of approaching Russia if the move were likely to result in a veto over U.S. action. The team members disagreed, however, about the

desirability of Russia serving as a repository for the material if Moscow were so inclined. The Defense Department in particular opposed giving the HEU to Russia, while the Department of Energy was more inclined to favor a "Russian solution" because of concern about the possible domestic political fallout of transporting the material to the United States. The Department of Energy was especially worried about protests by environmental groups and the potential opposition of state officials who might view the material as waste dumped on their doorstep.

Although the debate over the possible negative domestic side effects of Project Sapphire continued until the summer of 1994, the Tiger Team decided in early spring to approach Russia regarding the HEU at Ulba. Washington told the U.S. Embassy in Moscow to discuss the matter with senior officials at the ministries of Foreign Affairs, Defense, and Nuclear Energy. The U.S. message to the Russians was essentially: "Last summer you would not acknowledge the presence of HEU at Ulba; now we know it's there. We have two options: you take it, or we take it."

Although the principal U.S. players in Project Sapphire are not in perfect agreement about the Russian response, the following account can be pieced together from interviews. All agree that the Ministry of Defense expressed disinterest in the issue - a pleasant surprise for the United States. Senior Ministry of Nuclear Energy staff, it appears, were not available to respond to the U.S. inquiry at first. The ministry official who did reply initially indicated that he assumed his superiors would not like the idea of the United States taking "their material." The United States, however, persisted in getting a response from the head of the ministry, Viktor Mikhailov, who indicated that the material in question belonged to a foreign country and that the matter should be handled by the Ministry of Foreign Affairs. The initial Foreign Ministry response, it appears, was not regarded by the United States as either authoritative or clear, although it did not object specifically to the U.S. proposal to remove the HEU. A long silence - perhaps up to four weeks - then ensued before the Ministry of Foreign Affairs sent the United States a cable on the issue. Although the response was: "We don't want it," the Department of Energy reportedly still pushed to have the Russians take the material.

In order to settle the issue of material disposition, U.S. Vice President Al Gore raised the subject directly with Prime Minister Viktor Chernomyrdin during the visit of a high-level Russian delegation to Washington on 21-22 June 1994. According to one eyewitness, a number of Russian officials chuckled when Gore raised the issue. Apparently the Russians recognized that there had been an internal U.S. bureaucratic battle on the subject, because the matter was being raised at a high level after an initial response had been sent through diplomatic channels. The U.S. side could also smile, however, because the Russian prime minister said that the United States could have the material.

THE END GAME

One of the United States' major concerns since first learning of the HEU at Ulba was how to prevent that information from reaching potential nuclear states, terrorists, or black marketeers. In order to minimize the possibility of leaks, the United States sought to keep the operation as low-profile as possible and to conduct most of the negotiations through Ambassador Courtney in Almaty.

Keeping a lid on the project became more difficult as it moved into the operational phase. Fortunately, there was already a considerable amount of traffic between the United States and Kazakhstan because of the CTR program, implementing agreements that had been signed by Kazakhstan in December 1993. The United States could also attempt to mask its activities at Ulba under the guise of assisting Kazakhstan with meeting its IAEA safeguards obligations. It was one thing, however, to have a single Oak Ridge engineer at Ulba - or even nine experts there for several days, as was the case in early August 1994 - and quite another matter to maintain a team of 31 Americans inconspicuously at the Ulba facility for six weeks. That large and long-term presence, however, was necessitated by the very difficult task of transferring the uranium at Ulba into 1,300 steel cans, which in turn needed to be placed into IAEA-approved transport drums.

On 7 October 1994, within hours of President Bill Clinton's authorization of the airlift operation, 29 men and two women were en route to Ust-Kamenogorsk. The team, led by Oak Ridge scientist Alex Riedy, was composed of nuclear, chemical, and industrial engineers, health physicists, packing experts, safety engineers, maintenance technicians, a physician, and three Russian-speaking interpreters. In addition to personnel, the airlift delivered 130 tons of equipment, including a sophisticated array of technical instruments, the components for a chemical assay laboratory, electrical power supplies, satellite communications equipment, and a maintenance depot.

In March 1994, the Department of Energy had asked Oak Ridge's National Security Program Office to develop a conceptual plan for removing the HEU from Ulba. The task was complicated by the manner in which the HEU was stored at the plant in Ust-Kamenogorsk and by the fact that the fissile material was present in a variety of forms, many of which were hazardous to handle. For example, about two-thirds of the material designated for repackaging and transport, which totaled approximately 2.37 metric tons, was in the form of various beryllium-HEU alloys, including machine scrap.⁷ Originally, the material had been stored at the Ulba plant in more than 1,000 containers that did not meet international transport standards. The material had to be removed from the original containers, and in some instances the various HEU products had to be baked, cut, and crushed to make them easier and safer to handle and to fit them into the quart-sized stainless steel cans. The cans were in turn placed into IAEA-approved 55-gallon transport drums.

