Conversion and Job Creation in Russia's Closed Nuclear Cities

An Update, based on a Workshop held in Obninsk, Russia, June 27-29, 2000

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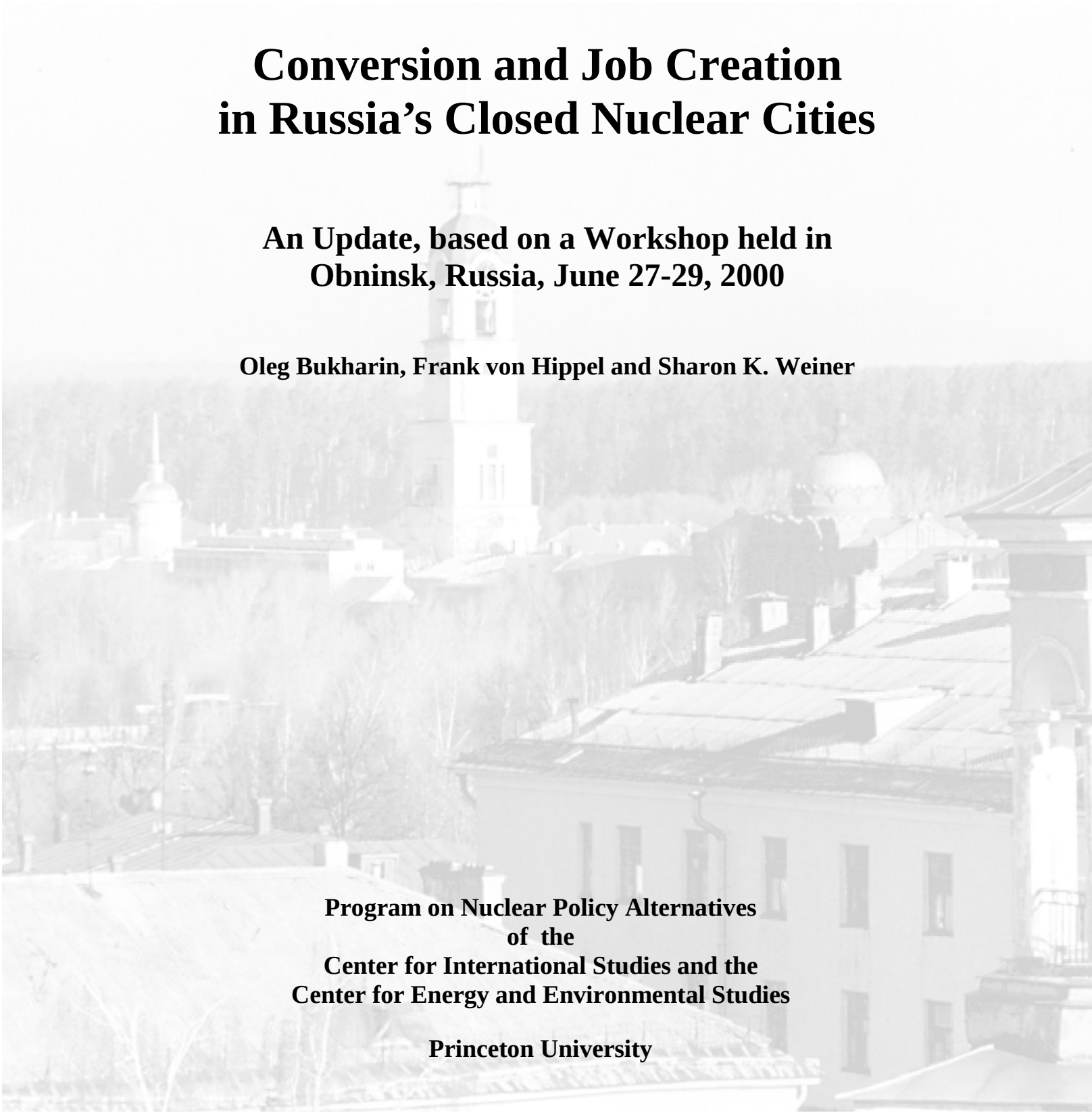

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Cover photo: The city of Sarov from *Sarov,* (Sarov-Saransk: Tipografiya "Krasnyi Oktyabr, 1999).

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PREFACE

On March 14 and 15, 2000, Princeton University's Program on Nuclear Policy Alternatives[1] hosted an international conference on "Helping Russian Downsize its Nuclear Weapons Complex."[2] Some of the conclusions we drew from that conference are summarized in an earlier report ***Helping Russia Downsize its Nuclear Complex: A Focus on the Closed Nuclear Cities***.[3]

At the March conference, Lev Ryabev, First Deputy Minister of Russia's Ministry of Atomic Energy (Minatom), agreed to a subsequent workshop where more details on Minatom's restructuring and conversion plans would be shared. This workshop was held on June 27-29, 2000, in Obninsk, Russia. In addition to representatives from Minatom, Russian participants included relevant officials from the defense nuclear facilities and city administrations of six of the ten closed nuclear cities.

This report conveys some of the details about conversion, employment, and job creation in the closed nuclear cities that were provided at this workshop and is intended as a companion to the earlier report referenced above. The first part of this report is a brief overview that summarizes our current understanding of the problem and describes possible approaches for strengthening U.S. assistance to Russia's down-sizing effort.

The rest of the report consists of appendices containing more detailed information about:

a) Employment and job-creation activities in the individual nuclear cities;
b) Minatom's restructuring and downsizing plans and how they might develop in the future; and
c) Some general background on the closed nuclear cities.

[1] The Program on Nuclear Policy Alternatives is a research program under the joint auspices of the Center for Energy and Environmental Studies of the Princeton Environmental Institute and the Center of International Studies of the Woodrow Wilson School, all at Princeton University.
[2] The conference was made possible by a grant from the JJJ Foundation.
[3] Oleg Bukharin, Harold Feiveson, Frank von Hippel, Sharon K. Weiner, Matthew Bunn, William Hoehn and Kenneth Luongo *Helping Russia Downsize its Nuclear Complex: A Focus on the Closed Nuclear Cities*, Program on Nuclear Policy Alternatives, Center of International Studies and the Center for Energy and Environmental Studies, Princeton University, June 2000. The report is available electronically at www.princeton.edu/~cees/arms/final_report.pdf.

EXECUTIVE SUMMARY

This report builds on the June 2000 Princeton University report, ***Helping Russia Downsize its Nuclear Complex: A Focus on the Closed Nuclear Cities,*** which provided an overview and analysis of the U.S.-Russian effort to reduce the nuclear weapons infrastructure in Russia and create alternative employment opportunities for excess workers. This updated report incorporates new information provided by officials from most of Russia's nuclear facilities and from the governments of most of its closed nuclear cities at a workshop convened in Obninsk, Russia at the end of June 2000.

It became clear to the authors at that workshop that Russia's Ministry of Atomic Energy (Minatom) and the city governments have been mounting major efforts of their own to create jobs for the approximately 35,000 workers – about half of its nuclear-weapons workforce – that Minatom hopes to lay off in the nuclear cities during the next 5 years as part of its nuclear complex restructuring effort. These indigenous efforts have so far created several thousand jobs according to Minatom officials. Most of the funding for Minatom's $50 million job creation effort in 1999 came from its share of the proceeds of the 1993 U.S.-Russia agreement under which the United States is currently buying blended-down excess Russian weapons uranium for resale as nuclear-power-reactor fuel. In 1999, Russia received approximately $390 million in payments under the agreement. Most of the funds for the efforts by the administrations of the nuclear cities in this area came from local taxes and taxes on businesses which relocated to the nuclear cities (sometimes physically and sometimes only on paper) in order to reap federal tax exemptions. Because of abuses, the federal tax exemptions now have been cut back.

A major recent development in the U.S. assistance effort for the down-sizing of Russia's nuclear-weapons complex has been an increase in the budget of the Department of Energy's (DOE's) Nuclear Cities Initiative (NCI) from $7.5 million in Fiscal Year 2000 to $27.5 million in FY 2001. However, $10 million of this funding allocation is conditioned by language in the Defense Authorization Act that requires the U.S. and Russian governments to sign a written agreement stating that Russia will close some of its four nuclear warhead assembly/disassembly facilities within five years. Until this agreement is submitted to the Congress, only $17.5 million of the $27.5 million appropriation can be expended. The provision reflects the focus of the Congress on the need to demonstrate nuclear complex downsizing in Russia in return for U.S. funding of the NCI and the future funding profile of the Initiative is likely to depend on the fulfillment of this requirement.

In principle, it should not be difficult for Russia to complete the agreement required by Congress. Minatom has already announced that warhead assembly has ended at two of its four warhead assembly/disassembly facilities, AVANGARD in Sarov and START in Zarechny, and that warhead disassembly will end there by 2003. Nevertheless, there are at least two reasons why Minatom officials are far from relaxed about the congressional shutdown requirement. First, there is a profound dissatisfaction with the amount of assistance received thus far for the conversion effort at the AVANGARD plant in Sarov, where U.S.-Russian cooperation on conversion has already

been initiated. This is viewed as a test case by the Russians and Minatom has made clear its reluctance to sign on to further specific downsizing commitments until there have been clear and substantial successes in U.S. funding for job creation at AVANGARD. Second, Minatom assumes that the United States will ask for transparency to assure itself that the facilities have really been shut down. If NCI assistance is resulting in large-scale job creation, this issue may become less problematic. But access to sensitive Russian nuclear facilities is a growing problem in many U.S.-Russian cooperative security activities. This issue will be further complicated by the fact that small-scale manufacture of non-nuclear weapon components is expected to continue and some manufacture of advanced conventional weapons may be launched at AVANGARD, at least.

In light of the shutdown agreement requirement, the size and scope of the U.S. assistance offer becomes relevant. Our estimate, based on Russian information, is that it will take $200-250 million to clean out the AVANGARD and START facilities and create jobs for their approximately 10,000 excess employees. In FY2001 the United States is offering only about one-tenth of this amount with no concrete promise for future funding. Of the $27.5 million appropriated for FY2001 about half will be spent by the Department of Energy, its laboratories and contractors. Minatom has made clear that it is reluctant to agree to shut down facilities in return for the $10 million fenced in the Authorization Act with no concrete understanding about how the reconfiguration of those facilities will be financed in the future.

