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DOCUMENTED
BRIEFING

Diversion of Nuclear, Biological, and Chemical Weapons Expertise from the Former Soviet Union

Understanding an Evolving Problem

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Keith Crane, Michael Chase, Michael Daugherty

Prepared for the United States Department of Energy

NATIONAL SECURITY RESEARCH DIVISION

The research described in this briefing was prepared for the United States Department of Energy. This research was conducted within the RAND National Security Research Division, which conducts research and analysis for the Office of the Secretary of Defense, the Joint Staff, the Unified Commands, the defense agencies, the Department of the Navy, the U.S. intelligence community, allied foreign governments, and foundations.

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PREFACE

Since the early 1990s, the United States has been concerned about the diversion of expertise and sensitive information from the nuclear, biological, and chemical (NBC) weapons complexes of the former Soviet Union (FSU). It has established a number of important programs to address the threat of NBC weapons proliferation. Several of these programs are managed by the Russian Transition Initiative (RTI) in the Department of Energy (DOE) Office of Nonproliferation and Arms Control. As part of its recent strategic planning process, RTI engaged the RAND Corporation to reassess the dangers that its programs are designed to curtail.

This documented briefing offers a structured assessment of the threat of NBC weapons proliferation and examines each of its key components. It examines the countries and individuals that seek to illicitly acquire expertise and sensitive knowledge as well as the institutions and types of individuals who have them. Despite fears that such diversion might occur, the empirical record of documented incidents is comparatively small. Nevertheless, the diversion of even a small number of people or a limited amount of critical information can create a significant security concern for the international community.

A key finding of this briefing is that the scope and the nature of the problem have changed considerably since the conceptualization and initiation of a number of U.S. government programs designed to reduce the risk of illicit diversion of expertise and sensitive information from FSU weapons complexes. While the situation in Russia and in the other Newly Independent States (NIS) of the FSU has changed, assessments of the potential problem of diversion of expertise and sensitive information have remained static and, as a consequence, are dated. This document also argues that the problem is larger in scope than just weapons scientists—the RTI's programs must also focus on highly skilled technicians, retirees, and key administrative and support personnel who can provide critical key information. Finally, this document argues that a simple market model of supply and demand does not fully capture all the dimensions of the danger posed by diversion of NBC weapons expertise and knowledge. A simple supply-and-demand model overlooks the critical role that barriers and disincentives have played in keeping the actual number of cases of diversion relatively low.

This reassessment of the potential threat of diversion of NBC weapons expertise may help U.S. authorities to target cooperative programs in the FSU to gain the maximum benefit per dollar spent on these programs.

In the course of this study, RAND researchers examined relevant unclassified and classified literature and conducted interviews with more than 30 government officials and outside experts. Earlier versions of this briefing were reviewed by many of the people who were interviewed as part of the study.

This research was conducted within the International Security and Defense Policy Center (ISDPC) of the RAND National Security Research Division (NSRD). NSRD conducts

research and analysis for the Office of the Secretary of Defense, the Joint Staff, the Unified Commands, the defense agencies, the Department of the Navy, the U.S. intelligence community, allied foreign governments, and foundations. For more information about this study, contact John Parachini at John_Parachini@rand.org or David Mosher at mosher@rand.org. For more information on the International Security and Defense Policy Center, contact the Director, James Dobbins. He can be reached by e-mail at james_dobbins@rand.org; by phone at 310-393-0411, extension 5134; or by mail at RAND Corporation, 1200 South Hayes Street, Arlington, VA 22202-5050. More information about the RAND Corporation is available at www.rand.org.

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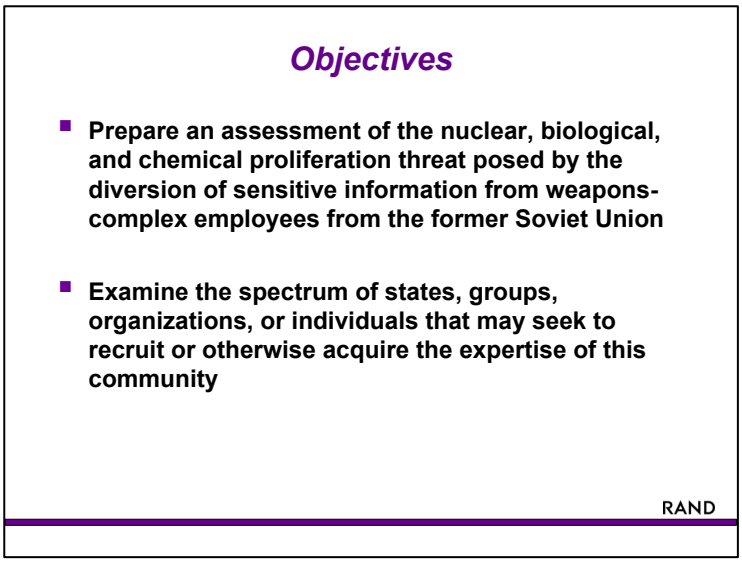
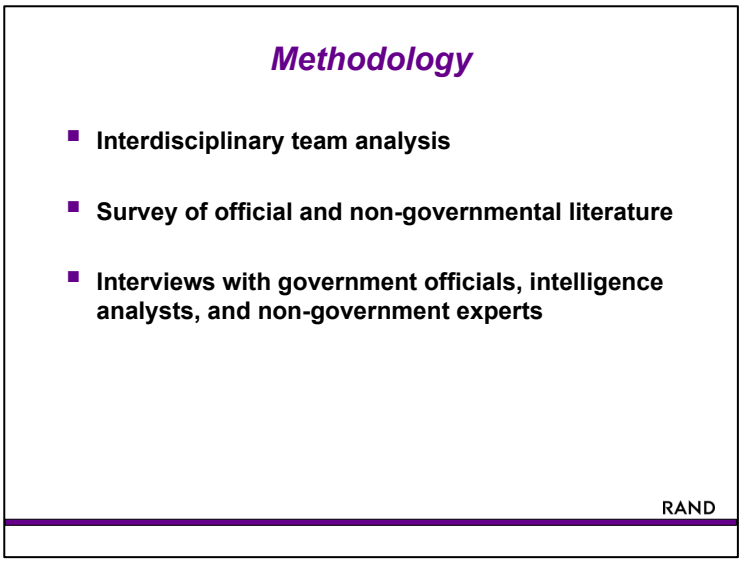


1. INTRODUCTION AND ANALYTICAL APPROACH

This review of the danger of transfer of weapons expertise and sensitive information covers current and former nuclear, biological, and chemical (NBC) facilities of the former Soviet Union (FSU) in the Newly Independent States (NIS). This briefing examines a variety of pathways by which proliferation-relevant knowledge can be diverted, including emigration of scientists, engineers, or employees of weapons complexes, illicit transfers of knowledge from the FSU, and transfers of knowledge during official contacts at home or abroad. The transfer of ballistic missile technology is outside the scope of this analysis.

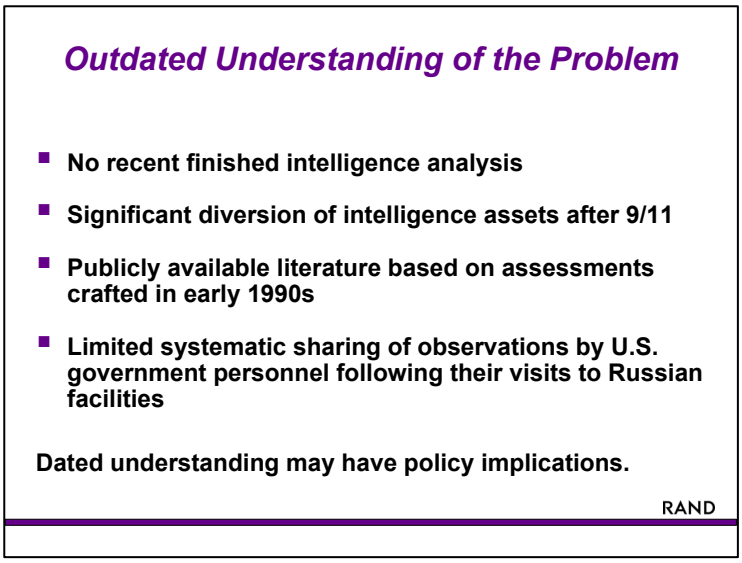
This study also examines the potential actors, including states, sub-national groups, and individuals, that seek weapons expertise. These entities may seek to acquire information clandestinely or through officially sanctioned contacts or collaboration.

Finally, this study examines the empirical record of actual and attempted knowledge diversion from the NIS to other states and to terrorists. We explore the factors that inhibit or permit the transfer of NBC weapons knowledge.



The RAND Corporation assembled an interdisciplinary research team to conduct this analysis. In addition to regional experts, the team included those with expertise in economics, business, political science, weapons proliferation, and terrorism. Additionally, some outside experts with unique knowledge briefed the RAND research team.

The research team collected a wide range of documents from government and non-government sources. The team also conducted more than 30 interviews with U.S. government policymakers, intelligence analysts, and non-governmental experts. The team met with individuals at key institutions in the intelligence community on multiple occasions to conduct interviews and to share draft versions of this briefing.



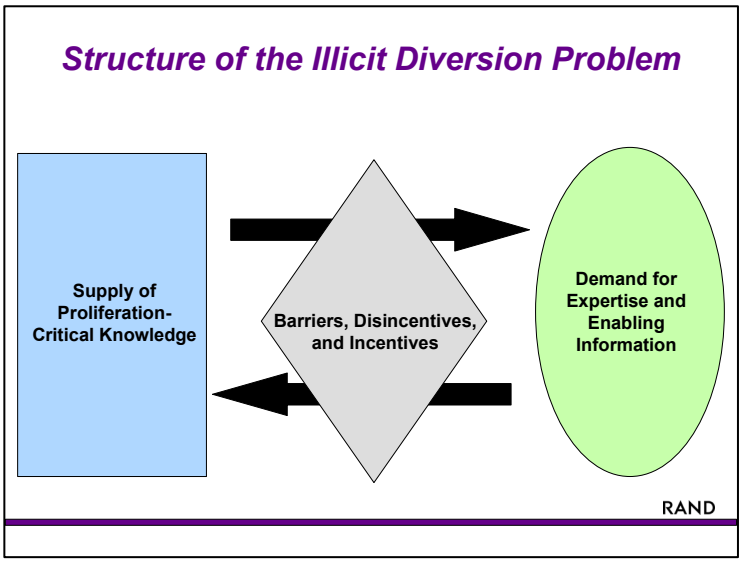
Diversion of expertise from the FSU was a much higher priority for U.S. policymakers and the Intelligence Community (IC) in the early and mid-1990s than it is now. Over the course of the past decade, the priorities of policymakers and the IC changed. The September 11, 2001, terrorist attacks on New York and Washington, D.C., caused a significant shift of intelligence resources to the global war on terrorism, a shift that continued with the war in Iraq. While the September 11 attacks did stimulate some examination of the security of nuclear materials and the prospect of nuclear terrorism, the issue of diversion of expertise was largely absent from these assessments.