In addition to the difficult task of repackaging HEU that often was contaminated with toxic and corrosive elements, the U.S. team, in collaboration with its Kazakhstani partners, sought to crosscheck the HEU being prepared for transport with that in the original Ulba inventory. That was not a simple exercise, since all material-accounting records at Ulba were maintained in paper form rather than on computer. It also proved highly embarrassing to both sides when, in the course of its inspection of Ulba's fissile material stocks, the U.S. team discovered a number of canisters that had not been tagged as part of the plant's HEU inventory.⁸ Although it certainly was preferable from the standpoint of nonproliferation to discover that Ulba contained more rather than less HEU than was recorded in the inventory, it also highlighted the more general problem of material-accounting practices in the Soviet nuclear industry.

During the course of their six-week mission at Ulba, the U.S. team also had occasion to observe firsthand the facility's underdeveloped state of physical protection. As with most Soviet-built nuclear installations, the principal security threat at Ulba was the risk of theft by insiders - a danger that was a function of inadequate material-control and -accounting procedures, the dire economic situation of plant workers, and the absence of basic security measures. (Wooden doors, some of which were not always padlocked, were used to safeguard weapons-grade material.) Thanks in part to their frequent interaction with U.S. nonproliferation specialists in conjunction with the CTR program, Kazakhstani officials had become increasingly concerned about the shortcomings of those safeguards. Their readiness to cooperate fully with the U.S. team at Ulba was remarkable and underscored the truly joint nature of the Project Sapphire nonproliferation mission.

The weather at Ust-Kamenogorsk was not very cooperative, however. As a result of several weeks' delay in the anticipated airlift date, winter arrived on the steppes of northeastern Kazakhstan before the repackaging of the nuclear material had been completed. Despite the Herculean work efforts of the U.S. team, which labored up to 14 hours a day, six days a week, the uranium was not ready for transport until a week before Thanksgiving. Due to bad weather, the first C-5 cargo jet did not arrive at the Ust-Kamenogorsk airport until 4 a.m. on 20 November 1994. Its arrival set in motion a convoy of trucks carrying the first shipment of nuclear cargo on an 18-mile trek to the airport. The team of U.S. technicians and scientists, along with an escort of Kazakhstani special-forces personnel and police, accompanied the HEU. Special precautions were taken to protect the cargo during transit to the airport, since the process of repackaging the fissile material had made it easier to handle and thus a more attractive target for theft.⁹

7 See Alexander W. Riedy, "Project Sapphire Briefing," Meeting of the U.S. German Study Group on Nonproliferation, Bonn, Germany, 12-13 June 1995. A detailed analysis is provided in "Sapphire Sampling Plan," Oak Ridge Y-12 Plant, December 1994.

8 See Graham T. Allison, Owen R. Cote, Jr., Richard A. Falkenrath, and Steven E. Miller, "Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material," CSIA Discussion Paper 95-08, Kennedy School of Government, Harvard University, July 1995, p. 23.

9 See John A. Tepak, "Project Sapphire," *Air Force*, August 1995, p. 53.

Although weather conditions were extremely poor at the airport, the first C-5 was able to lift off by afternoon. At about the same time, the second C-5 arrived, and another convoy from Ulba set off for the airport with the remaining HEU cargo.

After a flight of over 20 hours and five air refuelings, the planes landed at Dover Air Base in Delaware. The Ulba cargo was then loaded aboard 12 unmarked but heavily defended Department of Energy tractor-trailers for the final journey to Oak Ridge's Y-12 plant. Only after the material was secure at Oak Ridge was news of Project Sapphire made public during an unusual joint press

conference held by three cabinet officials - Secretary of Defense William Perry, Secretary of State Warren Christopher, and Secretary of Energy Hazel O'Leary. According to Perry, the operation had kept the weapons-grade nuclear material - enough for more than 20 nuclear bombs - from falling into the hands of "potential black marketeers, terrorists, or new nuclear regimes."

The operational phase of Project Sapphire ended with the successful delivery of the HEU to Oak Ridge. A number of issues related to the project, however, remained to be settled, including final agreement on the nature of the compensation package and the ultimate disposition of the fissile material from Ulba. The U.S. government had reached Interagency agreement on the amount of compensation for Kazakhstan in early September 1994. In subsequent discussions the two sides also agreed on the total value and the general shape of the compensation package. That initial agreement began to unravel later in the fall, however, when Kazakhstan requested changes in the types of in-kind assistance it would receive. The request was precipitated by a change in the governmental responsibilities of Mette, a key player in Project Sapphire. In his new post as deputy prime minister, he adopted a different stance on desirable non-cash forms of assistance. Those requests had to be reconciled with the availability of materials at different U.S. agencies. New requests for "high-tech" equipment, in particular, posed problems for the United States, which had found it easier to draw upon surplus stocks for items such as medical supplies. That request led to a lengthy negotiation that was not settled until late spring of this year. Kazakhstan initially sought \$25 million in compensation; although the total assistance package remained classified, it is widely believed to be in the \$10 million to \$20 million range and to include both cash and in-kind assistance.