In order to facilitate a resolution of the predictable political log-jam that will result from the Authorization bill language, we suggest a "step-by-step" approach in which Minatom agrees to open up portions of the warhead-dismantlement facilities in a negotiated proportion to the amount of matching U.S. assistance that is received. A precedent for this approach has already been set in 2000 by the NCI's paying for the cost of moving the security fence around the AVANGARD facility to make four of its large buildings available for conversion projects.

We further believe that the strategy for U.S.-funded downsizing and conversion activities should be modified and that a more flexible approach than the commercial job creation focus of current programs would be useful. In part this means utilizing some of the funds for more "public value" job creation that is not strictly dependent on commercial development in the nuclear cities. Such activities include non-proliferation analysis (already partially funded), as well as energy efficiency, energy technology development, and radioactive waste clean-up R&D, among other efforts.

In addition to the overall goal of reducing excess weapons complex employees as rapidly as possible by utilizing a variety of means, we believe that, in order to discourage the hemorrhage of proliferation sensitive material and technology, the objectives of U.S. conversion assistance should be to: i) reduce and avoid economic distress among excess Russian weapons experts and hence their susceptibility to temptations from nations or terrorists interested in acquiring nuclear-weapon capabilities; ii) facilitate the irreversible down-sizing of Russia's huge nuclear complex to a more manageable size; and iii) promote economic stability in Russia's closed nuclear cities during the downsizing effort.

At present, much international and U.S. assistance (from the International Science and Technology Center and the U.S. DOE Initiatives for Proliferation Prevention) is focused on providing nuclear workers with incomes to supplement the inadequate salaries that they continue to draw from their work at the nuclear facilities. NCI is specifically focused on the longer-term objective of down-sizing the complex primarily through the creation of career-oriented non-weapons jobs for weapons workers that would pull them permanently out of the weapons workforce.

An additional, complementary and potentially quite cost-effective approach would be to accelerate retirement. A large core of the excess weapon worker problem is made up of employees over 50 years of age who are near or beyond retirement age (55 for Russian women and 60 for Russian men with lower ages for some high-risk nuclear occupations). These workers number about 10,000 and they are people for whom it is most difficult to create jobs and for whom retirement may be a better option if retirement pensions in Russia (currently about $200/year) could be supplemented to livable levels (less than $2000 per year, based on surveys in the nuclear cities). Therefore, a new strategic focus for both the United States and Russia might involve pension supplements and perhaps a lowering of the retirement age in combination with job creation programs. Such actions could potentially solve one-quarter or more of the excess employment problem in a relatively short time.

The task of helping Russia down-size its nuclear-weapons-production complex is extraordinarily difficult. As with the economic transition of Russia more generally, neither the United States nor Russia have ready solutions. However, it is important that the U.S. government be engaged, innovative, and learn from its past mistakes. If the current effort begins to show promising results, it should be expanded to at least $100 million per year with the funds allocated to multiple solutions. That is still much less than the Department of Defense's $400 million per year Cooperative Threat Reduction initiative, which has focused principally and successfully on the much simpler task of helping Russia and other former Soviet Republics eliminate their excess strategic nuclear weapons.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

CENEf	Moscow Center for Energy Efficiency
CTR	Cooperative Threat Reduction Program
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DU	depleted uranium
EBRD	European Bank for Reconstruction and Development
EM	Environmental Management
EKhZ	Electrochemical Plant (Zelenogorsk)
FSB	Federal Security Service of the Russian Federation
FTE	full-time equivalent
FY	Fiscal Year
HEU	highly-enriched uranium (uranium that is greater that 20% U^{235})
I&C	instrumentation and control
IDC	International Development Center
IPP	Initiatives for Proliferation Prevention
ISTC	International Science and Technology Center (Moscow)
LEU	low-enriched uranium (less than 20% U^{235})
Minatom	Ministry of Atomic Energy of the Russian Federation
MCC	Mining and Chemical Combine (Zheleznogorsk)
MPC&A	material protection, control, and accounting
NCI	Nuclear Cities Initiative
NGO	Non-Governmental Organization

NIS	Newly Independent States
NP/AC	non-proliferation and arms control
NPP	nuclear power plant
RANSAC	Russian-American Nuclear Security Advisory Council
RR	Russian Rubles
RTG	radioisotope thermal-electric generator
START I and II	Strategic Arms Reductions Treaties I and II
UEKhK	Urals Electro-Chemical Combine (Novouralsk)
UEMZ	Urals Electro-Mechanical Plant (Yekaterinburg)
USEC	U.S. Enrichment Corporation
VNIIA	Institute of Automatics (Moscow)
VNIIEF	Institute of Experimental Physics (Sarov)
VNIITF	Institute of Technical Physics (Snezhinsk)

RUSSIA'S TEN CLOSED "NUCLEAR CITIES"

Former Name	New Name
Arzamas-16	Sarov
Chelyabinsk-65	Ozersk
Chelyabinsk-70	Snezhinsk
Krasnoyarsk-26	Zheleznogorsk
Krasnoyarsk-45	Zelenogorsk
Penza-19	Zarechny
Sverdlovsk-44	Novouralsk
Sverdlovsk-45	Lesnoy
Tomsk-7	Seversk
Zlatoust-36	Trekhgorny

BACKGROUND

The Russian Ministry of Atomic Energy's nuclear-weapons-production complex currently consists of 17 research institutes and manufacturing facilities (see Map 1). The core nuclear-weapon-production capabilities are located in closed nuclear cities (see Table 1 and Appendices 1 and 2).

The complex is already much smaller than its peak Cold War size (see Appendix 2). Approximately 75,000 workers are directly employed in nuclear-weapons facilities, down by about 50 percent from the late 1980s. However, the complex remains oversized relative to Russia's current and future national security requirements – and far larger than Russia can afford. Government funding for "nuclear-defense orders" in 1999 was only one-seventh of its level in 1990.

Minatom is therefore under pressure to further downsize its nuclear-weapons complex. Downsizing in the closed nuclear cities is not possible, however, unless new jobs or other opportunities are created for the displaced nuclear workers. Otherwise the social stability of the cities would be threatened and the danger of sales of nuclear materials and technology could increase dramatically. Minatom believes that non-weapons jobs for approximately half its current weapons workers must be created during the next five or so years.

Each of the nuclear cities has significant economic and social problems but their extent varies from city to city (see Appendix 1). The nuclear facilities in three cities (Novouralsk, Zelenogorsk, and Ozersk) have been doing relatively well because they have been able to market uranium-enrichment and other fuel-cycle services to foreign nuclear-power utilities and have been blending-down excess weapons uranium for sale to the United States under the 1993 U.S.-Russian HEU (highly-enriched uranium) agreement. Employment at the Novouralsk and Zelenogorsk enrichment facilities has been maintained. Employment in the Ozersk nuclear combine has dropped – and will most likely do so again in the future – but for now appears relatively stable.

The bulk of the near-term personnel reductions will therefore take place at the facilities of seven nuclear cities:

- Sarov, Snezhinsk, and Zheleznogorsk do not have export revenues but have benefited from Western (primarily U.S.) cooperative programs such as the International Science and Technology Center (ISTC), the Initiatives for Proliferation Prevention (IPP), the nuclear Material Protection, Control and Accounting (MPC&A) program, and the Nuclear Cities Initiative (NCI).
- Seversk receives revenues from exports of fuel cycle services and HEU downblending under the U.S.-Russian HEU agreement. However, the Russian government's decision to replace the plutonium production reactors in Seversk with a coal-powered plant will make redundant thousands of workers currently working at the plutonium reactors, reprocessing plant, and supporting facilities.

- Lesnoy, Trekhgorny, and Zarechny, which house nuclear-warhead assembly/disassembly facilities, have been kept closed to foreigners but are believed to be in relatively dire straits.

A number of the cities also have economic problems because of the down-sizing or failure of major employers other than the nuclear facilities. The construction companies in several cities and a satellite-construction complex in Zheleznogorsk have made massive layoffs, and a synthetic-cotton plant in Zelenogorsk has closed.