A growing body of publicly available scholarly research on the topic has steadily increased since the early 1990s, most of it focusing on policy measures for addressing the perceived problem.[1] Small portions of this literature are dedicated to the problem of the diversion of weapons expertise, and they generally draw on assessments developed in the early 1990s. A key element benchmarking the comparatively static nature of threat assessment in the literature is the discussion of the size, scope, and scale of the NBC complexes. While the September 11 attacks and revelations about al-Qaeda's interest in unconventional weapons prompted greater concern in the publicly available literature, with a few notable exceptions the extent and depth of the analysis of the threat are varied at best.

[1] For example, see Matthew Bunn and Anthony Wier, *Securing the Bomb: An Agenda for Action*, Project on Managing the Atom, Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, Commissioned by the Nuclear Threat Initiative, May 2004; O. Bukharin, "Strategies for Russian Nuclear Complex Downsizing and Redirection: Options for New Directions," Russian-American Nuclear Security Advisory Council (RANSAC), Washington, D.C., June 2003; Matthew Bunn, Anthony Wier, and John Holdren, "Controlling Nuclear Warheads and Materials: A Report Card and Action Plan," Project on Managing the Atom, Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, March 2003; and Scott Parrish and Tamara Robinson, "Efforts to Strengthen Export Controls and Combat Illicit Trafficking and Brain Drain," *The Nonproliferation Review*, Monterey Institute of International Studies, Center for Nonproliferation Studies, Spring 2000, pp. 112–124.

Over the course of the 1990s, the U.S. government, in cooperation with the Russian government and other governments of the FSU, initiated a number of programs to increase security at NBC facilities, eliminate excess weaponry and material, and reduce the incentives for personnel to illicitly transfer their expertise. This joint cooperation has resulted in a significant increase in transparency of the size, scope, and nature of the NBC weapons complexes of the former Soviet Union.[2] A systematic approach to sharing findings from these programs would benefit American and Russian cooperative efforts to address the danger of illicit diversion of weapons expertise and knowledge.

[2] National Intelligence Council, "Annual Report to Congress on the Safety and Security of Russian Nuclear Facilities and Military Forces," paper prepared under the auspices of the National Intelligence Officer for Strategic and Nuclear Programs, February 2003, pp. 2–7.



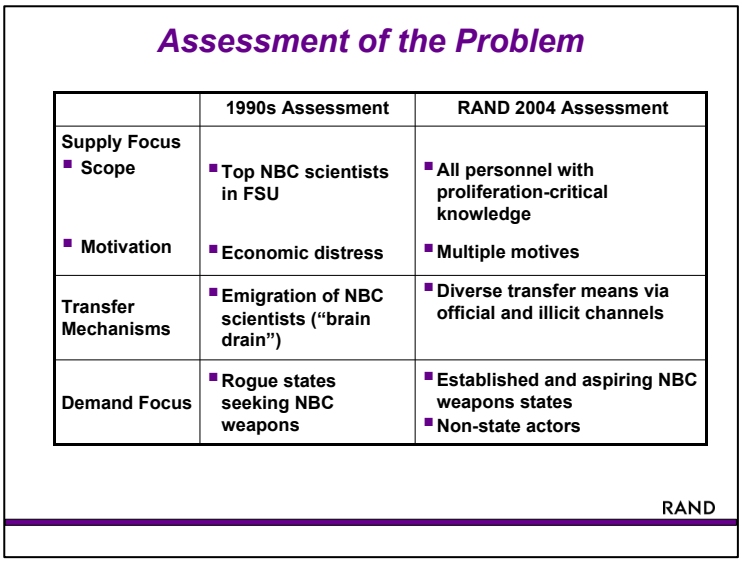
The problem of illicit diversion of NBC weapons expertise from the FSU is often presented as a problem of supply and demand in which normal market forces are at work. On the one hand, there is a huge supply of NBC-critical knowledge in the region. The FSU's NBC complexes were larger than any other nation's in history. On the other hand, states, terrorist groups, and individuals interested in developing NBC weapons have demonstrated a strong desire for weapons-critical knowledge and a willingness to pay for it. Indeed, many of the early assessments of the problem noted the large supply of expertise in the FSU and the unstable political, economic, and social circumstances that made that expertise ripe for acquisition by states, groups, and individuals who aspired to acquire unconventional weapons.

While the market concept does have appeal in its simplicity and familiarity, it may not be the best conceptual approach to the problem. The market concept is used in this study because of its broad acceptance, but we will point out a number of aspects of the problem that are not well illuminated by the market concept. For example, for ideological reasons, some types of diversion may involve forced entry or theft, neither of which involves any market forces. The market concept helps to structure thinking about the problem, but it does not adequately explain a number of important pathways that terrorists or states may attempt to use to acquire sensitive information from weapons complex personnel. What is missing from the conventional market concept is a full appreciation of the barriers between supply and demand and the complicated interplay of incentives and disincentives influencing personnel who make up the supply component of the equation.

Simply conceiving of the problem as a market situation in which supply and demand meet does not fully capture the factors that influence the interface in the weapons-expertise arena. In fact, the empirical record on weapons materials and knowledge suggests that supply and demand often do not meet because the mechanisms required for a market fail to develop. Other factors influence the interaction of those who possess sensitive information, those who oversee the possessors of sensitive information, and

those groups and states that may seek to obtain that information. Rather than relying on the traditional market concept to explain the interaction between these various entities, this study attempts to describe who they are and what may influence their behavior. The market depiction of the problem, drawn from the field of economics, is used only as a simple and familiar way to orient the reader to the conceptual structure of the problem, while noting that this is not the best and most revelatory approach for understanding the problem.

Accordingly, we have structured the problem of illicit diversion of NBC weapons expertise to take into account the barriers and disincentives that lie between the supply side and the demand side and to help explain why they often do not meet. The chart on the previous page illustrates a market model for illicit transfer of knowledge. It is a conceptual rather than a geographic construct. The barriers can be geographic, physical, or administrative and may be created by those who control the weapons complexes or who are responsible for security in Russia. The disincentives to transferring knowledge include cultural, professional, and financial factors. Incentives can be financial, ideological, or personal. Moreover, changes in the factors that mediate between supply and demand may provide valuable insights into instances in which supply and demand may meet and how policies can be designed to enhance the barriers to an illicit information market. The empirical record of illicit knowledge diversion from the FSU over the past decade suggests that the barriers and disincentives have been much stronger than the incentives. Additionally, U.S. policies may have periodically had significant impacts on the balance between incentives and disincentives to exchange information illicitly.



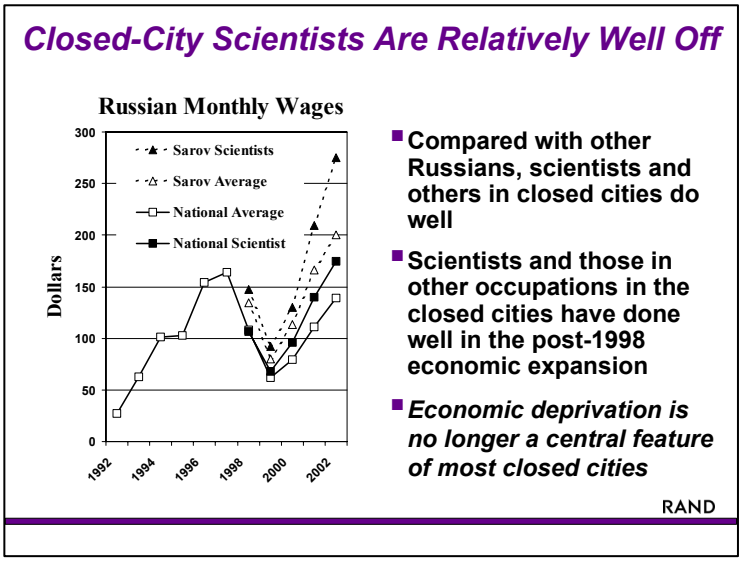
After the collapse of the Soviet Union in the early 1990s, Russia and the other newly independent states of the FSU experienced significant political instability, social upheaval, and economic decline. Many policymakers and analysts feared the prospect of a huge number of NBC weapons scientists in Russia illicitly selling their expertise to states seeking those weapons.[3] A "brain drain" phenomenon, in which top NBC weapons scientists emigrated to states seeking to acquire NBC weapons, became a priority problem with regard to proliferation.

Over the course of the past ten years, the nature of the problem has changed in several respects and so, too, should the assessment of the threat.

- First, the personnel of concern in the weapons complexes who have knowledge that might be valuable to states and terrorists are larger in scope than just weapons scientists.
- Second, the motivation for the illicit diversion of expertise by these individuals is much more varied than just economic distress. With the significant improvement in Russia's economic situation, economic deprivation is no longer the primary motivation of concern. Greed, ideological sympathies, and pride now loom as important motivators.
- Third, while emigration from the FSU remains a concern, the increased transparency of societies in the region, the development of communication technologies facilitating global communication, and the increased travel by FSU NBC complex personnel and foreigners to the region and officially sanctioned exchanges and cooperative projects all combine to increase the avenues for transfer.
- Finally, the nature of the demand for NBC weapons and NBC weapons expertise has changed. In addition to states seeking NBC weapons capabilities, now there is

[3] Sam Nunn, "Opening Statement, Hearings Before the Permanent Subcommittee on Investigations of the Committee on Governmental Affairs, United States Senate (Part II)," March 13, 20, and 22, 1996, pp. 4, 7.

great concern about the prospects of terrorist groups seeking to acquire these capabilities. Terrorists may achieve their clandestine acquisition goals in very different ways from states that clandestinely acquire NBC weapons. Where states might seek high-end and sophisticated weapons capabilities, terrorists may be satisfied with simpler and improvised weapons capabilities.



One of the primary concerns that precipitated the creation of the Department of Energy/National Nuclear Security Administration (DOE/NNSA) Nuclear Cities Initiative (NCI) and Initiatives for Proliferation Prevention (IPP) was that destitute individuals in the nuclear weapons research and production complex would feel compelled to sell their knowledge to obtain funds to enable their families to survive.[4] Similar concerns contributed to the creation of programs to support individuals involved in research and production of biological and chemical weapons. Since the assessment in this report runs counter to commonly held impressions of the Russian economy, the evidence behind our conclusions is laid out in some detail.

Assertions about the Russian economy made in recent studies are specifically referenced and examined. Russians, including Russian scientists engaged in NBC research and production, the group of greatest concern in terms of proliferation, experienced sharp, periodic reductions in income during the 1990s. With the collapse of the Soviet Union in the early 1990s, wages failed to keep up with inflation rates that ran as high as 2,525 percent (in December 1992). Breakdowns in government administration and the banking system coupled with corruption and graft in government led to frequent delays in wage payments. With inflation running at such high levels, wage-payment delays resulted in sharp reductions in the real value of wages. In some instances, wages were not paid at all. Consequently, individuals engaged in weapons research and production, along with most other Russians, suffered very sharp declines in real income in the 1990s. Furthermore, as markets replaced central allocation of goods, these individuals no longer enjoyed the superior access to consumer goods that was the hallmark of individuals employed by the NBC complexes during the Soviet period, reducing the relatively favored economic position of employees in this sector.

[4] See United States Executive Branch Report to Congress, *Plan for Securing the Nuclear Weapons, Material, and Expertise of the States of the Former Soviet Union,* 2003, pp. 47–57.