The issue of what to do with the HEU from Ulba proved even more bedeviling than how to pay for it. The Defense Department had briefly considered storing the fissile material at a military facility in the United States but had learned that this option was precluded by provisions of the Atomic Energy Act. At one point it had also contemplated, and then rejected, the possibility of shipping the material to a third country that might be interested in blending it down for use in commercial power reactors. In the end, though, the Defense Department saw no real alternative to transferring the HEU to the Y-12 facility for interim storage before being processed for use as commercial fuel.

It took longer to persuade the Department of Energy. In addition to overcoming its concerns about the political risks of importing the material, it also was necessary to satisfy the environmental-impact statement requirements of the National Environmental Policy Act. The Defense Department finessed that issue by attaching the Project Sapphire material to an environmental-impact statement that was already being conducted for HEU at the Y-12 plant. Although the Department of Energy correctly anticipated the opposition of the state government to the import of the Kazakhstan material, the Tiger Team succeeded in enlisting the support of Gore - who represented Tennessee in the U.S. Senate before becoming vice president - to reassure state authorities who were initially opposed to the idea of storing any new HEU at Oak Ridge.

The Department of Energy eventually acquiesced to the Defense Department's position and agreed to store the Ulba material at Y-12 prior to its conversion to commercial nuclear fuel. U.S. officials reportedly also made verbal commitments to their Kazakhstani counterparts to blend the Ulba HEU into low-enriched uranium within six to nine months after receiving the material. Impurities in the Kazakhstani material, however, have made the blending process more complicated and costly than originally anticipated. A lawsuit filed by a local Oak Ridge environmental group in June 1995 also stalled the Department of Energy's plans to convert the HEU into commercial fuel. As a consequence of those unanticipated delays, the final chapter in the history of Project Sapphire has yet to be fully written.

LESSONS LEARNED

Because many of the circumstances of Project Sapphire are peculiar to post-Soviet Kazakhstan and are unlikely to be found elsewhere, generalizations should be made cautiously. Nevertheless, it is possible to derive a number of lessons from the Sapphire experience that may have broader applications.

Perhaps the most important lesson to be learned from the project is the necessity of shared objectives between parties in U.S.-Commonwealth of Independent States denuclearization assistance. In contrast to the frequently strained relationship between CTR donor and recipient countries, Project Sapphire was an example - from the outset - of how two states can forge what Graham Allison and his colleagues from Harvard University refer to as a "shared sense of mission." Indeed, what is particularly striking in the Sapphire project is that in interviews with more than a dozen U.S. participants from six different agencies, all uniformly praised Kazakhstani intentions and behavior in the removal of the fissile material from Ulba. That symmetry in U.S.-Kazakhstani

objectives can be attributed to a number of factors, including the history of U.S. -Soviet cooperation for non-proliferation; the recognition by the small group of key Kazakhstani participants that their country's security and energy needs were best served by embracing the global norms of nuclear nonproliferation; and the reinforcement of that nonproliferation sentiment by an assistance program in the form of the CTR. A second lesson pertains to the "buyback bargain."

Today, most programs funded by the U.S. government are under attack in Congress, including the CTR program. Project Sapphire, however, demonstrates that the purchase of weapons-grade material such as that acquired from Kazakhstan can be a prudent, cost-effective nonproliferation and defense strategy for the United States. Even if one assumes the high estimate of \$20 million for the Sapphire compensation package and adds an additional \$5 million in costs to mount the repackaging and airlift operation, Project Sapphire appears to have been a bargain from the standpoint of purchasing national security. How much, one may ask, would the United States have to pay to defend against weapons equivalent of the HEU that was present at Ulba, if it were to find its way to powers hostile to the United States?

One of the most disturbing lessons of Project Sapphire is the indications that there are probably other caches of undeclared weapons-grade material in the former Soviet Union. It is estimated that Russia's nuclear material inventory alone - distributed over more than 50 sites - consists of approximately 1,100-1,300 tons of HEU and 165 tons of weapons-grade plutonium.¹⁰ Although the bulk of the former Soviet Union's nuclear assets are concentrated in Russia, significant quantities of weapons-grade material also are present in Belarus, Kazakhstan, and Ukraine. Given the vast quantity of fissile material produced in the Soviet Union, the secrecy that surrounded the Soviet nuclear industry complex, and the generally underdeveloped state of material control and accountancy that persists, it should not be surprising to see the declared nuclear material inventories in a number of CIS states increase as IAEA inspections take place. The five-fold increase in weapons-grade uranium reported to the IAEA last year at Ukraine's Kharkiv Physical Technical Institute (from 15 to 75 kilograms of HEU enriched to 90 percent U-235) was indicative of that phenomenon, as was the IAEA's discovery during its February visit to Sevastopol of a previously undeclared research reactor at the Naval Academy of the Ukrainian Ministry of Defense. Those developments suggest that the relevant question to ask is not if any more forgotten caches of fissile material exist, but how many there are and where they are located.

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¹⁰See Thomas B. Cochran, Robert S. Norris, and Oleg A. Bukharin, *Making the Russian Bomb* (Boulder, Colorado: Westview Press, 1995), p. 51.