Map 1. Russia's Nuclear-Weapon-Production Complex

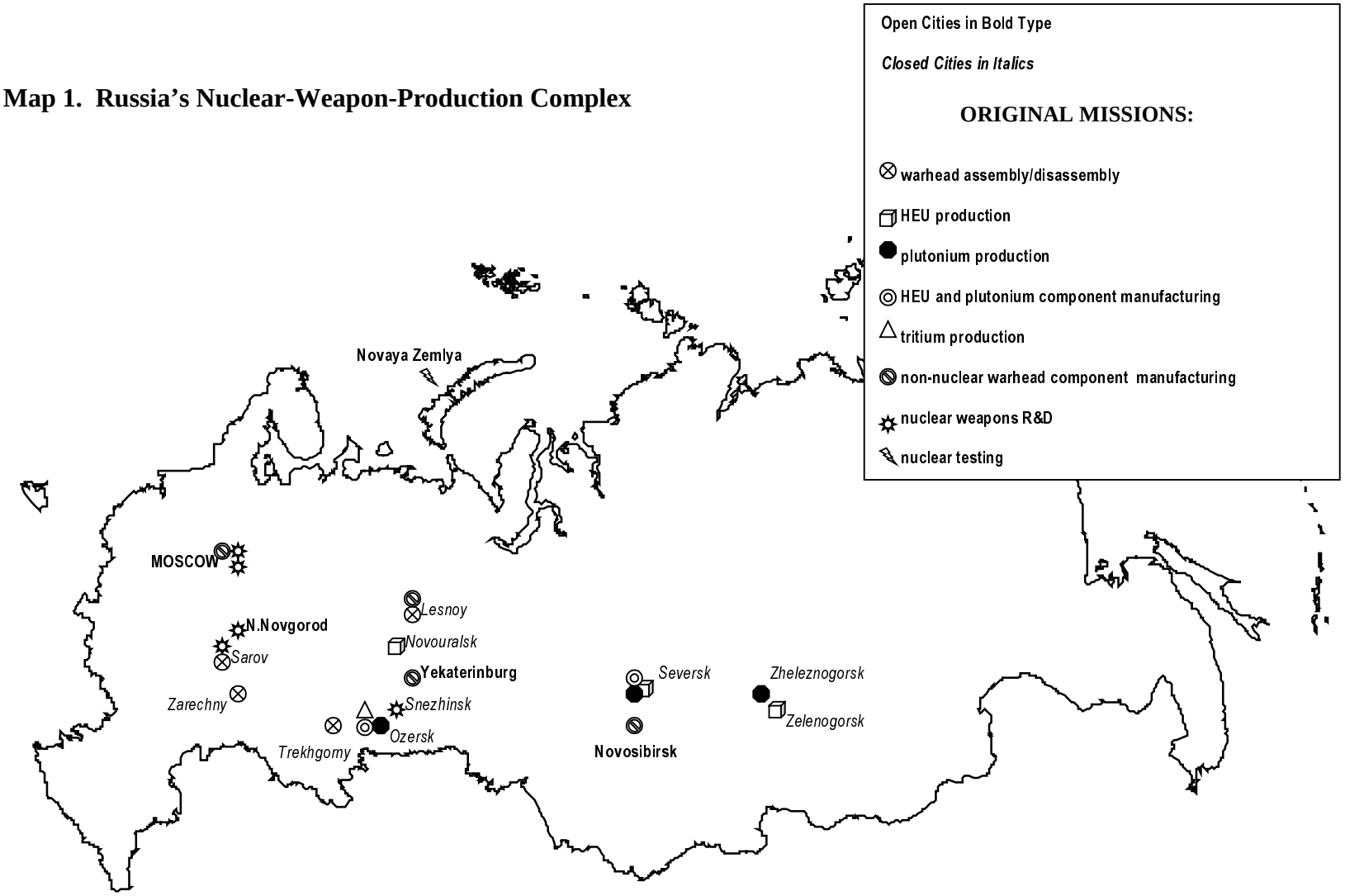

Table 1. Russia's Nuclear Cities in 2000

City (former identification by postal-box number in a nearby city)	**Population** **Registered Unemployment (04/01/2000)**[4]	**Weapons Activities (*Discontinued Activities*)**	**Nuclear Facilities Workforce**	**Weapons Program Workers at Present** **Weapons Workers Projected for 2005**
Sarov (Arzamas-16)	85,000 1,089	Nuclear weapon R&D, stockpile stewardship, warhead disassembly, (*warhead assembly*)	21,800	19,000 12,900
Snezhinsk (Chelyabinsk-70)	49,000 341	Nuclear weapon R&D, stockpile stewardship	9,500	9,000? 7,000?
Ozersk (Chelyabinsk-65)	86,000 1,607	Tritium, fissile component production, fissile material management (*plutonium production*)	14,500	6,000? 4,000?
Seversk (Tomsk-7)	119,000 1,970	Fissile material storage and management (*plutonium, HEU, fissile component production*)	15,000	5,000? 0?
Zheleznogorsk (Krasnoyarsk-26)	102,000 770	Currently no weapons work, fissile material storage?, (*plutonium production*)	9,500	4,000? 0?
Novouralsk (Sverdlovsk-44)	96,000 2,007	Currently no weapons work (*HEU production)*	15,000	0 0
Zelenogorsk (Krasnoyarsk-45)	70,000 1,083	Currently no weapons work (*HEU production)*	10,000	0 0
Lesnoy (Sverdlovsk-45)	58,000 1,089	Warhead assembly, disassembly	10,000	7,000-10,000 5,000?
Trekhgorny (Zlatoust-36)	33,000 801	Warhead assembly, disassembly	6,400	3,600 2,800
Zarechny (Penza-19)	64,000 1,862	Warhead disassembly (*warhead assembly*)	10,000	7,000-10,000 A few hundred?
Total	762,000 12,619		121,700	60-67,000 32,200?

[4] The unemployment numbers are from *RFNC-VNIIEF Quarterly Information Bulletin*, Issue 3,VNIIEF Analytical Center for Nonproliferation, Sarov, Fall 2000, p. 47.

PROGRESS IN DOWNSIZING

The urgency of downsizing and restructuring of the nuclear weapons complex is well understood by Minatom and the Russian government. Already in the late 1980s, the Russian (then Soviet) government began to phase out the production of fissile materials for weapons. It also initiated a defense conversion program but, aside from the success of the uranium-enrichment facilities in foreign markets, few of these early defense conversion efforts were successful.

Defense conversion and complex restructuring efforts received a fresh start in 1998 when Minatom developed a complex downsizing and conversion program (see Box 1: *Minatom's Downsizing and Conversion Plan*). During the following two years, individual nuclear weapons facilities developed detailed facility-level plans in coordination with Minatom headquarters. The plans specify how many workers and which equipment and buildings will be required for future defense tasks and how much it will cost to consolidate weapons-related equipment in a smaller number of buildings to make space available for new commercial enterprises. Every facility has also developed a prioritized list of defense-conversion projects.

By the end of 2000, Minatom hopes to have government approval for a more refined ten-year master plan for downsizing and conversion of its nuclear weapons infrastructure. Minatom estimates that it will cost approximately $1 billion[5] to carry out the task. About half of the cost would be for consolidation and cleanup; and about half would be to create new jobs for the workers made excess.

Box 1: MINATOM'S DOWNSIZING AND CONVERSION PLANS

The program "On Restructuring and Conversion of the Nuclear Weapons Complex in 1998-2000" was adopted by the Russian government in June 1998 as part of a broader plan to restructure Russia's defense industries. At the 1999 Carnegie Nonproliferation Conference, First Deputy Minister of Minatom L. Ryabev made public the following key milestones:

2000	Stop warhead assembly at the warhead production plants in Sarov and Zarechny. (Warhead assembly/disassembly would continue in Lesnoy and Trekhgorny.)
2003	Stop warhead dismantlement in Sarov and Zarechny.
	Stop fabrication of fissile material components at Seversk. (This activity would continue in Ozersk.)
2005	Reduce the defense program workforce from 75,000 to 40,000.

The future of the weapons complex is also discussed in other (presumably secret) planning documents that support the downsizing process, including the program of armaments (which discusses Minatom's responsibilities to 2005) and the federal program for increasing the safety of nuclear weapons.

[5] Throughout this report we have converted from Russian rubles (RR) to U.S. dollars at a rate of 25 to one.

A great deal of downsizing has already taken place:

- The production of HEU for weapons ceased in 1988-89.

- Between 1987 and 1992, ten out of 13 plutonium production reactors were shut down. Major equipment has been or is being removed. Three plutonium-production reactors (two in Seversk and one in Zheleznogorsk) continue to operate because they produce heat for the local populations. The plutonium produced since October 1994 has not been used for weapons. A joint U.S.-Russian project is under way to replace the heat and electricity generated by the two reactors in Seversk with a coal-fired plant and to either similarly replace the reactor in Zheleznogorsk or convert it to a fuel cycle that does not result in the production of separated plutonium.

- The AVANGARD plant in Sarov has already ended assembly of new nuclear warheads. Its current level of weapons-related work is reportedly minimal.[6] Recently, its security fence was moved inward to make four buildings with a total floor area of approximately 45,000 square meters available for new non-weapons ventures. Other production buildings are being cleaned out.

- In 1999, assembly of nuclear warheads ended in the second of Russia's four warhead assembly/disassembly facilities, the START plant in Zarechny. Weapons work there is expected to end completely by 2003.

- The weapons R&D institutes are being downsized as well. Three buildings of the Institute of Technical Physics (VNIITF) in Snezhinsk have been transferred to the city for civilian purposes and more transfers are planned.

- The chemical and metallurgical plant in Seversk, which in the past produced plutonium and HEU components for nuclear warheads, has reportedly stopped weapons work. Most of its workers are now tearing down excess weapons components and purifying and oxidizing the recovered HEU to be blended down to low-enriched uranium (LEU) under the U.S.-Russian HEU agreement.

- Drastic downsizing has also occurred at the nuclear-weapons R&D and non-nuclear component production facilities in open cities. The Molnia plant in Moscow, which in the past produced electronic, electrical, and mechanical components of nuclear warheads, has essentially stopped weapons-related work. The number of weapon-program workers at the Urals Electro-Mechanical Plant in Yekaterinburg has declined from 12,000 to 1,500 and all its weapons activities are now consolidated in one area. The number of weapons workers in a third non-nuclear component manufacturing facility, the Sever plant in Novosibirsk, has similarly declined from 7,500 to 550, with all weapons work now being carried on inside a single technical area.[7]

[6] L. Saratova, "How do You Live, the Weapons Plant?" *Gorodskoy Kuryer*, No. 3, January 23, 1999.
[7] Sever is expected to stop weapons work altogether within the next five or so years.

RUSSIA'S OWN CONVERSION EFFORTS

Russia has been mounting conversion programs for the nuclear cities which are much larger than the still small foreign-funded efforts.

An early success story that predates Minatom's current program was the conversion of a one-kilometer-long HEU-production building in the uranium enrichment complex in Zelenogorsk. The building now accommodates a video and audio cassette manufacturing facility (see Box 2: *From HEU to Videotape*). The Institute of Automatics, a warhead design and engineering facility in Moscow, has similarly shifted much of its reduced workforce to the production of instrumentation and control equipment for nuclear and conventional power plants. The Sever plant mentioned above has more electrical equipment orders from the coal and transport industries than it can fulfill.

Most of the funding for conversion in the closed cities has come from Minatom, which has established a Department of Conversion to provide central support for downsizing and defense-conversion activities. In 1999, this department funded conversion projects selected through a competitive process from among those proposed by the nuclear facilities. Prioritization was based upon a methodology developed by the Russian Ministry of Economy. Projects were ranked according to combined ratings based on potential job creation, the job needs of the sponsoring organization, competitiveness of the proposed products, start-up cost, and other criteria. The prioritized list was then subjected to independent outside review before the winners were selected.

Box 2: FROM HEU TO VIDEOTAPE

In 1989, the Soviet government ended the production of HEU for weapons. As a result, the Electrochemical Plant (EKhZ) in Zelenogorsk shut down the HEU "cascade" of its gaseous-diffusion enrichment plant, which filled a huge, 900-meter-long hall. Tens of thousands of tons of equipment were dismantled and the steel, nickel, and other metals they contained were decontaminated and recycled. Uranium, deposited on internal surfaces, was recovered and returned to the fuel cycle. Approximately 200 plant workers were involved in the cleanup operations. Others retired.

In the early 1990s, the Russian government allowed Minatom to buy a $215 million tape-manufacturing plant from BASF in exchange for uranium and enrichment services provided to German utilities. The production equipment was installed inside the now empty hall. The problem of access for BASF was resolved. In 1996, the plant reached its full capacity of approximately 10 million audio and video tapes per year. The products, under the trademark BASF/EKhZ, are sold in Russia and other BASF markets. The initial investment made in production equipment has already been recouped. BASF continues to provide spare parts and marketing support.