The Russian economy began to stabilize in 1995; it registered very modest growth in 1997.[5] However, the August 1998 collapse of the ruble resulted in another sharp decline in Russian wages, both as compared with domestic purchasing power and in U.S. dollars. The dollar value of wages had become increasingly important by 1998, as Russian consumers switched from Russian products to imported foods, clothing, shoes, and household electronics.

Since 1998, living standards in Russia have risen sharply. Rapid economic growth coupled with a firming ruble have dramatically increased dollar incomes and wages across Russia. Average dollar wages hit $141 a month in 2002, almost returning to their peak of $164 a month in 1997. By December 2003, wages hit $249 per month, exceeding their previous dollar peak in mid-1998. Although very low by U.S. standards, this figure compares with the average wage of $62 a month as recently as 1999. It is also comparable with Central European wages in the early 1990s.

The improvements in the Russian economy have not bypassed employees in the nuclear weapons sector. Average wages in one closed city[6] in the nuclear weapons complex, Sarov, had risen by half between 1998 and 2002 and more than doubled from their low in 1999. Wage growth remained very strong in 2003. Scientists living in Sarov enjoyed even more rapid increases in wages: Dollar wages jumped 87 percent between 1998 and 2002; they had more than doubled by 2003.[7] In both instances, for the city as a whole and for scientists living in Sarov, increases in wages were much higher than the national average.

The problem of wage arrears—wages that remain unpaid to workers for weeks or months at a time—has diminished greatly since 1998 and 1999. In 1999 nationally, wage arrears ran $17.6 billion, almost a third of total wages paid. By 2000 under Putin, they had dropped to $1.1 billion, just 1.4 percent of the total wage bill. Since 2000, further progress on reducing arrears appears to have stalled. In April 2003, arrears were still running $1.1 billion. However, there have been few reports of arrears in the nuclear cities in recent years. The Russian government appears to be making a particular effort to eliminate wage arrears to the military, border guards, and others in the security sectors, although wage arrears continue to affect the economy as a whole.

The combination of wage growth and the decline in wage arrears has had very salutary effects on living standards. Economic deprivation is no longer an omnipresent fear for most Russians. The World Bank notes that according to Russia's official measure, the portion of the population living in poverty has fallen from 38 percent at the end of 1998 to 16 percent in the fourth quarter of 2003. Because wages in Sarov are substantially

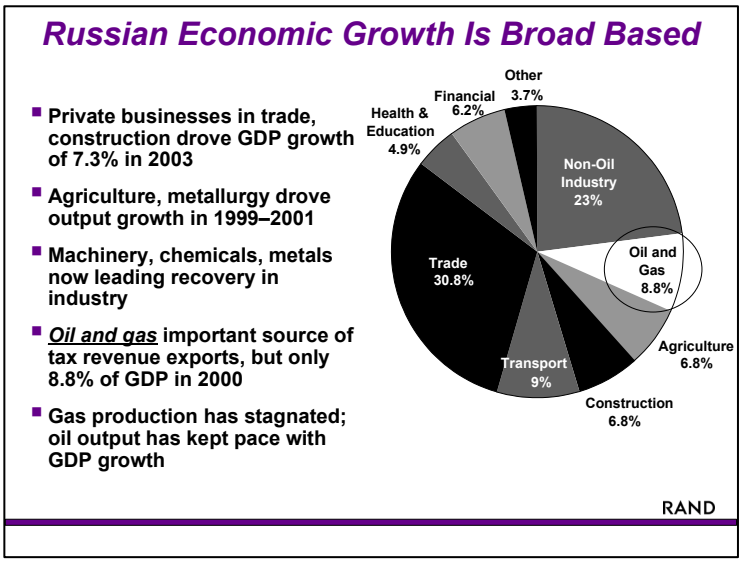
[5] Unless otherwise indicated, the economic data in this section are taken from V. L. Sokolin, *Rossiskii Statisticheskii Ezhegodnik 2002: Statisticheskii Sbornik*, Goskomstat, Moscow, 2002.

[6] The Russian nuclear complex was centered in facilities in ten cities that were closed to the average Russian and the outside world. These cities officially "did not exist" and were not listed on maps. They are referred to as *nuclear cities* or *closed cities.*

[7] All Russian Research Institute of Experimental Physics (RFNC-VNIIEF), *Quarterly Reports on Economic Conditions in the Closed City Sarov,* Sarov: RFNC-VNIIEF, various issues, 1999–2003.

higher than the national average wages, the incidence of poverty in Sarov is likely to be commensurately smaller.

Continued solid growth in the economy in 2004 and Russia's strong fiscal position make the outlook bright for continued growth in wages. Although average wages for nuclear scientists of more than $300 a month in 2004 will not make those scientists rich, in the context of the cost of living in Sarov and in Russia as a whole, economic deprivation is no longer an imminent concern for individuals engaged in nuclear weapons research and production in closed cities such as Sarov.



There is no disputing that Russia's economy has enjoyed rapid growth since 1998.[8] Between 1998 and 2003, its gross domestic product (GDP) rose by 37 percent, an average annual increase of 6.5 percent per year. In 2003, GDP rose 7.3 percent. For the past five years, Russia has enjoyed one of the highest economic growth rates among the larger medium-developed economies.

The expansion since 1999 has been driven by different sectors at different times. Initially, the sharp depreciation of the ruble in 1998 and 1999 resulted in a surge in non-energy industrial output as Russian manufacturers of foodstuffs, machinery, and metals increased their exports and took market share from imports. The rebound in industrial output has been led by the production of intermediate goods, especially metals and chemicals: Output of the metallurgical and chemical industries rose 50 percent between 1998 and 2003. Output of services fell in 1999, but in 2000 and 2003, growth in market services led the recovery. Domestic demand, especially in retailing and consumer services, became a major driver of growth in GDP since 2000. Agriculture had a major impact on GDP growth in both 1999 and 2001 when agricultural output soared at double-digit rates. Rising corporate profits contributed to a boom in commercial construction in 2000. Housing construction boosted economic growth in 2003.

Energy (electric power, oil, gas, and coal) is an important component of the Russian economy, accounting for 30.1 percent of Russian industrial output. Industrial output, in turn, contributed 31.8 percent to nominal GDP in 2000, of which oil extraction, refining, and natural gas contributed 8.8 percent. This share, 8.8 percent, was up sharply from 1998 as higher world market prices boosted the value of the output, the value-added in these sectors.[9] In addition to its contribution to GDP, the energy sector is a major source of profit and excise tax revenue. It was responsible for 22 percent of total corporate

[8] World Bank, *Russian Economic Report,* Washington, D.C.: World Bank, February 2004, p. 3.
[9] *Value-added* is the difference between the value of gross output generated by a sector and the cost of materials, value of wages, rents, profits, and depreciation in that sector.

profits in 2002. Although higher prices for exports of oil and gas have had highly beneficial effects for the budget, the balance of trade, and corporate profits of energy companies, in terms of output, energy has not driven the recovery. Output of natural gas fell in the first years of the recovery and was lower in 2002 than it was in 1998, the year of the economic crisis from the decline of the ruble. In 2003, electric power output rose at half the rate of the GDP, which reflects an improvement in energy efficiency. Due to a resurgence in investment in the sector, oil output has risen at the same rate as GDP since 1998.

Higher oil and gas prices have been beneficial for the Russian economy. In 2003, the average price per barrel for Russian crude rose from $21 in 2002 to more than $43 a barrel in October of 2004. This increase has contributed to higher-than-expected tax revenues and a surge in corporate profits, which in turn have boosted investment. However, much of the benefit from higher revenues from oil and gas exports has been kept offshore, as Russians increased capital exports and the Central Bank of Russia has piled up reserves.

The recent *Russian Economic Report* published by the World Bank makes the argument that Russia is more dependent on oil and gas than official figures suggest, arguing that oil and gas contribute 25 percent of GDP rather than 8.8 percent.[10] The World Bank estimates use British and Dutch data on value-added accruing to the transport and trading sectors from the oil and gas industries to recalculate the composition of Russian value-added.

Based on our analysis of the World Bank report, we find that the 25 percent figure exaggerates the role of oil and gas in the Russian economy. The assumptions used in this exercise seem very strong: Russia has to transport its gas and oil over thousands of kilometers, whereas Dutch and British oil and gas are much closer to consumers. The World Bank recalculations are inconsistent with value-added from oil and gas in other energy-exporting countries such as Mexico. As noted above, trends in energy output run counter to recent increases in GDP in Russia, a situation that the World Bank does not challenge.

What happens to growth in Russian GDP if oil prices fall? According to estimates by Moscow banks, a $1 drop in the price of a barrel of oil on international markets translates into a $1 billion decline in tax revenues from all sources. To put this in context, the budget surplus in 2002 was $5 billion, so a $5 drop in the price of a barrel of oil in that year would have eliminated the surplus. Despite the importance of energy taxes to the budget, however, even a sharp drop in oil prices would be unlikely to derail economic recovery at this point in time. Other tax revenues form such a large share of the total that the budget surplus is large enough, and Russia's creditworthiness has improved to the point that the economy should be able to weather a very sharp fall in world market oil prices without a dramatic slowdown in growth. The government could counteract the effects of a decline in oil revenues by a combination of borrowing, drawing down a

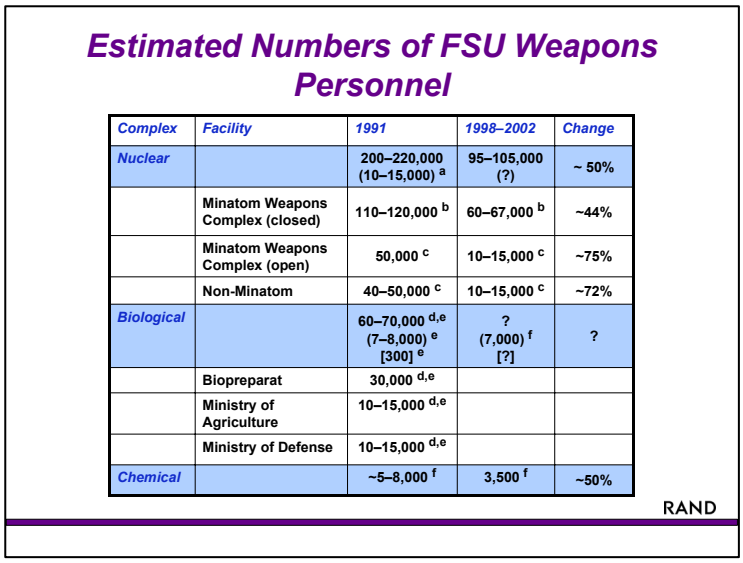
[10] World Bank, 2004, Table 7, p. 15.

contingency fund that has been set up precisely to create a buffer for times when oil prices will be lower, and modest reductions in expenditures.

RAND conducted a simulation of the impact of a decline in the price of oil from about $26 a barrel (Urals blend) to $12 a barrel in 2005. The simulation results in a 16 percent decline in corporate profits and a 3 percent decline in investment as opposed to increases of 4 and 7 percent, respectively, under a constant oil-price scenario. Russia's terms of trade[11] fall by 17.5 percent, resulting in a much smaller rise in household consumption (2 percent) than the 7.3 percent increase in consumption enjoyed in 2003. However, lower energy prices result in increases in the output and export of energy-intensive industries such as metallurgy and chemicals. Even under such a drastic decline in oil prices, the Russian economy would continue to grow.