Through this process, Minatom allocated $50 million in 1999 to support 26 conversion projects. By its own estimate, it created 2,500 non-weapons jobs in this manner in 1999 and the first half of 2000.[8]

Most of the $50 million for these projects came from the HEU agreement. Additional funds are generated by 1.5 percent R&D and 3 percent conversion taxes, as well as depreciation funds. In Sarov and some other closed cities, nuclear-facility conversion projects have also received support from the local governments.

The governments of the closed cities also have detailed plans for job creation. They have acquired tax resources and federal subsidies and have invested the equivalent of many millions of dollars to create thousands of jobs outside the nuclear facilities. Often their initiatives focus on small business opportunities created by needs in the nuclear city or the surrounding region. In the weapons design institutes in Sarov and Snezhinsk, joint stock companies have been created to help commercialize promising technologies. Each of the city governments has a prioritized list of additional conversion projects if more funding becomes available, including cost estimates and job-creation potential. Although these lists are discussed in terms of "business plans," "market research," and "returns on investment", the degrees of rigor and realism that have gone into their development may vary.

Box 3: THE INVESTMENT ZONE OF SAROV

The Investment Zone of Sarov (IZS) was established on February 4, 1997 by the Sarov City Duma. On that same date, three separate funds were chartered as legal entities with representatives of VNIIEF, the city Duma, and the city administration on their board of directors. These three funds were established to promote defense conversion (broadly defined as the development of any civilian economic activity in Sarov), support the municipal and social infrastructure, and improve public safety. The city's legislation requires that enterprises wishing to register in the IZS sign an agreement with the city to transfer a fraction of their benefits to the funds and the city budget.

In 2000, the Russian Duma amended the law to limit a company's tax benefits to 50 percent of its total tax payments. Also, for the year 2000, the city of Sarov was limited to granting no more than RR 1,200 million in tax benefits.

The Sarov city government has developed a new approach to managing the IZS. Any large company registered in the zone can write-off up to RR 40 million in federal and regional taxes per quarter. (All companies are ranked by size and smaller companies have smaller benefits but also pay smaller fees.) A company keeps approximately 40 percent of this write-off and the city gets 58.2 percent (RR 23 million). According to the new city Duma law, 34 percent of a company's tax benefit (RR 40 million) goes to the city budget, 12.2 percent to the conversion fund, 11 percent to social development, and one percent to public safety. In 2000, Sarov is projected to receive an estimated $14 million from the IZS. This is to be supplemented by approximately $2 million from the federal budget.

[8] Minatom First Deputy Minister Lev Ryabev, private communication, Oct. 3, 2000.

The closed city governments obtained much of their funding for these efforts from companies that received exemptions from federal taxes if they set up business in nuclear cities. However, businesses claimed huge tax exemptions, even when they had moved only a small portion of their activities to a closed city – or were "off shore" in the sense that they had moved there in name only. Starting in 2000, therefore, only Sarov and Snezhinsk are allowed to offer tax exemptions and these are limited to a total of $80 million for the two cities over the next two years ($40 million per year) (see Box 3: *The Investment Zone of Sarov*). To compensate for the loss of revenue, the Russian government has budgeted two billion Russian Rubles (approximately $80 million) in subsidies in 2000 to be shared by all ten closed nuclear cities.

INTERNATIONAL ASSISTANCE EFFORTS

In the early 1990s, the United States and other countries launched a number of efforts to help create non-weapons jobs for Russia's excess nuclear-weapons workers.

The largest and most important of these initiatives was the 1993 U.S.-Russian HEU agreement, according to which the United States is buying, over a period of 20 years, 500 tons of excess Russian weapons uranium after it has been down-blended to low enrichment for resale as nuclear-power reactor fuel. In 1999, Russia's earnings from this deal were $390 million.[9] As already noted, in 1999, the bulk of Minatom's defense conversion and complex restructuring funding came from Minatom's share of the proceeds from the HEU deal. In addition, thousands of Russian nuclear workers are gainfully employed tearing down nuclear warhead-components and blending down the recovered HEU. The enrichment complex in Zelenogorsk, for example uses approximately 12 percent of its enrichment capacity to produce 1.5 percent enriched blend-stock.

The United States government also funds stabilization and conversion efforts in the closed cities through the Nuclear Cities Initiative (NCI), the Initiatives for Proliferation Prevention program, and the International Science and Technology Center. Efforts to strengthen the security of Russian weapons-usable fissile materials through the Material Protection, Control and Accounting (MPC&A) and the Cooperative Threat Reduction (CTR) programs create additional U.S.-funded jobs. Although these last two programs are not aimed at creating jobs per se, they do so by virtue of their employment of Russian nuclear experts and their construction activities in the nuclear cities.

We focus below on the U.S. Department of Energy's (DOE's) NCI because it is the only program whose explicit mission is to assist Russia in the downsizing and conversion of its nuclear-weapons-production complex.

[9] Thomas Neff, private communication, Oct. 21, 2000. Russia delivered LEU blended down from only about 20 metric tons of weapon-grade uranium in 1999, although, under a 1996 agreement with USEC, deliveries were to have been at a rate of 30 tons a year starting in 1999 (http://www.usec.com/Structure/Navigation/ThirdTier/newsreleases/08-31-98.htm).

Russian Nuclear Weapons Complex Conversion Act of 2000

The future of U.S. assistance to the downsizing and conversion efforts in Russia's closed nuclear cities may depend on the outcome of a congressional initiative to increase funding for the NCI program in exchange for transparent downsizing of Russia's nuclear weapons complex.

In its first two years, the NCI has focused on three cities: Sarov, Snezhinsk, and Zheleznogorsk. Additional cities, including Ozersk, Zarechny, Trekhgorny, Seversk and Zelenogorsk, have expressed interest in joining the initiative. However, both the U.S. Congress and the Russian government have insisted that the NCI demonstrate significant results in the first three cities before extending the program to additional cities.

Unfortunately, as of the summer of 2000, the NCI could claim to have created only about 100 jobs. This paltry result has fed the paranoia in Russia's counterintelligence establishment which sees the United States as more interested in spying than helping. At the same time, the size of the program has been limited on the U.S. side by congressional skepticism about its effectiveness and opposition in the powerful right wing of the Republican congressional leadership which fears that, as a result of U.S. assistance, Russia's nuclear-weapons establishment might be able to rebuild itself.

To deal with this last concern, during the spring of 2000, Senator Pete Domenici (R-NM), Chairman of the Senate Appropriation's Committee on Energy and Water, which deals with the DOE budget, developed a proposal to expand NCI funding in exchange for Russian agreement to reduce the size of its nuclear-weapon-production complex. Specifically, Section 3172 of Title XXXI of the Defense Authorization Act of FY 2001, which grew out of Senator Domenici's "Russian Nuclear Weapons Complex Conversion Act of 2000," requires:

> "a written agreement between the United States and the Russian Federation which provides that Russia will close some of its facilities engaged in nuclear weapons assembly and disassembly work within five years of the date of the agreement in exchange for receiving assistance through the [Nuclear Cities] Initiative."

The assistance conditioned by this language is any amount appropriated by Congress to the NCI program for FY 2001 beyond the $17.5 million requested by the Clinton Administration.

In September 2000, the Fiscal Year (FY) 2001 Energy and Water Appropriations Act provided $27.5 million for the Nuclear Cities Initiative, up from $7.5 million in FY 2000.[10]

Thus, according to the restrictions established in the Defense Authorization Act, expenditure of the $10 million added by Congress to the Clinton Administration's original request of $17.5 million is conditioned upon a written agreement between the United States and Russia that the latter will close some nuclear weapons assembly and disassembly

[10] See the Conference Report, *Making Appropriations for Energy and Water Development for the Fiscal Year Ending September 30, 2001, and for Other Purposes*," Joint Explanatory Statement of the Committee of Conference, Title III, Defense Nuclear Nonproliferation," Report 106-907, U.S. Congress, Sept. 27, 2000.

facilities within five years. Furthermore, according to another condition in the Defense Authorization Act, NCI may spend no more than $8.75 million prior to establishing and implementing procedures to ensure that any "scientific, technical, or commercial project" funded by the NCI thereafter will:

1. Not enhance Russia's military capabilities,

2. Be "carried out in conjunction with an appropriate commercial, industrial or non-profit entity as partner," and

3. Be "commercially viable" within three years.

The bill also calls on the president to appoint a coordinator for Russian non-proliferation programs and to open discussions with the objective of encouraging Russia to develop a plan to complete the restructuring of its nuclear-weapons complex by 2010 including:

A. "[M]echanisms to consolidate the nuclear weapons production capacity in Russia to a capacity that is consistent with the obligations of Russia under current and future arms control agreements.

B. "Mechanisms to increase transparency regarding the restructuring of the Russian nuclear complex and weapons-surplus nuclear materials inventories in Russia to the levels of transparency for such matters in the United States, including the participation of Department of Energy officials with expertise in transparency of such matters.

C. "Measurable milestones that will permit the United States and the Russian Federation to monitor progress under the plan."

Full FY2001 funding for NCI is not contingent upon achieving such an agreement but there is definitely an implication that Congress's attitude toward funding for future years will be more favorable if such an argument is achieved.

In the past, Senator Domenici has been able to make major changes in the Department of Energy's budget in areas of concern to him – primarily the funding of weapons research and development and support for the HEU deal.[11] His Senate colleagues were much less deferential, however, toward his efforts to reform and expand the NCI. As a result, in addition to the above restrictions, Senator Domenici was forced to reduce his proposed increase in FY 2001 funding for the NCI from $33.5 to $10 million.

As has already been noted, the requirement in the Domenici amendment that Russia commit to shutting down some nuclear weapons assembly and disassembly facilities within five years reflects the worry by many members of Congress (especially Republican

[11] Senator Domenici represents New Mexico, the home of two of the Department of Energy's three nuclear-weapon R&D laboratories.

members) that Russia's capacity to produce nuclear weapons is now much larger than that of the United States. In fact, in addition to shutting down its production of HEU and plutonium for weapons, the U.S. DOE has also shut down, for safety and environmental reasons, the Rocky Flats plant at which all U.S. plutonium pits were manufactured[12] and has only one warhead assembly/disassembly facility versus Russia's four. Table 2 provides more detail on the down-sizing of the U.S. weapons-production complex between 1985 and 1998.