The World Bank argues that Russia remains dependent on high oil prices for growth to exceed 5 percent per year. For growth to run more than 5 percent per year during periods of lower oil prices, the World Bank states, "… will require sustained effort to set the reform boat afloat once more. But it needs to be done, to minimize the other risk to Russia's high growth rates, its dependency on hydrocarbon exports."[12] We concur with this assessment: For the Russian economy to grow at a sustained basis of 6 to 7 percent per year, the business environment in Russia will need to improve greatly. Onerous registration and regulatory requirements will need to be eliminated, in part to prevent Russian bureaucrats from threatening to levy fines for violation of those requirements in order to obtain bribes. Russia will also need to integrate more closely with the global economy. Currently, high tariffs on some components of goods and bureaucratic customs procedures dampen trade in manufactured goods. Onerous visa requirements for individuals attempting to visit Russia and for Russians attempting to travel to North America and Europe pose substantial barriers to enhanced economic interaction. Until these barriers are reduced, the integration of Russian manufacturing into global industry will be slow, retarding economic growth.

[11] *Terms of trade* measures the purchasing power of exports relative to imports.
[12] World Bank, 2004, p. 3.



2. SUPPLY OF PROLIFERATION-CRITICAL KNOWLEDGE

This section examines sources of the supply of personnel with proliferation-critical knowledge who may divert their expertise to proliferant states and terrorist groups. A key question that this section addresses is the size of the pool of NBC weapons expertise in the former Soviet Union. Unfortunately, there is little confirmable data on the number of personnel in the NBC weapons complexes, and estimates of these numbers vary widely, particularly for the chemical and biological complexes.

The table above provides a rough estimate of the changing size of the workforce associated with the former Soviet nuclear, biological, and chemical weapons complexes based on publicly available sources.[13] It also highlights the substantial uncertainties that persist concerning the estimated downsizing since the early 1990s of personnel with proliferation-critical expertise. This table highlights the outdated and imprecise understanding of the potential problem of weapons complex personnel diverting sensitive information. Without a more complete understanding of the number of personnel, it is hard to calibrate the scope of the danger of diversion.

[13] The table footnotes are as follows: [a]According to former Minatom head V. Mikhailov (*Komsomolskaya Pravda,* January 31, 1992), 10,000 to 15,000 people have "really secret information," and 2,000 to 3,000 people have information of "paramount importance"; [b]Oleg Bukharin, Frank von Hippel, and Sharon K. Weiner, *Conversion and Job Creation in Russia's Closed Nuclear Cities,* Princeton, N.J.: Princeton University Press, 2000, p. 13; [c]Oleg Bukharin, Princeton University, interview with the author, RAND Corporation, Washington, D.C., December 19, 2003; [d]Ken Alibek and Stephen Handelman, *Biohazard,* New York: Random House, 1999; Amy Smithson, *The Toxic Archipelago,* Stimson Center Report No. 32, Washington, D.C., 1999, p. 10; Milton Leitenberg, University of Maryland, interview with the author, RAND Corporation, Washington, D.C., December 12, 2003; [e]Leitenberg, 2003; [f]Smithson, 1999, p. 47; Gulbarshyn Bozheyeva, "The Pavlodar Chemical Weapons Plant in Kazakhstan: History and Legacy," *The Nonproliferation Review,* Summer 2000, pp. 136–145.

The former Soviet nuclear weapons complex experienced a substantial reorganization and reduction in its skilled workforce during the first decade following the dissolution of the Soviet Union. Most of the Soviet nuclear weapons infrastructure is found within Russia and a few facilities of proliferation concern are located in non-Russian states (e.g., Ukraine, Kazakhstan, Georgia). Following the reorganization of the Ministry of Atomic Energy (Minatom) in early 2004, the ministry continued to have responsibility for the nuclear weapons and civilian nuclear power activities of the Russian Federation.[14] Publicly available sources indicate that the Minatom workforce was reduced by nearly 50 percent (from more than 200,000 to about 100,000) over the 1991–2002 period, because orders from the Ministry of Defense (MOD) for Minatom's products and services dropped off substantially and the Russian government was unable to sustain earlier budgets.[15] There are some indications that after adjusting to these dramatic reductions in personnel levels through about 2000, the current workforce levels have not substantially changed over the past few years.

Minatom appears to have given priority to trying to sustain a core capability in its skilled workforce distributed among the ten closed cities. The facilities in these cities have been the backbone of its nuclear weapons "archipelago" for producing fissile materials and designing and manufacturing nuclear weapons. Other Minatom facilities located outside of the closed cities have also experienced significant workforce reductions. In addition, there are several nuclear facilities, such as the Kurchatov Institute located in Moscow, that possess individuals with weapons-critical expertise but are no longer part of the Minatom organization. There are also a number of institutes and facilities that are involved in the design and manufacture of centrifuges for enriching uranium that are completely outside of the Minatom umbrella.[16]

The former Soviet biological weapons (BW) and chemical weapons (CW) programs face significant restructuring pressures, and their personnel levels have declined since 1992. Similar to the nuclear program, the remnants of the robust Soviet BW and CW programs are largely found in Russia. The BW program involves a diverse array of institutes and facilities associated with Biopreparat, the Ministry of Defense, and the Ministry of Agriculture. According to publicly available sources, up to 70,000 individuals were associated with the Soviet BW program at one time.[17] Estimates of the total number of

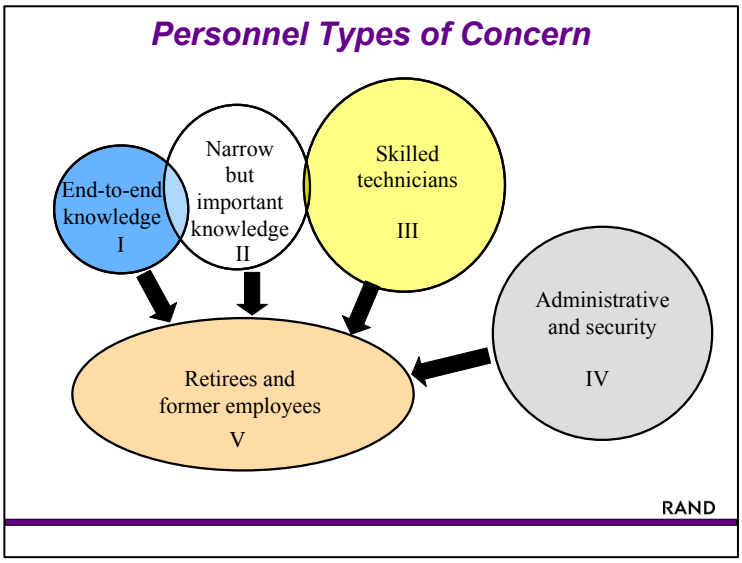
[14] See Federation of American Scientists, "WMD Around the World: Ministry for Atomic Energy," Minatom, http://www.fas.org/nuke/guide/russia/agency/minatom.htm (as of April 6, 2004).
[15] Some public sources, such as a 1992 statement by the head of Minatom, V. Mikhailov (1992), suggest that the number of Minatom personnel with real weapons-critical knowledge is a relatively small subset (10,000 to 15,000) of the larger nuclear workforce.
[16] See Oleg Bukharin, "Russia's Gaseous Centrifuge and Uranium Enrichment Complex," Program on Science and Global Security, Woodrow Wilson School of Public and International Affairs, Princeton University, January 2004.
[17] Similar to the nuclear program, it is estimated that about 7,000 to 8,000 individuals in the BW program in the early 1990s were key scientists and engineers, and some analysts suggest that only about 300 possessed the most important type of weapons-critical expertise (Leitenberg, 2003). Estimates of the total number of scientists to have been working on BW reach 60,000 to 70,000 (see Alibek and Handelman, 1999; Smithson, 1999, p. 10; and Jonathan B. Tucker, "Biological Weapons in the Former Soviet Union: An Interview with Dr. Kenneth Alibek," *The Nonproliferation Review,* CNS, Vol. 6, Spring/Summer 1999, pp. 1–6.

individuals currently associated with the facilities that once were part of the Soviet BW program are not available.

The Soviet chemical program involved substantial production and storage of chemical weapons agents. It also maintained several huge facilities on standby for surge production if needed. Publicly available sources suggest that the CW program employed about 6,000 to 8,000 personnel by the early 1990s and that it has experienced a reduction of 50 percent or more since then.[18] Although Russia has pledged to eliminate its CW stockpiles, progress has been delayed by funding shortfalls and local opposition to CW-agent destruction plans.

In sum, the massive Soviet NBC weapons program is currently fragmented among numerous countries and employs only a fraction of its former workforce. Despite these major dislocations and workforce reductions, its residual personnel possess substantial weapons-critical expertise and are potentially attractive to potential proliferant states and non-state actors seeking to acquire NBC weapons. Whether the scope of the personnel of concern is large or small has important policy implications. While even a small number of people who illicitly transfer their expertise can create a serious security problem, it is much easier to contain the threat of a smaller, easily identified group of people than the threat of a larger, more diverse one.

[18] Smithson, 1999, p. 47; Bozheyeva, 2000, pp. 136–145; Russian Munitions Agency, homepage, http://www.munition.gov.ru/eng/oldobj4.html (as of April 6, 2004).



Another way to think about the supply of proliferation-critical knowledge in the former Soviet Union is to examine the types of individuals that are in the complexes and the knowledge they possess that would be useful to states or terrorist groups seeking to acquire nuclear, biological, or chemical weapons or the know-how to develop their own weapons.

We identified five distinct types of individuals who possess the knowledge and expertise of concern regarding proliferation (see the figure above). Type I individuals are the senior facility managers or chief scientists who are most likely to have an end-to-end knowledge of the materials and processes needed to develop NBC weapons capabilities. In comparison, we define Type II individuals as scientists and engineers with detailed knowledge and experience in specific aspects of the weapons development process. Their narrow, but important, knowledge could involve the weaponization process, component design, plutonium or uranium metallurgy, the production of weapons-grade materials, or testing methods. A larger group of potentially significant personnel are skilled technicians, or Type III individuals. These individuals include various specialists and skilled workers who possess the actual know-how for achieving the desired results and products. For example, they could be skilled in manufacturing or operating high-quality gas centrifuges for enriching nuclear materials, or they might have practical knowledge of the technologies and techniques for manufacturing nuclear pits or aerosolizing biological agents. Potential proliferants are likely to target Type II and III individuals if they are facing a specific hurdle that is impeding their progress in acquiring NBC weapons.

Although often overlooked, two other types of individuals could also play a role in the illicit transfer of sensitive NBC knowledge by former Soviet Union experts. We identified Type IV individuals as those administrative and security personnel who are likely to possess sensitive information about the facilities or institutes in which they work and the Types I, II, and III personnel found at those facilities or institutes. These support

personnel are potentially important to proliferants because they could help to better identify where the proliferants should focus their efforts to acquire special materials, weapons, or sensitive knowledge or where and how to recruit disgruntled individuals with relevant expertise and the access they need at a particular facility. Finally, we identified Type V personnel as former employees and retired personnel who are a proliferation risk if they possess knowledge on programs of interest to proliferants. As with the Type IV personnel, these retirees could add to the proliferation risk if they serve in a go-between role by connecting outside parties with their former colleagues who might be current employees willing to transfer their weapons-critical knowledge and experience through a trusted former colleague.