Russia's Response

As already noted, the Russian Government has publicly announced its decision to shut down warhead assembly/disassembly operations in Sarov and Zarechny by 2003. Nevertheless, Minatom's leadership views the negotiation of a formal agreement to do so as problematic. Such a government-to-government agreement would presumably require signoff from other Russian government agencies – including from the resurgent counter-intelligence agencies. And, although the legislation does not explicitly require arrangements to allow the United States to verify the shutdown of the Russian warhead assembly/disassembly operations, it does urge the President to negotiate a follow-on agreement with "mechanisms to increase transparency… to the levels of transparency for such matters in the United States" and "measurable milestones."

The $10 million additional funding approved by Congress for FY 2001 in exchange for the proposed government-to-government agreement under which Russia would shut down some of its warhead assembly/disassembly facilities is very small in comparison to the funding needed to convert these facilities. The two warhead assembly/disassembly facilities slated for closure employ together an estimated 9,000-12,000 nuclear-weapon workers. Assuming that creating one civilian job requires an investment of $10,000, Minatom needs $90-120 million to provide AVANGARD and START workers with civilian employment.[13] An investment of similar magnitude is required to remove fissile materials, cleanup (if economic) or close down production buildings, and dismantle and remove specialized weapons manufacturing equipment. Thus, Minatom needs an estimated $200 to $250 million (or $40-50 million per year) to close its two warhead production facilities by 2005. The $10 million U.S. offer of assistance for FY 2001 is diminished further in comparison by Congress' permission to DOE to spend almost half the funds in the United States. [14]

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[12] U.S. plutonium "pits" are very stable, however, and several thousand reserve pits have reportedly been stored at DOE's Pantex warhead assembly/disassembly plant in Amarillo, Texas. In addition a small (50 pit per year) production capability is being established at the Los Alamos National Laboratory and the possibility of building a new much larger pit-production facility is being studied.

[13] According to the Accelerated Conversion Plan for AVANGARD, the facility needs $18 million until 2005 to create 1,800 civilian jobs for its displaced weapons workers. (*Review of Conversion Capabilities and Conversion Experience of the AVANGARD Plant*, report under DOE contract DE-AC01-99NN40123, Analytical Center for Nonproliferation, VNIIEF, Sarov, September 2000, p. 89).

[14] The NCI office expects that ultimately 35 percent of the $20 million total in FY 1999 and FY 2000 NCI funds will be expended in Russia (private communication, Oct. 7, 2000). The FY 2001 Energy and Water Appropriations Act requires that at least 51 percent of the FY 2001 funding for NCI be spent in Russia (Conference Report, *Making Appropriations for Energy and Water Development for the Fiscal Year Ending September 30, 2001*).

An additional complication is that Minatom's plans do not envisage a complete demilitarization of AVANGARD and START. Warhead assembly and disassembly operations would end at these facilities but limited manufacturing of non-nuclear warhead components and support equipment would continue, and, at AVANGARD, at least, manufacture of advanced conventional weapons might be initiated. Such plans could exacerbate the reluctance of Russia's security services to allow the facilities to become more "transparent" to the United States.

What the Russian government would call a "step-by-step" approach to the resolution of this impasse would be to agree that the warhead facilities would be demilitarized and made open for foreign visits section by section in exchange for an agreed level of U.S. conversion assistance. Such an approach would focus initially on the AVANGARD facility since Minatom officials have made clear that the NCI program will be given access to the START facility only after it has demonstrated success at AVANGARD.

A precedent for this approach has already been established by the NCI-funded movement of the security fence around the AVANGARD complex to make possible access to four buildings designated for commercial projects. However, Minatom officials complain that the United States has not yet delivered on its commitments to fund the startup costs of these commercial ventures. Indeed, they have informed us that, because of this failure, senior AVANGARD officials have begun to lobby for a resumption of funding for weapons work there. NCI's credibility in Russia must be restored by putting substantial funding into conversion projects in AVANGARD as soon as market and other feasibility studies establish that they are likely to be viable.

Table 2. Defense-Program (DP) Missions and the Workforce at U.S. DOE Nuclear Facilities in 1985 and 1998[15]

Facility	**DP Missions (*former activities*)**	**DP Program Workforce, 1985**	**DP Program Workforce, 1998**
Lawrence Livermore National Laboratory	Nuclear weapon R&D and stockpile stewardship	3,198	3,450
Los Alamos National Laboratory	Nuclear weapon R&D; stockpile stewardship; Pu pit and non-nuclear component production*	4,322	4,000
Sandia National Laboratories	Nuclear weapon R&D; stockpile stewardship; non-nuclear component production*	4,138	4,000
Oak Ridge Y-12 Plant	Storage of HEU and lithium-deuteride materials and components; surveillance and dismantlement of warhead secondary assemblies	7,213	4,200
Savannah River Site	Tritium management; recycle and loading of tritium reservoirs (*Production of plutonium and tritium*)	6,647	1,400
Pantex Plant	Warhead assembly, surveillance, disassembly; high-explosives component production; plutonium pit storage	2,749	2,650
Kansas City Plant	Non-nuclear component production	7,853	2,600
Nevada Test Site	Subcritical tests; testing readiness* (*Nuclear testing*)	8,414	1,780
FACILITIES NO LONGER PART OF THE DOE WEAPONS COMPLEX			
Rocky Flats Plant	(*Plutonium pit reuse and replacement; production of uranium and beryllium components; tritium reservoir production*)	5,991	none
Mound Laboratory	(*Non-nuclear component production and surveillance*)	1,770	none
Pinellas Plant	(*Non-nuclear component production and surveillance*)	1,926	none
Hanford Reservation	(*Plutonium production*)	7,800	none
Total		62,021	24,080

* Denotes new missions.

[15] T. Cochran, W. Arkin, R. S. Norris, M. Hoenig, *U.S. Nuclear Warhead Facility Profiles*, Nuclear Weapons Databook, Vol. III, Ballinger Publishing Co: Cambridge, MA, 1987. *FY 2000 Stockpile Stewardship Plan*, DOE/DP, March 15, 1999.

RE-THINKING CONVERSION

If U.S. conversion assistance is to be successful, it has to be based on an accurate analysis of the problem.

In our view, the near-term problem is three-fold:

1. The excess weapons personnel that Minatom can no longer support need either new jobs or adequate pensions to assure that they are not driven by desperation to take actions that could help rogue states or terrorist groups acquire nuclear weapons;[16]

2. Russia's weapons complex needs to be down-sized and the excess facilities cleaned out in order to help assure that it is manageable and not a proliferation problem and that the absurdly huge nuclear arsenals of the Cold War will not be recreated.

3. The nuclear cities need to be economically healthy so that they don't breed crime that could lead to thefts of materials and technology from the nuclear facilities.

Income for excess weapons personnel. Many of the existing U.S. programs (including IPP and ISTC) were originally designed to stabilize nuclear weapons personnel by providing gainful work and additional income. In the coming years, however, the core of the problem will be excess workers of age 50 or over. A large fraction of younger workers are already leaving for jobs in commercial ventures. The retirement age in Russia is 55 for women,[17] 60 for men, and lower for individuals working in dangerous or hazardous environments. Therefore, if some way can be found to supplement the pensions of people who will be of retirement age by 2005, much of the problem could be solved.

Shutting down excess infrastructure. Consolidation of weapons work at fewer sites and in fewer technical areas and buildings within the remaining sites is a complex task that involves dismantlement or relocation of specialized weapons equipment, packaging and removal of fissile materials, and environmental cleanup or placement in a safe condition of excess buildings (if cleanup is not economical). Based on detailed technical assessments at individual facilities, Minatom has estimated that restructuring its weapons complex according to its 1998-2000 down-sizing plan would cost $0.5 billion. Much of this restructuring effort will be supported by Minatom's internal funds. International assistance, however, could accelerate the process. For example, the United States has already paid for the movement of the security perimeter at the AVANGARD plant in Sarov.

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[16] The importance of providing such financial security is confirmed from the answers to a questionnaire that was administered to a random sample of nuclear workers in 1999. About 10 percent expressed an interest in working abroad. Almost 1 percent said that they would work "any place at all." When asked to name three countries where they would not work under any circumstances, only 60 percent of those interested in working abroad mentioned Iraq, 33 percent Libya and 16 percent North Korea. See: Valentin Tikhonov, *Russia's Missile and Nuclear Complexes: Personnel Mobility and Security*, Working Paper No. 1, Moscow Carnegie Center, chapter 7.

[17] About one third of nuclear "specialists" who responded to a survey in several nuclear cities were women (Tikhonov, *Russia's Missile and Nuclear Complexes: Personnel Mobility and Security*, Fig. 3-2).

Job creation in the nuclear cities. Defense conversion and job creation at nuclear facilities is an important task and is a priority for Minatom. However, as already indicated, many of Russia's excess nuclear-weapon experts are ready to retire. In many ways, the health of the closed city economies depends on job creation efforts for people who might or might not be weapons workers. Indeed, 75 percent of the children of current nuclear workers in the cities are between 10 and 29 today, and they therefore either need jobs now or will within the next ten years or so.[18]

Given the above description of the problem, we discuss below three elements of a response:

- Business development;
- Contracts for public goods and services required by the U.S. government; and
- Retirement incentives.

Business Development

Thus far, NCI has focused primarily on the most difficult challenge: promoting the development of businesses in the closed cities. The most successful project at this stage is an Open Computer Center in Sarov, which currently employs 100 Russian scientists to develop software under contract with the U.S. government and private companies (see Box 4: *The*

Box 4. THE SAROV OPEN COMPUTING CENTER

Due to its role in the Russian nuclear weapons program, the Institute of Experimental Physics in Sarov (often referred to in this report by its Russian acronym VNIIEF) was one of Russia's main centers for software development and computing. The Mathematics Division of the Institute currently employs 1,400 workers (FTEs). The Nuclear Cities Initiative has sought to turn this expertise into a business opportunity by creating the Sarov Open Computing Center (OCC) in 1999 with initial contracts worth $1 million from the DOE and its national laboratories. This made it possible for the OCC to establish itself as an institution independent of VNIIEF and to rent and equip space in the Sberbank building in Sarov with an initial workforce of about 100 people.

The DOE-funded projects focused on applications of interest to different classes of potential customers: parallel computing and software development for modeling oil and gas flows underground, molecular dynamics, bio-molecular modeling, and radiation shielding designs for the Geneva-based European Center for Nuclear Research.

The OCC recently signed an open-ended commercial contract with Credit Suisse First Boston for programming in the information technology area for banks. Pilot projects are also pending or underway with a handful of other private firms. The OCC hopes that, by 2004, it will employ 400 people working on over $7 million in commercial contracts.

[18] Tikhonov, *Russia's Missile and Nuclear Complexes: Personnel Mobility and Security*, Table 2-1. There are only 40 percent as many children of current nuclear workers aged 0-9 years old as children 10-19. This presumably reflects the fact that only about 30 percent of the nuclear workforce is less than age 35.

Sarov Open Computing Center). NCI is also working with AVANGARD to develop possible commercial ventures to use the buildings made available by the shifting of the security fence. The most developed of these proposals is a joint venture to initially make the single-use replaceable components for German-made kidney dialysis machines. It is hoped that, at a later stage, it will be possible to jointly develop and produce lower cost dialysis machines.

Efforts to facilitate such joint ventures currently depend upon the costly involvement of U.S. national lab personnel, who are often dedicated but usually have no business background. To help entrepreneurs in the nuclear cities make their own business contacts directly, the NCI has underwritten the cost of small business loans (see Box 5: *Loans from EBRD)* and created "international development centers" at Zheleznogorsk and Snezhinsk. These IDCs, starting with the one in Zheleznogorsk, have been active in providing business training and resources to local entrepreneurs, providing them with access to internet resources, and providing potential investors with office space and communications equipment (see Box 6: *International Development Centers*).

Box 5: LOANS FROM EBRD

Business development in Russia is often complicated by the unwillingness of banks to provide micro and small business loans, which are usually not profitable for the lender. To ease this problem in the closed cities, in December 1999, NCI committed $1.5 million to the European Bank for Reconstruction and Development (EBRD) to start a loan program in the closed cities of Sarov, Snezhinsk and Zheleznogorsk. With this money, EBRD opened offices in the cities, provided management training for banks and loans officers, and is subsidizing these officers until they have a portfolio large enough to be self-sustaining. Because of experience with lending in Seversk, EBRD used its own resources to open a loan office there as well.

The program is based upon EBRD's Russia Small Business Loan Fund, which is financed by contributions from G-7 countries and additional donors. EBRD loans money from this fund to Russia's Sberbank, which in turn loans to its smaller regional banks near the closed cities. Loan officers who reside in the closed cities then provide access to micro credit (up to $20,000) and small business loans (up to $125,000). Typically, the interest rate for a ruble loan is around 40%.

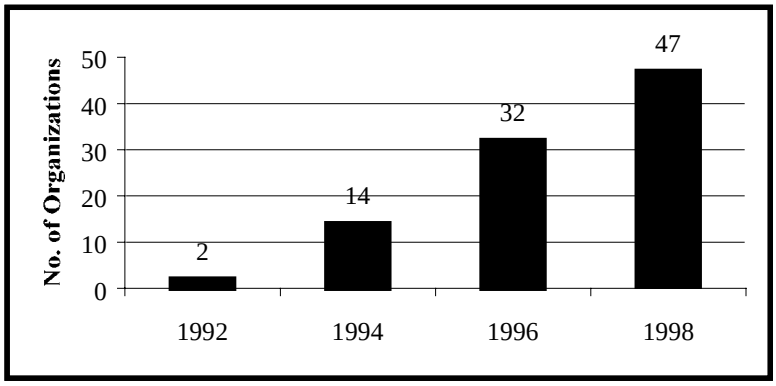
According to EBRD, as of October 2000, there have been 250 loans totaling approximately $1 million.

One important area of future focus for NCI relates to the need to improve energy efficiency in the nuclear cities and surrounding regions (see Box 7: *Energy Efficiency Centers*). As Russian energy prices inexorably rise toward international levels, the cost of energy is becoming a major burden on the nuclear cities and their facilities. Even though the prices are still very low, organizations often find that they cannot pay and try to enter into barter arrangements with energy utilities – or get the federal or regional government to force the utilities to continue to supply energy without payment.

This situation could be mitigated if Russia's energy efficiency could be increased. The Moscow Center for Energy Efficiency (CENEf), established in 1992 with U.S. foundation funding, and numerous other regional energy efficiency centers and funds that have been established in Russia (see figure 1) have been working successfully producing analyses which, in recent years, have led cities and regions to invest about $100 million a year in tax funds and World Bank loans in energy efficiency measures. The establishment of energy analysis centers inside the nuclear cities could help catalyze similar energy efficiency investments and jobs there and help develop expertise and hardware that could find growing market opportunities outside the cities.

CENEf's approach requires that the new energy efficiency centers that it sponsors become self-supporting within three years by selling their analytical services and energy-efficiency loan development assistance. Funding energy efficiency centers could therefore satisfy the stringent requirements imposed by Congress on the $10 million added to the FY 2001 NCI funding: that projects be "commercially viable within three years after the date of the initiation of the project."

Figure 1. Increase in Russian Energy Efficiency Centers and Funds



Source: Meredydd Evans, Pacific Northwest National Laboratory

Contracts for Public Goods

Even with greater funding, it seems unrealistic to expect that it will be possible to create tens of thousands of new private-sectors jobs in Russia's nuclear cities during the next 5 years. This has not been done in counterpart U.S. nuclear communities, such as those surrounding the shut-down U.S. plutonium-production facilities at the DOE's Hanford, WA and Savannah River, SC sites, or the shut-down plutonium-component production plant in Rocky Flats, CO. Instead, the U.S. Government has turned those facilities into environmental-cleanup sites with work forces of roughly the same sizes as those that formerly did weapons work there. The DOE nuclear cleanup effort is currently running at a level of $6 billion dollars per year and is expected to continue for decades.[19]

[19] See the Department of Energy's FY 2001 Environmental Management Budget Request, www.em.doe.gov/ftplink/budget/fy2001.pdf.

Box 6: INTERNATIONAL DEVELOPMENT CENTERS (IDCs)

Jana Fankhauser (Pacific Northwest National Laboratory)
Carol Vipperman (President of the Foundation for Russian American Economic Cooperation (FRAEC)

In 1999, NCI tasked Pacific Northwest National Laboratory (PNNL), in cooperation with the Foundation for Russian American Economic Cooperation (FRAEC), to establish and manage International Development Centers (IDC) in NCI's target cities. The first IDC opened in the fall of 1999 in Zheleznogorsk. This was followed in June 2000 by an IDC in Snezhinsk.

Each IDC is an independent Russian non-profit entity duly registered with local government. The governing board is comprised of representatives from the City Administration, the local Minatom entity, PNNL, FRAEC, DOE (ex-officio), with possible participation by other entities such as regional governments or NGOs.

The IDCs are a place where international and local businesses and community members can go for assistance and information. Each center is fully equipped and located strategically within the city. The centers provide access to the Internet and other information resources, a training room, and work centers, complete with computers for visitors to use.

The IDC is not just a place; it is also the people it comprises. The effectiveness of the resources and assistance provided by the IDCs is directly related to the quality of the people who work there. A Russian director with hands-on experience in business development in Russia and an understanding of the demands and dynamics of a market economy is key to ensuring a well-run center. In addition, the IDCs are staffed by Russian nationals, many of whom are residents of the nuclear city selected through a competitive search process. This has resulted in attracting some of the best people from the city and region.

IDC Services. The IDCs have developed services intended to serve all constituents of NCI, including those at the heart of sustainable job creation:

- Leading and supporting projects of importance to the community;
- Providing consultations to new and existing entrepreneurs on a variety of topics;
- Conducting and facilitating business and other types of training;
- Facilitating access to information on markets and capital sources through the Internet and other channels;
- Providing support to all activities of NCI whether through the national laboratories or DOE headquarters;
- Providing information and support to international projects (companies and other organizations) interested in working in the nuclear cities.

It is understood that as the centers learn more about each community's specific needs, the IDCs may evolve into service areas not yet contemplated.

Accomplishments. The work of the Zheleznogorsk team illustrates the impact that the IDCs can and do have in promoting the goals of NCI. Some examples of their key accomplishments include:

- **Business Assistance to the General Community**. The IDC offers internet access and business consultation to existing and new business people as well as to the general community. Since its opening in November 1999, more than 800 people have used the IDC's resources.
- **Consultation and Advice to the City Administration and the MCC**. The IDC has been playing a pivotal role in helping both the City Administration and the MCC plan their investment strategies. In the past year, the city received $17 million from Minatom for development of 14 job creation projects. The IDC developed and reviewed 9 of these projects.
- **Facilitation of Economic Assessment for Zheleznogorsk.** The contractor Carana Corporation is working to assess Zhelenogorsk's economic situation as a first step towards the development of a comprehensive strategic plan for the city. The IDC is facilitating this process through consultations, sharing of insights, providing

workspace for Carana personnel and organizing meetings with the city's key players.

- **Seminar on Business Planning**. The IDC identified and selected (through a competitive process) a training resource from Moscow to conduct a business-planning seminar in Zheleznogorsk to help the city's business owners prepare for the City Administration's Business Forum. The Management School of the Moscow Physics and Technology Institute conducted a 6-day course for over 31 participants, which resulted in 20 business plans. The organizers of the Forum officially recognized the contributions of the IDC: "The International Development Center - Zheleznogorsk, provided invaluable assistance in the preparation of business plans and conducted targeted training of participants whose projects were presented at the Business Forum."
- **Project Expert Training**. The IDC has been certified as a Learning Center for Project Expert, a software business-planning program. There has been good response and success in training local Russian entrepreneurs in how to use this software and the IDC continues to offer this training and to invite Russian specialists to offer additional seminars. Nine projects prepared at the IDC using Project Expert have received financing from the Russian federal budget.
- **Krasnoyarsk State University Business Training Seminars**. The IDC has partnered with Oak Ridge National Laboratory to sponsor a series of workshops on business training. The experts for these workshops will come from Krasnoyarsk State University.
- **Computer Training Center.** The IDC has reached an agreement with Oak Ridge National Laboratory to set up a Computer Training Center with 10 computer workstations within the IDC.
- **Website Development.** The IDC maintains a website in both English and Russian (www.atomlink.ru/idc) that includes relevant information about the city and its various projects, as well as links to other NCI programs and resources.
- **Assistance to Project Aid Siberia**. Project Aid Siberia is an NGO headquartered in Novosibirsk and contracted by the U.S. Department of Agriculture (USDA) to distribute food under the bilateral humanitarian aid agreement. Project Aid Siberia found itself with surplus food available and decided to send the surplus to Zheleznogorsk. They contacted the IDC for future assistance in monitoring the distribution of food to orphanages and hospitals in Zheleznogorsk. The IDC, in this case, acts as an inspector, thereby fulfilling a necessary USDC requirement the distribution of humanitarian aid.
- **Information and Assistance on US/International Programs.** The IDC is gathering information on U.S. Agencies working in and with Russia and will provide a contact and coordination point for their programs and grant application forms if needed. The Bureau for Educational and Cultural Exchanges has already expressed interest in utilizing the IDC as a contact point and could assist in selecting participants for their international programs.
- **Support to NCI Efforts**: The IDC teams have been in contact with both Sandia and Lawrence Livermore National Laboratories, which are charged with developing accelerated conversion plans for Zheleznogorsk and Snezhinsk. The IDC teams will provide information and support where needed. In addition, the IDC can and is providing assistance to NCI's Community Development Working Group and the Training Working Group as well as others.