Individuals with proliferation-critical expertise gained from experience and training with various NBC programs are distributed throughout the former Soviet Union weapons complexes. Personnel classified as Type I, II, or III are likely to be concentrated in the research and production facilities for nuclear, biological, and chemical weapons facilities, as well as facilities that produce (or previously produced) nuclear materials. To a far lesser degree, individuals with weapons-critical expertise and experience could also be found at facilities responsible for weapons or material storage or demilitarization, such as nuclear warhead disassembly facilities. The proliferation risks associated with these diverse facilities will vary with the particular type of NBC program. For example, a nuclear weapons program requires expertise that is widely distributed among a larger, more specialized workforce. By comparison, even a single individual can offer substantial illicit knowledge transfer for a BW program by providing both sensitive information and/or an agent culture to an outside party.

The risk of diversion of expertise from specific facilities of the former Soviet NBC programs vary greatly according to the economic and social conditions and the potential for outside parties to access those facilities. In some cases, such as Russia's closed nuclear cities, individuals with weapons-critical expertise are comparatively isolated from external access by both geographic location and continuing Russian security practices. The restricted access of the closed nuclear cities and certain other types of facilities (e.g., MOD chemical and biological facilities) increases the challenges of trying to transfer sensitive information without being noticed. In comparison, the many NBC facilities located outside the closed cities, particularly those associated with the BW and CW programs, are more vulnerable to proliferants seeking the skills and experience of interest to them.

In addition, the economic wellness of a facility is an important factor in determining the potential proliferation risks associated with it. Although the quality of life for the workforce associated with former Soviet NBC programs has declined significantly since

the late 1980s, some facilities have been relatively successful in achieving a degree of stability due to sustained government funding or the ability of scientists and technicians to supplement their incomes through commercial activities in the local economy or through major Western corporations. In comparison, other facilities continue to suffer from severe financial distress and morale problems resulting from significant downsizing or a planned shutdown as NBC programs are terminated or consolidated.

The former Soviet NBC facilities all have Type IV personnel performing key administrative and security functions. These individuals often possess sensitive information of interest to outside parties. Such enabling information might include ways of gaining external access to sensitive information or weapons-related materials, as well as knowledge about specific weapons scientists and technicians who could help outside parties connect with or coerce individuals possessing the expertise and experience those parties are seeking. Similarly, retirees and former employees (Type V individuals) with continuing connections to particular institutes and facilities could also possess such enabling information of interest to proliferants.

Illicit transfers can occur in any facility regardless of the current economic conditions, as the United States' experience with knowledge diversion from its own weapons complex has shown. However, in the context of the economic, political, and social turmoil that still exists in Russia, some facilities are at greater risk than others.

Our threat assessment focuses attention on former Soviet NBC facilities that are of greater concern with regard to proliferation because they have a concentration of weapons-critical expertise *and* are experiencing substantial economic distress with limited prospects for improvement. For illustrative purposes, the list above provides some examples of NBC facilities in which Type I through Type V personnel could have increased incentives for undertaking illicit knowledge transfer of proliferation-critical expertise (e.g., weapons-critical or other enabling information).

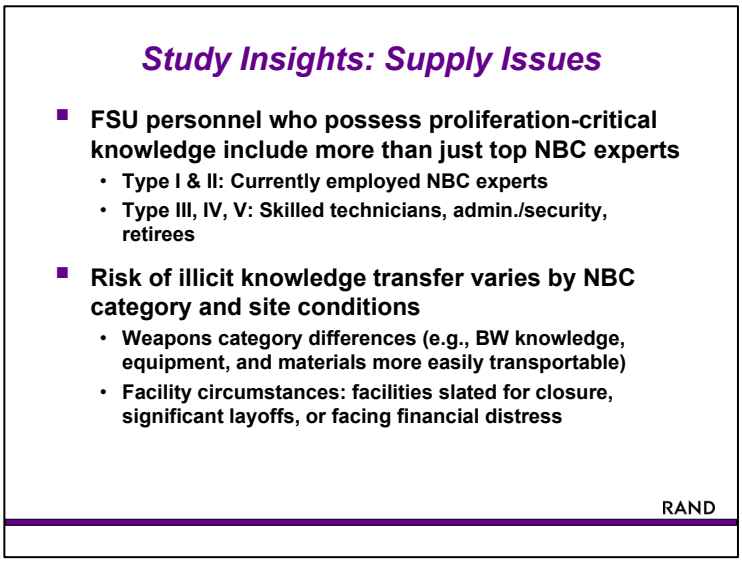
Many former Soviet nuclear facilities and institutes have individuals possessing either weapons-critical expertise or knowledge and skills relevant to producing fissile materials, producing key weapons components, or assembling weapons. Facilities of particular proliferation concern are ones with personnel with experience in nuclear weapons research and development and development and production of highly enriched uranium using sophisticated centrifuge technologies and techniques or production of weapons-grade plutonium. Some of these facilities have been sustained by continuing financial support from Minatom as part of Russia's nuclear weapons complex, while other facilities are undergoing substantial downsizing or facing full shutdowns.[19] Examples of

[19] As part of Russian President Vladimir Putin's major government reorganization that started in March 2004, Minatom (the Ministry of Atomic Energy) was reorganized into the Federal Agency for Atomic Energy (FAAE), and subordinated to the Ministry of Industry and Energy (for matters of nuclear energy) and the Ministry of Defense (for matters of nuclear weapons and defense). How this reorganization will affect previous Minatom plans for both sustaining and consolidating various nuclear facilities and their workforces remains to be seen. See Charles Digges, "Details of Minatom's Dismantlement Becoming Clearer," Bellona Foundation, March 30, 2004, http://www.bellona.no/en/international/russia/nuke_industry/33156.html (as of April 29, 2004).

specific Russian nuclear facilities likely to undergo substantial dislocations include Zarechny (Penza-19), a warhead disassembly facility slated for a full shutdown, and the Avangard facility for warhead disassembly located in Sarov (Arzamas-16), which has been closed and its workforce consolidated with the corresponding VNIIEF warhead research and development facility in Sarov. In addition, uncertain prospects exist for facilities at both Seversk (Tomsk-7) and Zheleznogorsk (Krasnoyarsk-26), which were involved in fissile material activities. Both sites were scheduled for shutdown under earlier Minatom plans.

Not all facilities of concern are found in the former Soviet nuclear complex. Some facilities and institutes that have been involved in the Soviet BW program are facing substantial financial distress and tend to lack the type of rudimentary social support that nuclear facilities have received from Minatom over the past decade. Specific examples are the key biological institutes, such as Vector and Obolensk in Russia.[20] In addition, there are a few facilities associated with the Soviet CW program that raise concerns about expertise diversion, such as a chemical facility located in Ukraine. In general, however, the proliferation concern presented by the expertise found in the former Soviet CW program is limited by the fact that chemical agent production requires relatively less specialized knowledge for potential proliferants compared with nuclear and biological weapons production.

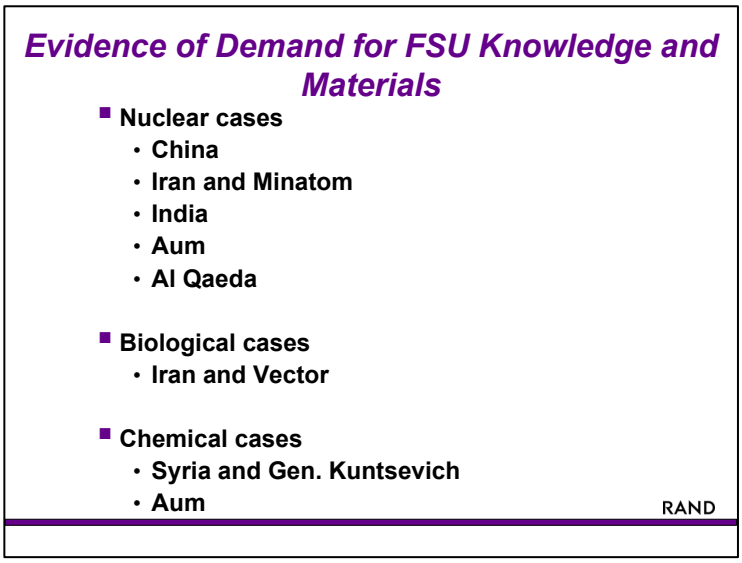
[20] Aleksey Khadayev, "Russia: Virology Center Seen Threatened by Financial Crisis, Short-Time Work," *Moscow Rossiyaskaya Gazeta,* in Russian, FBIS CEP20031110000037, November 5, 2003; Sergey Ptichkin, "Russian Daily Speculates on SARS Origin; Decries Bankruptcy of Research Center," *Moscow Rossiyskaya Gazeta*, in Russian, FBIS CEP20030527000125, May 23, 2003; Margaret Coker, "Russian Cash Crisis Unleashes Bio Threat," *The Atlanta Journal-Constitution*, October 19, 2002, p. 1A.



The approach we derived for this analysis offers some important insights on the "supply issues" associated with the former Soviet NBC workforce regarding both the types of personnel of proliferation concern and the challenge of identifying facilities where the risk of illicit knowledge transfer is greatest.

First, the traditional focus of U.S. proliferation policy in the region has been on the top scientists and engineers associated with the former Soviet Union's NBC weapons programs. We identified Type I and Type II personnel who have either unique expertise in managing weapons programs and/or possess specialized technical knowledge integral to acquiring NBC weapons systems. However, we also concluded that the range of personnel possessing sensitive information is broader than just these top-level managers and scientists. Skilled technicians and workers who have gained experience and practical know-how on accomplishing weapons-critical tasks should also be considered very useful to proliferants. Furthermore, we identified other personnel, such as support personnel (Type IV) or even retirees (Type V), who could provide outside parties with enabling information that might substantially improve those parties' chances of successfully finding and acquiring the weapons-critical expertise or information they are seeking.

Second, the risk of illicit knowledge transfer is not necessarily uniform among former Soviet facilities; it varies by NBC category and by the particular economic, working, and living conditions for the personnel at a given facility. Different types of weapons (nuclear, biological, or chemical) are likely to present distinct challenges for individuals and groups seeking to engage in illicit transfer of weapons-critical knowledge to unauthorized outside parties. Similarly, the potential incentives that personnel possess for taking the risk of engaging in illicit knowledge diversion could be driven by the economic conditions of their facilities. Facilities that have bleak prospects for sustaining weapons experts and their families, such as facilities in nuclear cities that are slated for closure, potentially present greater incentives for personnel to engage in illicit knowledge transfer as a means of reducing their current or expected future financial distress.



3. DEMAND FOR PROLIFERATION-CRITICAL KNOWLEDGE

This section examines the scope and nature of those who demand proliferation-critical knowledge that may be available in the FSU. So far, we have examined the supply of weapons-critical knowledge within the former Soviet Union, but what about the demand for that knowledge? The fear that such knowledge would end up in rogue states is what drove the United States to establish its nonproliferation programs in Russia and in other FSU states during the 1990s.