As illustrated by these future and current accomplishments and programs, the IDCs are actively involved in building the more competitive environment needed to attract both foreign and domestic investment, while at the same time, facilitating the growth of small and medium-sized businesses within these cities. While working in partnership with City Administrations, Minatom entities, and regional governments, the IDCs are providing services essential to the creation of sustainable jobs for both the near and long-term while ensuring that the goals of NCI are fulfilled**.**

Box 7: ENERGY EFFICIENCY CENTERS

Meredydd Evans (Pacific Northwest National Laboratory)

Energy prices in Russia are generally very low compared to those in most other industrialized nations. Russia's lower energy costs are in part due to being a major energy producer, but also because the price of energy is still heavily subsidized in some cases. Local governments, for example, subsidize the district heating prices that town residents pay. This puts a heavy burden on municipal budgets. In nuclear cities such as Snezhinsk, municipal budgets now subsidize approximately 70% of the total cost of providing energy to citizens and businesses. Reducing energy use will save the cities money – money that could be redirected to improving citizen's lives and encouraging economic growth. Municipalities thus have a large incentive to attract investments for energy efficiency.

In 1992, the Pacific Northwest National Laboratory (PNNL) helped create the Moscow Center for Energy Efficiency (CENEf) to provide analyses to help target these investments. CENEf has assisted many local governments to adopt new building codes. It has also helped develop proposals for hundreds of millions of dollars worth of investments in improvements of the efficiency of existing heating systems including leveraging money available from World Bank loans and matching local financing.[*] CENEf and the 50 or so regional energy efficiency centers and funds that have sprung up since 1992 have also helped develop a market for energy-efficient appliances, equipment and services. Russian-made refrigerators are now more than twice as efficient as they were in 1993, no small achievement in a country experiencing economic crisis. Companies producing controls, meters, turbines and boilers are all trying to improve their products, and there are now numerous companies that provide energy efficiency services ranging from energy audits to assistance with developing, financing and implementing projects.

In the summer of 2000, CENEf carried out energy-efficiency analyses in the nuclear cities of Seversk and Zheleznogorsk in connection with the US-Russian project to either replace or convert the three plutonium-production reactors that still operate to provide heat to populations of these cities. Its analyses identified significant errors in previous estimates of residential energy demand and identified major opportunities to save energy at a lower cost than that of replacement energy supply.[**] CENEf did not have time to conduct an instrumented audit or to test other potentially cost-effective energy efficiency improvements, however CENEf's results are very much in line with the results of more detailed energy audits in other cities. The revised demand projections and proposed energy efficiency measures could save the cities and governments involved hundreds of millions of dollars in avoided capital costs.

Energy Efficiency and the Nuclear Cities

Researchers and municipal leaders in Russia's nuclear cities are increasingly coming to the decision that energy efficiency is not only desirable but also necessary for their survival. Energy efficiency can help address many of the problems facing nuclear cities, including the needs for quality jobs, reduced energy costs, alternatives to the energy generated at plutonium production reactors, and better environmental protection.

The nuclear cities in Russia need to target economic areas that are not only growing, but are likely to provide sustainable jobs over the long term as they shift their economic focus. Energy efficiency is an expanding business in Russia: cities, companies and individuals are increasing their investments in efficiency because of rising energy costs and environmental concerns. Energy efficiency provides quality jobs and is job-

[*] The major World Bank programs are the $400 million Enterprise Housing Divestiture Project, which aims at making apartment ownership affordable, and the Energy Efficiency Project and the District Heating Project, which are under development.

[**] *Assessment of End-Use District Heat Efficiency for Seversk; Assessment of End-Use District Heat Efficiency for Zheleznogorsk* (CENEf Reports for the W. Alton Jones Foundation, 2000).

intensive, creating a long-term demand for skilled employees.

The needs of the energy sector mesh well with the skills and capabilities found in the nuclear cities. Nuclear scientists pursue the same curricula as energy engineers until relatively late in their education. Physics, mathematics, thermodynamics, materials research and advanced computation are skills critical to both fields. As the nuclear scientists look for new work and sources of income to supplement their dwindling nuclear research budgets, energy efficiency holds out the promise of long-term opportunity in a meaningful field.

While the opportunities are likely more diverse than this short list , there are four areas in particular that hold promise for creating jobs in the nuclear cities relating to energy efficiency:

District Heating. Energy losses in many district-heating systems are staggering. Energy is generally not produced very efficiently at centralized boiler houses. It is then transported through pipelines that waste up to half of the energy through losses, warming the environment rather than people's homes. Finally, the heat reaches end consumers, who usually have no way to control it other than opening the window. Russian's numerous pre-fabricated apartment houses are notoriously inefficient. Nuclear city scientists and residents could contribute to this energy efficiency work by conducting technical assessments of district heating systems, designing upgrades, implementing changes, and monitoring the system to ensure long-lasting results.

Design and modeling. Modeling energy use in buildings allows construction and architectural companies to create more efficient buildings. Likewise, many industrial companies need more comprehensive energy modeling to understand where to save energy and money. Energy and emission modeling capabilities are also needed to help Russia comply with international treaties, such as the Framework Convention on Climate Change. Some Russian nuclear scientists have years of expertise in designing and running complex models to develop nuclear weapons. This expertise could be adapted to designing better models of energy use.

Likewise, nuclear scientists could improve product designs to increase energy efficiency. Such work would also place the nuclear city in a strong position for fabricating and testing equipment prototypes, and could eventually help pave the way for new manufacturing facilities for energy-efficient equipment in or near the nuclear city.

Fuel Cell Research. Many energy companies and experts believe that fuel cells will be a major new energy technology in the 21st century. The Soviet Union was one of the world's leaders in fuel cell technologies and much of this expertise was in the nuclear cities as fuel cells were first developed for rockets and space vehicles. Russia has many innovative fuel cell technologies, but most are far from commercial viability. That said, Russian researchers have technologies for fuel cell components that are potentially much more cost-effective than their Western counterparts, particularly for certain membrane technologies and auxiliary equipment. Western investors might be willing to partner with Russian fuel cell experts to develop Russian technology in this field. The W. Alton Jones Foundation is currently funding research on developing partnerships and understanding the market for Russian fuel cells, as a first step in reinvigorating this industry in Russia.

Energy Efficiency Centers. Energy efficiency centers could promote energy efficiency in the nuclear cities and surrounding region by helping the cities design policies and incentives to promote energy efficiency; providing outreach to scientists and the community on opportunities for work related to energy efficiency, including district heating improvements; and linking scientists to Russian firms seeking modeling, design, or energy assessment expertise.

There are many reasons to promote and invest in energy efficiency in the nuclear cities, and energy efficiency can and does pay for itself because of the energy savings. Thus, energy efficiency can become an element of a sustainable solution for economic development in the nuclear cities.

Both NCI and a new smaller European Community funded Nuclear Cities Initiative therefore are considering funding the establishment of energy-efficiency centers in the nuclear cities.

Russia does not have funds for such massive cleanup efforts. However, its facilities and expertise could be tapped to strengthen those of the United States. Indeed, the DOE's IPP program recently provided startup funding for a High-Level Waste Tank Retrieval and Closure Demonstration Center in Zheleznogorsk, which is to provide R&D in support of DOE's $20-30 billion task of cleaning out the high-level waste tanks at Hanford and Savannah River (see Box 8: *Zheleznogorsk High-Level Waste Tank Retrieval and Closure Demonstration Center*). This effort will only succeed, however, if the leadership of the DOE's Environmental Management program can be convinced to put some of its own R&D funds into the effort.

The United States could also profitably invest in strengthening its nonproliferation partnership with Russia. With the end of the Cold War, the proliferation of nuclear weapons – and biological and chemical weapons of mass destruction – is being used to justify ever larger portions of the $300 billion-a-year U.S. defense budget.

Box 8: ZHELEZNOGORSK HIGH-LEVEL WASTE TANK RETRIEVAL AND CLOSURE DEMONSTRATION CENTER

One of the by-products of nuclear-weapon production in the United States was high-level radioactive waste. This waste is often stored in above- and below-ground tanks, some of which leak and all of which need to be cleaned-up. Currently, the United States has over 300 high level waste (HLW) storage tanks located at four sites in the DOE complex (Hanford, Oak Ridge, Savannah River, and the Idaho National Engineering and Environmental Lab). A rough estimate by the Sandia National Laboratories puts the cost of clean-up at Hanford alone at approximately $10 billion.

Russia has similar problems with HLW contamination. Remediation efforts there have been led by the Mining Chemical Combine (MCC) in Zheleznogorsk, which has storage tanks similar to those found at the U.S. facility in Hanford. Scientists at the MCC have developed a pump and chemical techniques which helps mobilize radioactive sludge. The sludge can then be pumped out of the waste storage tank and converted into a more environmentally-safe storage form. Using this technology, the MCC has successfully retrieved waste from several HLW storage tanks, and decontaminated those tanks enough to allow human access.

Scientists at the Sandia National Laboratories have taken up the task of applying this Russian technology to clean-up efforts at Hanford. In a series of projects funded through the Initiatives for Proliferation Prevention (IPP) program, the MCC, and several other Russian institutes that have expertise in the remediation of waste storage tanks, have formed a research consortium. Working with U.S. scientists, promising decommissioning and decontamination technologies have been identified, and currently an effort is underway to create a Tank Retrieval and Closure Demonstration Center and pilot scale development project at Zheleznogorsk. This Center will provide facilities to demonstrate the technologies and qualify remediation equipment and processes to international standards. A future project seeks to apply the same technology to the clean-up effort at the U.S. Savannah River site. MCC experts hope that eventually the center would actively partner with U.S. industrial companies to participate in the cleanup effort in the United States.