According to the open-source empirical record, there have been clear examples of demand for Russia's NBC weapons knowledge. For example, in the nuclear sector, the agreement that Iran has with Minatom to build the light-water reactor at Bushehr is an example of the demand for Russian nuclear expertise, but not specifically weapons expertise. Given that Iran has vast natural reserves of oil and has attempted to enrich uranium to weapons-useable levels, Bushehr could well be a means for Iran to get plutonium for nuclear weapons.[21]

In the early 1990s, leaders of Aum Shinrikyo, the Japanese religious cult that in 1995 attacked riders on the Tokyo subway with a sarin nerve agent, made numerous trips to Russia.[22] The group's leader in charge of weapons procurement made 21 trips to Russia between 1992 and 1995. Group leaders frequently met with senior government officials, such as the secretary of Russian Security Council, the Parliament speaker, and vice

[21] The International Atomic Agency has recently revealed that Iran has produced small quantities of highly enriched uranium. See Peter Slevin and Joby Warrick, "Iran Faulted on Nuclear Declaration," *The Washington Post,* Wednesday, February 25, 2004, http://www.washingtonpost.com/wp-dyn/articles/A3297-2004Feb24.html (as of April 29, 2004).

[22] U.S. Congress, Senate, Committee on Governmental Affairs, Permanent Subcommittee on Investigations, *Global Proliferation of Weapons of Mass Destruction, Part I,* Washington, D.C.: U.S. Government Printing Office, 1996, pp. 72–73.

president. Aum members also met frequently with scientific experts. The group established branches in many cities near important weapons research facilities in Russia. A few employees of the Kurchatov Institute actually became members of Aum.
Osama Bin Laden and the al-Qaeda movement he helped create sought nuclear weapons capabilities throughout the 1990s.[23] A number of reports indicated that al-Qaeda operatives sought to purchase nuclear weapons and nuclear material.[24] Several Pakistani nuclear scientists met with Bin Laden and other al-Qaeda leaders to offer their services. If their contact continued, it may have led to a more sophisticated effort to acquire nuclear capability.[25]

In the biological sector, there have been several instances in which Iran sought information or materials from Russian biological institutes.[26] In one case, Iranian agents were negotiating a deal with Vector, one of Russia's premier biological research centers that previously performed important weapons research. The United States discovered the deal and was able to stop it by threatening to pull all financial assistance to Russia if the deal went through.[27]

In the chemical sector, the most prominent example of demand for chemical weapons knowledge is Syria, where General Anatoly Kuntsevich, head of Russia's chemical weapons program, built a chemical weapons infrastructure.[28]

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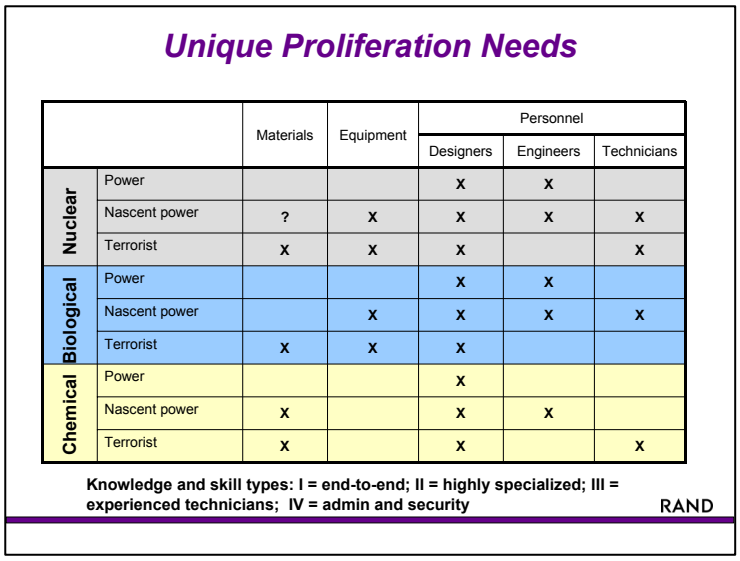
[23] *United States of America v. Usama Bin Laden et al.,* United States District Court, Southern District of New York, S (7) 98 Cr. 1023 (Indictment), July 2, 2001, pp. 1–7.
[24] George J. Tenet, "The Worldwide Threat 2004: Challenges in Changing Global Context," Senate Select Committee on Intelligence, February 24, 2004, p. 3. See also, David Albright and Holly Higgins, "A Bomb for the Ummah," *Bulletin of the Atomic Scientists*, Vol. 59, No. 2, March/April 2003, pp. 49–55, and Anonymous, *Through Our Enemies' Eyes: Osama bin Laden, Radical Islam, and the Future of America*, Washington, D.C.: Brassey's Inc., 2002, pp. 186–193.
[25] Bunn and Wier, 2004; Albright and Higgins, 2003, pp. 49–55.
[26] Miller, Judith, Stephen Engelberg, and William Broad, *Germs: Biological Weapons and America's Secret War*, New York: Simon and Schuster, 2001.
[27] See *RANSAC Nuclear News,* Russian American Nuclear Security Advisory Council, September 18, 2000, http://www.ransac.org/Projects%20and%20Publications/News/Nuclear%20News/2000/09_18_00.html (as of April 29, 2004).
[28] See, for example, "Chemical Chronology, 1993–2003, Syria Profile," NTI, http://www.nti.org/e_research/profiles/Syria/2976_3281.html (as of April 30, 2004); see also Federation of American Scientists, "WMD Around the World: Syria—Special Weapons," Federation of American Scientists, http://www.fas.org/nuke/guide/syria/ (as of April 30, 2004); "Kulikov Militarizes Russian Police Force," http://www.afpc.org/rrm/rrm379.htm (as of April 30, 2004); "DIA (Defense Intelligence Agency) Testimony to Select Committee on Intelligence: Worldwide Threat to U.S. National Security Interests," http://www.securitymanagement.com/library/000255.html (as of April 30, 2004).



Another way to approach the problem of knowledge diversion is to understand the unique proliferation needs of the various types of groups or states. Those needs are driven in large part by the role that NBC weapons play in the security strategies of these groups and states and how far along they are in the process of developing those weapons.

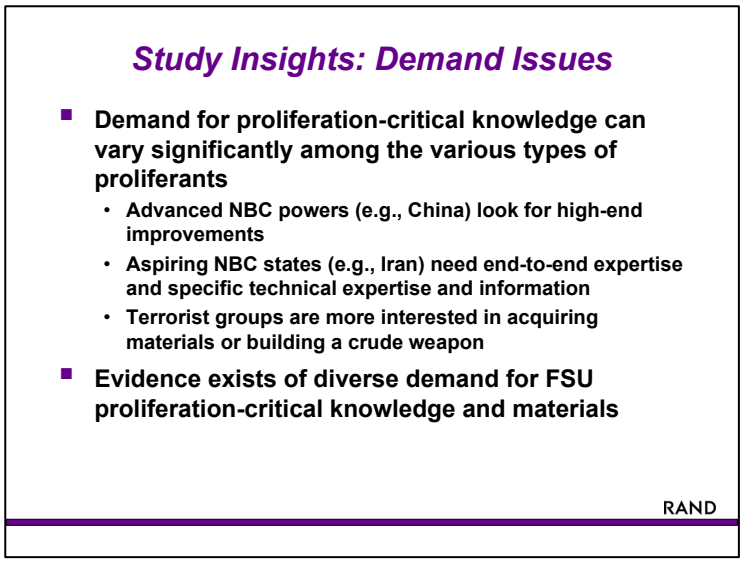
Unique weapons acquisition needs include the specialized materials, equipment, knowledge, or skills (not dual-use; e.g., phosgene is used in making plastics and has been used as a chemical weapon) that a country must acquire from abroad. In general, the more advanced a country's indigenous program is, the more specific or high-end its requirements will be. For example, China has a well-established nuclear weapons program and does not need to acquire nuclear materials or most of its equipment from abroad. However, China's program could be advanced significantly with knowledge from Russian or U.S. weapons experts who could help China to improve its weapons designs for efficiency, miniaturization, and reliability, which in turn would make for significant improvements in the military utility of those designs. High-end tools or specialized non-nuclear materials might also be useful to that end. China could also improve the safety and surety of its weapons with outside assistance.

By contrast, a nascent nuclear power, such as North Korea or Iran, that is seeking to establish a credible nuclear deterrent either needs or could benefit immeasurably from assistance at all points of the process, from specialized equipment to design information to production technologies and skills. A nascent nuclear power must invest in the relevant infrastructure that a credible deterrent requires. Recent activities in both countries to establish nuclear materials production capabilities indicate that they believe it is important to build these capabilities. These activities also suggest that these two countries are less likely to aggressively pursue weapons-usable materials from Russia than what was feared in the early 1990s. These activities may, however, have increased their demand for certain types of knowledge and skills.

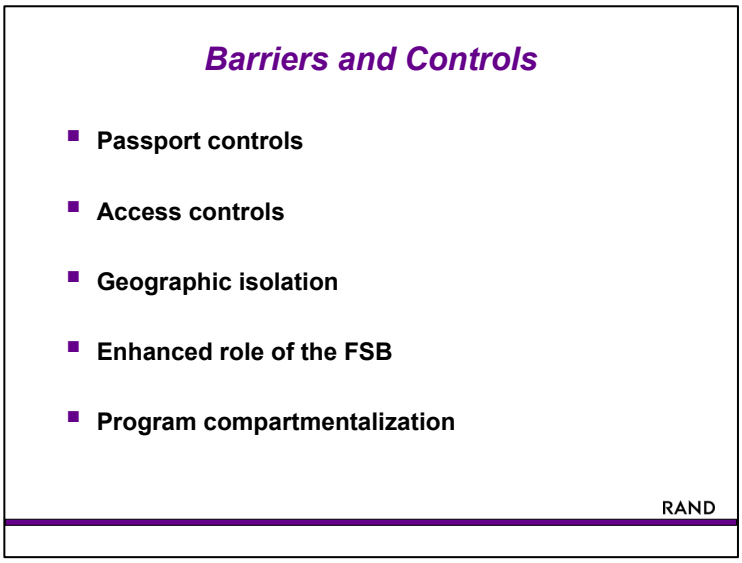
A terrorist group, on the other hand, is much more likely to use weapons to kill people than to wield weapons as part of a comprehensive nuclear deterrent. Therefore, a terrorist group needs basic materials and skills to make a simple fission device that will achieve the group's goals. A terrorist group can achieve this capability without many of the more demanding and sophisticated needs that a state might require to build a credible nuclear deterrent. For example, if a terrorist group is able to acquire a stolen weapon, it will need only access to technicians or bomb designers who know enough to detonate the device. If, instead, the group must assemble an improvised nuclear device, the group will need fissile materials, machining equipment, a simple weapon design, and a few technicians with the skills to work the nuclear material, fit the explosives, and assemble the device. As a result, a terrorist group will be most interested in nuclear materials, Type III technicians, and possibly weapons designers.

The same basic division of personnel applies to biological and chemical weapons, except that the required materials, equipment, knowledge, and skills are much more widely available as dual-use items and, in some cases, are easier to master.

One conclusion from this analysis is that the concerns regarding proliferation differ for each of the three types of entities seeking NBC weapons capabilities. Terrorist groups primarily need the fundamental materials for building nuclear, biological, or chemical weapons, so restricting access to these materials should be the most effective strategy to diminish the proliferation threat from terrorists. Nascent states are more interested in advanced weapons knowledge, skills, and technologies across a broad range of areas, which will allow them to establish a militarily credible nuclear deterrent. Established nuclear powers have much more specific and specialized needs to advance their weapons programs; they aim primarily at making their weapons lighter, smaller, more accurate, or more efficient.



The nature of the desired weaponry and capabilities and goals of a state or terrorist group influences the types of expertise the state or group may seek. States with considerable NBC weapons capabilities may still seek to acquire greater expertise, but their needs are much more sophisticated and specialized than those of a state that aspires to acquire NBC weapons capabilities. Terrorists, in contrast, have been satisfied with crude capabilities. Understanding the importance of these distinctions allows for a more discriminate assessment of the dangers of expertise transfer.



4. BARRIERS TO KNOWLEDGE TRANSFER

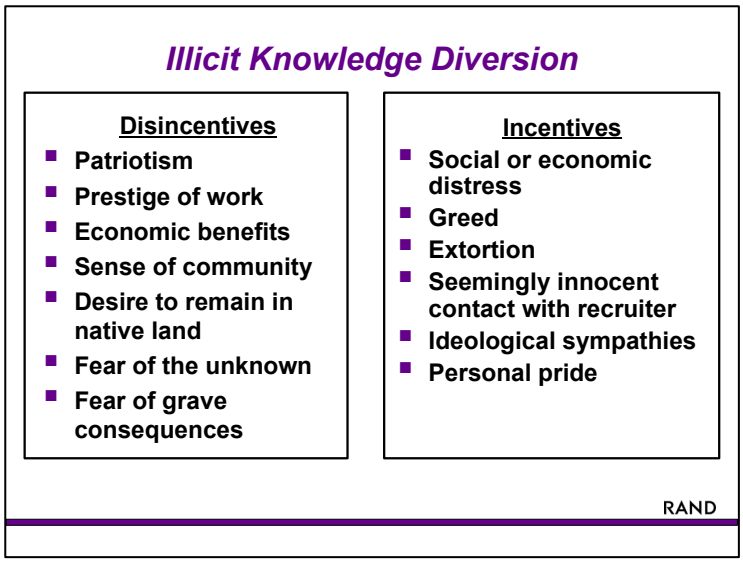
If there is such a large supply of proliferation-critical knowledge for NBC weapons in the former Soviet Union and a demonstrated demand for such knowledge by some states and terrorist groups, why has there been so little documented evidence of illicit transfers of knowledge (or transfers of materials and weapons)? What is impeding supply and demand from meeting to form a market? Is a traditional market even the right model to use when analyzing the problem of proliferation from the former Soviet Union?

We found that a complex set of barriers and disincentives have significantly limited the transfer of knowledge (and materials) from the FSU. That is why in Section 1 of this briefing we suggested using a very different formulation of the market model to better understand why so little NBC information has been illicitly transferred to date from the FSU.

Several different physical, legal, and policy barriers restrain individuals in the FSU NBC weapons complexes from transferring their expertise to states and terrorist groups. In most of the closed cities, administrative and security personnel maintain tight controls on the travel of key personnel. For example, authorities exercise great control over passports, which restricts the ability of personnel to travel abroad.

In addition, access to closed cities is regulated. Many of the closed cities and weapons-related facilities are geographically located in remote areas, making contact with personnel difficult. The location of facilities in more isolated, less populated, and predominately Slavic areas also makes it more difficult for foreigners to operate without being noticed. Geographic isolation in Russia is reinforced by the difficulty of travel in rural Russia.

Finally, the Federal Security Bureau (FSB) has assumed greater responsibility for the security of weapons facilities in recent years. This greater responsibility is accompanied by an increase in its stature as a bureaucratic organization in the Russian government. During President Vladimir Putin's presidency, the FSB and other security organizations have assumed augmented powers, making it even more difficult for foreigners to visit sensitive facilities.



In addition to formal and informal barriers and controls, incentives and disincentives also influence personal considerations and attempts to transfer one's expertise. *Disincentives* serve as a type of barrier to knowledge transfer because they provide the individuals of concern with ample reason not to proliferate, while *incentives* may lead a specialist or support person to ignore disincentives and share sensitive information.

In the former Soviet states, disincentives include the following:

- **Patriotism.** Russian scientists and other workers in the weapons complexes generally remain proud to be working for the motherland, and the sense of duty to the state that was instilled by the Soviet government is enough in many cases to dissuade specialists from engaging in proliferation activities. The idea of selling information to other governments is considered to be treasonous and disloyal.

- **Prestige of weapons work.** In many cases, weapons work carries with it enough importance and prestige to ameliorate specialists' needs for recognition, and most scientists are unwilling to trade their status of contributing to national security for defection or possible imprisonment.

- **Economic benefits.** Weapons specialists continue to make significantly more than the average monthly wage in Russia, and they do not wish to lose access to special benefits and projects, such as the IPP projects through the U.S. Department of Energy or the International Science and Technology Center (ISTC) projects through the U.S. Department of State.

- **Sense of community.** Many specialists have worked together for years, and over time have formed close-knit communities. Especially in the closed nuclear cities, this communal sense of loyalty and duty serves as a deterrent to proliferation, which is seen as a betrayal and even a threat to the scientific community,

especially in cases in which the institution could be sanctioned or otherwise punished for individuals' sharing of sensitive information.

- **Desire to remain in native land/fear of the unknown.** While economic conditions in Russia may be tough, an unfamiliar existence in a foreign land, living far away from one's community and loved ones, and promises of money and prestige from states and sub-national groups that many Russians consider inferior may provide little incentive for specialists to risk their careers and home life for the sake of profiting from proliferation.

- **Fear of grave consequences.** The prospect of being considered a traitor or "enemy of the people" weighs heavily on a specialist who may be deciding to proliferate. This fear is in part a vestige of the Soviet era.

Incentives, although they are fewer in number, may feel more tangible to personnel with proliferation-critical knowledge or satisfy more immediate needs, and thus may lead to proliferation of weapons knowledge:

- **Social or economic distress.** In some economically depressed regions, or in the event of severe economic decline or catastrophe, personnel may become convinced that the potential gains from proliferation outweigh the risks, or worse, that they "have nothing to lose" in proliferating sensitive knowledge. These incentives are likely to be more acute at facilities facing downsizing, shutdown, or an uncertain future.

- **Greed.** This factor, to a varying extent, strips nonproliferation programs and efforts of their usefulness, because no matter how helpful or beneficial a program may be, there is always the possibility that some individuals may simply "want more"; thus, no specific amount of aid or disincentives can prevent proliferation. A RAND study of insider theft in high-value industries in the United States and Europe found that greed was the most common motivation for theft, even in well-developed economies.[29]

- **Extortion.** The possibility that an individual or group seeking sensitive information may threaten a person or his or her family to gain access to that information seems plausible and, although there have been no documented cases of such threats to date, successful extortions may have occurred but remain undetected.

- **"Innocent" interaction with foreign intelligence operative.** Specialists may accept invitations to attend international conferences or to give lectures, and during such events sensitive information may unwittingly pass between parties.

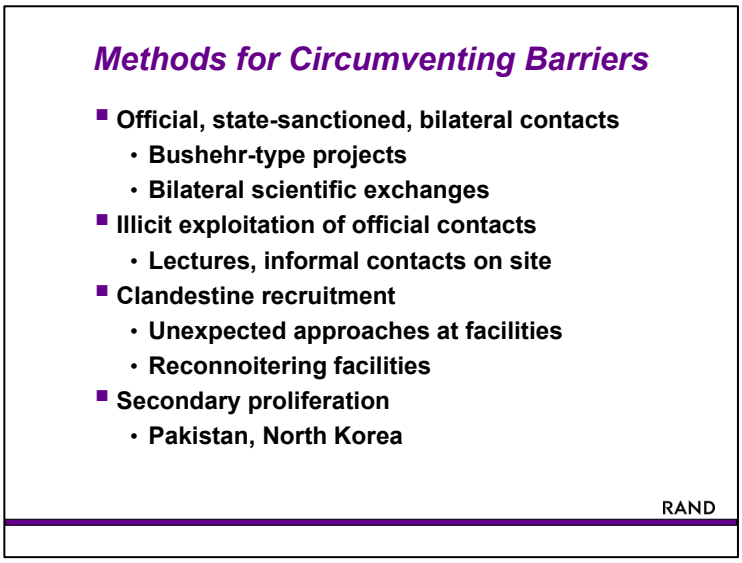
[29] Bruce Hoffman, et al., *Insider Crime: The Threat to Nuclear Facilities and Programs*, Santa Monica, Calif.: RAND Corporation, R-3782-DOE, February 1990.

- **Ideological sympathy with recruiter.** Specialists and support personnel may be sympathetic to the political, religious, or other causes of someone who is seeking sensitive information or an operative who is trying to recruit personnel. Extremist religious fervor in particular may outweigh political or social disincentives to proliferate. For instance, members of Aum Shinrikyo had worked at the Kurchatov Institute and arranged for meetings between Aum representatives and institute leaders.

- **Personal pride.** In the face of an economic crisis, scientists and other key staff in a facility may believe that they and their families "deserve better." This incentive is of particular relevance to Russia's NBC weapons scientists and other specialists, who came to regard themselves as the "vanguard" of defense of the Soviet state. If these staff people view their situations as being insulting or beneath them socially or professionally, personal pride may drive them to seek affirmation of their importance elsewhere.

It is also possible that the effect of specific disincentives or incentives will vary by type of occupation. For example, scientists may have stronger feelings of pride or may be more apt to view themselves as part of an international professional community with accepted norms of behavior.

Given the very few known examples of illicit knowledge diversion, the disincentives for transferal seem to have outweighed the incentives, even when Russia's economy was in shambles. However, this trend is certainly reversible, particularly in the face of renewed economic difficulty, either at specific facilities facing downsizing or shutdowns or as part of a nationwide economic downswing.



Although there are substantial barriers preventing knowledge transferal in the states of the former Soviet Union, methods for circumventing those barriers do exist. These methods include official contacts, illicit exploitation of those official contacts, clandestine recruitment, and secondary proliferation. Attempts to clandestinely acquire expertise from FSU scientists should be considered in the context of other pathways that states and terrorist groups might use to enhance their capabilities.

Official, state-sanctioned, or bilateral contacts. These pathways may include any contact, program, or event under the auspices of the state. Publicly available assistance to other states is one option, i.e., building a facility (such as a plant) or educational exchanges.[30] Bilateral scientific exchanges also provide ideal conditions for transferal of sensitive information, whereby officially exchanged information on nuclear processes, ostensibly for peaceful use, may be used for weapons purposes.

Illicit exploitation of official contacts. Official contacts can be used as a "back door" for proliferation, especially under the auspices of conferences, lectures, or presentations that may have nothing to do with weapons information.[31]

Clandestine recruitment. Such recruitment can occur at the specialist's institution in the home country.[32] Other possibilities for accomplishing this include simply breaking into

[30] Russia's open nuclear assistance to Iran during the building of the nuclear plant at Bushehr is the most obvious example. Several Russian nuclear institutes were placed on the U.S.-sanction *Entity List* in 2001 because of joint educational programs with states the United States considered unsuitable; see, for example, U.S. Department of Commerce, Bureau of Industry and Security, *Entity List,* January 9, 2004, http://www.bxa.doc.gov/Entities/Default.htm (as of April 30, 2004).

[31] Informal settings surrounding the conference, however, provide ample opportunity for quiet discussion of other, more sensitive topics. Informal contacts on construction sites such as Bushehr provide another forum for proliferation that is hard to control.

[32] There have been cases of informal domestic knowledge transferal. For example, in 2000, operatives of the Federal Security Bureau (FSB) regional directorate in Chelyabinsk apprehended a Chinese national as

facilities with less-than-adequate security, which at the present time is not out of the realm of possibility.

Secondary proliferation. Assuming the former Soviet states may avoid proliferation, there remains the specter of secondary proliferation: Countries which themselves obtained weapons through outside assistance are turning around and now reselling that capability to other states. The most recent example is the revelation that Pakistan provided North Korea, Libya, and possibly Iran with nuclear information in the late 1980s and early and mid-1990s.[33]

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he was buying centrifuge documentation and equipment from Russian enrichment workers in the Urals (see "People in the South Urals Phone the FSB," *Chelyabinskii Rabochii*, October 27, 2000). The Chinese national almost certainly did not acquire the technology without some assistance.

[33] See, for example, "Pakistan's Bomb Hero 'Confesses,'" *cnn.com,* Monday, February 2, 2004, http://www.cnn.com/2004/WORLD/asiapcf/south/02/02/pakistan.nuclear.ap/ (as of April 30, 2004).

Examples of Attempts to Circumvent Barriers

	Formal Bilateral Contact	Exploitation of Official Contacts	Illicit Recruitment	
	Bushehr-like Projects	Lectures, Informal Contact on Site	Approaches to Personnel	Reconnoitering Facilities
Iran	■	■	■	
Pakistan	■	■	■	
India	■	■		
Syria	■	■		
China	■	■		
Al Qaeda			?	?
Aum		■	■	
Chechen Rebel Groups				?

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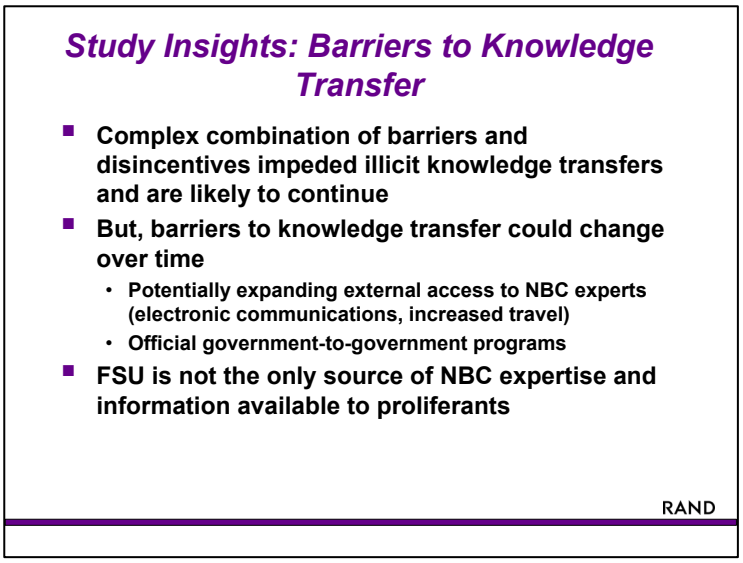
Recent cases in which the barriers to the transfer of expertise have been evaded reveal that formal and government-approved contacts provide significant opportunities for diversion. These government-approved contacts have been much more common in state-to-state relationships. However, there was a brief period in the early 1990s when Aum Shinrikyo had extensive contacts with Russian politicians and personnel at scientific and military facilities.[34]

There are diverse pathways to acquire NBC weapons expertise. Documented evidence of proliferant states seeking to acquire weapons-critical expertise via formal and approved contacts, which are extremely difficult to impede, is greater than the documented evidence of actual illicit contacts. The extensive technical assistance AQ Khan provided to the Libyan government is a prime example. Thus, the danger of illicit acquisition of expertise should be assessed in the context of other pathways that may be as large or larger than illicit ones and that are difficult to impede.

[34] U.S. Congress, Senate, 1996, pp. 69–73.



The combination of barriers and disincentives has thus far impeded significant illicit transfers of sensitive weapons knowledge from the FSU. This trend is likely to continue. A reverse trend, however, cannot be ruled out.

Renewed economic difficulty could cause a shift in the balance between the disincentives and incentives to transfer sensitive information. A countrywide economic crisis or a set of smaller, facility-focused events, such as downsizing or closures, could rapidly change the disincentives/incentives balance to favor incentives. The possibility of expanding external access to NBC experts is a cause for concern for a number of reasons. While barriers and controls seem unlikely to change in the event of economic decline, the future possibility of opening closed cities and facilities would certainly undermine this control system to some extent unless precautionary measures are taken to secure personnel. Concomitantly, the prospect of increased travel as well as electronic communications for weapons specialists lessens control and the transparency of information that is transmitted. Unrestricted access to the Internet is of particular concern. In addition, official government-to-government programs, ostensibly for academic or non-weapons-related work, may bring the seekers right to the specialists' door and vice versa.

Finally, there remains the fact that the countries of the former Soviet Union are not the only source of weapons expertise or information available to seekers, as Pakistan has shown. Secondary proliferation seems to have been more extensive than diversion from the FSU countries. To some extent, this secondary proliferation may reduce the demand for weapons-critical knowledge from the FSU.

5. KEY FINDINGS AND POLICY IMPLICATIONS

Over the past decade, states and terrorist groups have attempted to acquire weapons-critical knowledge, skills, equipment, and materials from the FSU. Yet, reporting on attempts to clandestinely acquire expertise from the FSU has declined in recent years. It is difficult to know with a high degree of confidence if illicit acquisition has occurred and gone undetected or, alternatively, that it has not occurred.

The dual objectives of downsizing the FSU weapons complexes and preventing the diversion of expertise may present greater proliferation dangers in the short run, but lower the danger over time as the complexes diminish in size. While smaller weapons complexes are more likely to receive consistent financial support and make it easier to ensure security, the downsizing process may create short-term instability at certain facilities and thereby raise the risk of personnel diverting their expertise.

Diversions from state-approved activities may provide significant opportunities for proliferation that equal or exceed the danger posed by illicit acquisition from the FSU. Extensive government-sponsored cooperation between FSU states, especially Russia, and regional states such as Iran, India, Libya, and Syria provides channels for officially approved and illicit transfer of critical weapons knowledge. Furthermore, secondary proliferation from China, Pakistan, and North Korea is another significant channel for the transfer of nuclear, biological, and chemical weapons expertise.

While Russian economic conditions are improving, the risk of knowledge diversion remains. Economic growth is broad based, and the economic prospects of most weapons scientists are improving at a greater rate than what most other Russians are experiencing. Nonetheless, there are many other potential motives, such as greed, ideology, pride, or extortion, for scientists considering the transfer of their expertise.

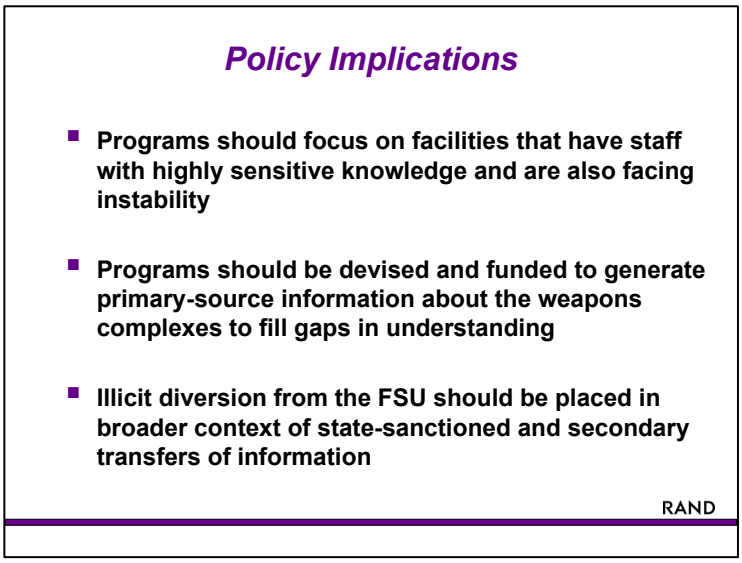
A combination of incentives, disincentives, barriers, and controls likely explains the paucity of documented cases of illicit diversion of NBC weapons expertise from the FSU. U.S. programs have contributed to the incentive structure in specific ways.

NBC facilities facing transition (closure, downsizing, and financial distress) pose the biggest proliferation risk. Employees facing loss of their livelihood or status may be most vulnerable to illicit recruitment. Nuclear facilities such as Avangard and Penza-19 and biological facilities such as Vector and Obolensk are examples of facilities confronting changes.

Several types of weapons-complex personnel may divert important knowledge about weapons facilities and pose a proliferation risk. In addition to scientists and engineers, skilled technicians, retirees, and former employees could provide important information about the facilities in which they work. Administrative and security personnel can also provide information on who to recruit or how to overcome physical safeguards.

As the review in this briefing of the supply and demand for proliferation-critical knowledge and skills suggests, the United States' understanding of the problem would be improved significantly if it had better information about the NBC complex in the former Soviet Union. Information gaps may be filled in part by U.S. and Russian cooperative programs. Examples of the sort of projects that would be helpful include those that would generate information about the types and numbers of employees at each facility. One significant gap in information concerns the future plans for each of the weapons complexes to downsize, close, or enter alternative work. It is also important to better understand the proliferation risks posed by technicians, retirees, and former employees—groups that we have identified as potential sources of concern. Also important is understanding the trends in foreign and domestic migration of proliferation-critical personnel, including those types of employees (technicians, retirees, and former employees) that have not been tracked as carefully as weapons scientists. A related issue is the need to better understand the nature and extent of contacts that proliferation-critical personnel have with foreigners.

Acquiring this information will not be easy for political, logistical, and cultural reasons, but a better understanding of the problem will help U.S. programs established to address the threat of NBC weapons proliferation to focus limited resources where they can be most effective.



The United States' understanding of the problem of knowledge diversion from the FSU is incomplete and needs to be updated so that policymakers can adjust their programs to address the biggest threats.

First, U.S. programs established to address the threat of NBC weapons proliferation should focus on facilities that (1) have staff with highly sensitive knowledge and highly skilled staff who can provide enabling information and (2) are experiencing or anticipating significant instabilities due to economic distress or impending downsizing. These facilities pose the greatest knowledge-diversion risk. The list of endangered facilities should be revisited every year to make sure that U.S. programs continue to focus on the most worrisome facilities.

Second, the United States should devise and fund programs intended to generate information from primary sources (as opposed to secondary news sources) about the weapons complexes to fill in some of the gaps in the current understanding of the knowledge-diversion problem. The Analytical Center for Non-Proliferation at Sarov is a promising model for other facilities in the nuclear complex and in other complexes.

Third, in the process of reassessing the threat of knowledge diversion, the United States should place diversion of knowledge from the FSU in the broader context of state-sanctioned proliferation, particularly from secondary proliferators such as Pakistan and North Korea.

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