The United States has launched a major effort to enhance safeguards and security of Russian nuclear materials and initiated "lab-to-lab" projects to develop nonintrusive approaches to the verification of the dismantlement of nuclear warheads. U.S. contributions through the ISTC and IPP to support collaborative R&D projects in the nuclear cities are also largely justified by nonproliferation considerations. However, progress in the area of nonproliferation has been slow and the collective impact of these programs is still inadequate.[20] What is needed is a community of analysts who are able to subject these efforts to effective outside peer review and inject their views and proposals for new initiatives into the policy-making process.

A number of U.S. non-governmental organizations and university groups have been trying to do this. However, they lack a sustained presence in the nuclear cities. The Russian-American Nuclear Security Advisory Council (RANSAC), in collaboration with Princeton University's Program on Nuclear Policy Alternatives and other organizations, has therefore been working with NCI and a group of private U.S. foundations to establish nonproliferation analysis centers in Sarov and Snezhinsk, the closed cities that host Russia's two nuclear-weapons R&D centers, and in Russia's two leading nuclear-reactor design institutes: the Institute of Physics and Power Engineering in the open nuclear city of Obninsk and the Kurchatov Institute of Atomic Energy in Moscow. It is hoped that these Centers will provide high-quality Russian analysis and ideas for cooperative nonproliferation initiatives.

Workforce Downsizing through Retirement

Russia's nuclear weapons production workforce is aging. According to a recent demographic study at several facilities of the complex, about 20 percent of the personnel in the nuclear-weapon laboratories and assembly/disassembly facilities are over 50 years old and at least 5 percent are over 60 years old.[21] In part, this trend is due to an outflow of younger workers to the local services, banking, and commercial manufacturing sectors, especially in the mid-1990s. Two other significant factors in the 1990s were the decline in the retirement rate for older workers, and a significant reduction in new hires. Many workers are staying on beyond retirement age because of the abysmal benefits paid by Russia's equivalent of the U.S. Social Security program. Russia's pensioners get the equivalent of only $180 *per year*.[22] Also, often older workers have to support their children and/or grandchildren who do not have high-paying jobs and who were too young to get free apartments and dachas during the Soviet era. As a result, nuclear facilities, which are under pressure to cut personnel levels, have reduced their hiring requirements to avoid displacing retirement-age veterans.

[20] See e.g. Oleg Bukharin, Matthew Bunn and Kenneth Luongo, *Renewing the Partnership: Recommendations for Accelerated Action to Secure Nuclear Material in the Former Soviet Union* (Russian-American Nuclear Security Advisory Council, August 2000 (http://www.ransac.org/).
[21] Tikhonov, *Russia's Missile and Nuclear Complexes: Personnel Mobility and Security*, Figures 3-3 to 3-5.
[22] There is, however, the massive concealed subsidy of almost free – a few dollars a month – housing, healthcare, and other social support services.

Problems of personnel aging are reported by most facilities in the complex.[23] Approximately 2,000 pensioners could be retired at VNIIEF in Sarov and 200 additional workers reach the retirement age each year. [24] As of 2000, there were almost 2,000 persons of the retirement age (13 percent of the workforce) on payroll at the Urals Electro Chemical Combine (UEKhK) enrichment complex in Novouralsk and an additional 1,000 workers are projected to reach the retirement age during the next three years. The AVANGARD plant in Sarov is projected to have 379 retirement age workers by 2002 and 444 by 2003.[25] Assuming that the demographic situation at these facilities is representative for the weapons complex in general, 10,000 nuclear weapons workers (13 percent of the current 75,000 defense program personnel) could be of retirement age at present complex-wide and this number will rapidly increase during the next three to five years.

Retiring workers does not, of course, automatically result in workforce reductions. If a retiree's skills or position are considered "mission-critical," a facility has to hire a replacement worker. For example, the VNIITF institute in Snezhinsk urgently needs to hire and train young specialists in order not to lose critical capabilities.[26] Also, some older workers have unique knowledge and experience and would likely be asked to stay on the job to train younger workers. Nevertheless, assuming conservatively that every second retiree stops working and does not need a replacement, over the next five to ten years, the retirement process would reduce the Minatom's nuclear weapons workforce by approximately 10,000 workers. If the retirement age were reduced to 55 for all workers, retirements could account for almost one third of the projected workforce reductions by 2005 (see Table 1) and job creation requirements could be thousands of jobs less than the current estimates.

For the retirement process to work, nuclear facilities must offer older weapons scientists and engineers a set of financial and social security incentives, including timely pensions, and improved healthcare. The nuclear cities have therefore obtained permission from the Russian Government to raise the pensions of all their retirees. VNIIEF's Director Radi Il'Kaev, for example, believes that, if he had $1 million per year, he could persuade 2,000 of his excess personnel to retire with supplemental payments totaling $500 per year.[27] Over 5 to 10 years, this would amount to $2,500-5,000 per retired worker – considerably less

[23] The exceptions include the plutonium-production combine in Zheleznogorsk, where over 70 percent of the workforce is under 49, and the Institute of Automatics in Moscow where the average age of workers is 48.
[24] According to other reports, persons beyond retirement age account for 20 percent of VNIIEF's workforce – approximately 3,600 workers. (See, for example: Olga Zaguskina "E. Adamov: 'The Nuclear Industry Created More Problems Than It Resolved,'" *Gorodskoy Kuryer* (Sarov), September 2, 1999.) The two numbers are not necessarily contradictory as many retirement-age workers have critical skills and will not retire under the existing plan.
[25] O. Zaguskina, Interview with A. Orlov, AVANGARD's New Director, *Gorodskoy Kuryev*, October 19, 2000.
[26] Presentation by E. Avrorin, "Helping Russia Downsize Its Nuclear Weapons Complex," conference at Princeton Conference, March 2000.
[27] This relatively low amount of supplement reflects the low wages in the weapons R&D institutes, where less than 30 percent of the workers earned more than $600 per year in 1999. They are able to survive on such low salaries because many take second jobs – with salaries comparable to or higher than their jobs in the nuclear facilities. Also the costs of rent, heat and electricity are extraordinarily low because of subsidies by the facilities and cities and many raise food in garden plots.

than the estimated cost of a high tech-job, which may not be sustainable.[28] If some arrangement for special early-retirement pensions for nuclear workers could be contrived, the contribution of retirements to the problem of excess workers could be even larger.

However, any foreign assistance for a nuclear worker retirement-incentive program should require the assurance that workers will not return to work in the nuclear complex and that the size of the workforce in the complex is being reduced on at least a one-for-one basis. Such reassurance would be provided in good part if, along the lines of the requirements of the Domenici amendment, the physical infrastructure of the nuclear-weapons facilities are reduced or converted in parallel to the workforce down-sizing effort.

No one has dared to try to sell the idea of "golden parachutes" for aging Russian weapons workers to Congress, however. Nor would Minatom and the Russian nuclear cities like to see too much of an emphasis on this particular approach to downsizing as the issue of retirement in Russia is traditionally surrounded by cultural sensitivities. The closed cities also do not want to turn into isolated, impoverished retirement communities. They want new jobs. The retirement strategy will therefore probably depend upon the cities becoming prosperous enough to be able to supplement the retirement stipends of their pensioners. The Duma has passed a law which allows them to do so.[29]

In any case, it appears clear that worker retirement should be a major factor in any down-sizing effort for the Russian nuclear-weapons complex. Indeed, the value of 10,000 retirements may understate the potential contribution of a retirement program. This is because it would likely be much more difficult to create new jobs for older workers than for younger workers. On the other hand, even if new jobs are not required for the retiring workers, new jobs will be required for the large number of younger people growing up in the cities if the cities are to remain economically and socially healthy.

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28 Thomas Neff has suggested that the United States and Minatom each provide a $600/year supplemental annuity to each closed-city nuclear worker willing to retire. This would bring the total income of a pensioner to about $1,400, which is well above the average current income in the cities, even including second jobs. The average cost to the United States for paying it share of these annuities would be about $5,000 per worker or a total of $50 million for 10,000 retirees. Neff estimates the cost at $4,030-$6,760 for 10-30 years assuming that the money is invested at a real rate of return of 8 percent per year. Even if the rate of return were 3 percent per year, the annuity would cost $5,180 for 10 years. (Thomas L. Neff, "Accelerating Down-Sizing of the Russian Weapons Complex," October 2000, unpublished).

[29] On August 23, 2000, President Putin signed Decree No 1563 "On Immediate Measures of Social Support to Specialists of the Nuclear Weapons Complex of the Russian Federation." According to the decree, nuclear weapons veterans, who have received special awards or participated directly in dangerous nuclear weapons activities, are to receive pensions amounting to 66 to 75 percent of their average monthly salary during the last 12 months of work. No worker, however, may receive a pension more than 20 times higher than the minimal pension offered. The decree also increases salaries for civilian and military personnel who are directly involved in nuclear weapons work. (*Rosiiskaya Gazeta*, 166, August 26, 2000.)

CONCLUSION: A DIFFICULT BUT ESSENTIAL TASK

Thus far the nuclear enterprises in the closed cities have not released excess workers unless they were spun off with their work units to the control of the city administrations or new jobs could be created for them. This has kept unemployment figures artificially low and underemployment very high. However, 35,000-40,000 excess weapons workers cannot be supported by the nuclear facilities indefinitely.

Despite some successes, the progress towards downsizing and conversion is still slower than needed. Conversion has succeeded primarily in the area of the nuclear fuel cycle – especially enrichment facilities. It has been easy to convert facilities that produced HEU for weapons to provide enrichment services to foreign customers and support HEU-downblending work.

There is no question that both Minatom and NCI could further improve their programs that facilitate the development and selection of good proposals for new commercial ventures. They are, however, facing many adverse factors that are outside of their control. These include:

- the poor climate for domestic and foreign investment in Russia in general;
- the difficult access arrangements inflicted upon the nuclear cities by the Federal Security Service (FSB);
- non-cash payments or non-payments for products and services sold domestically; and
- insufficient funding.

These problems provide ample reason for Minatom to remain interested in Western financial and technical assistance for defense conversion. There is, however, clearly a "crisis of expectations." Minatom expended substantial political capital to get the original NCI agreement signed in the expectation that tens or hundreds of millions of dollars would be forthcoming as a result. The limited progress to date has undermined the position of NCI supporters in Russia. Minatom claims (perhaps incorrectly) that only about $1 million in NCI money actually reached the closed cities in 1999, mostly for the Open Computing Center in Sarov. The “crisis of expectations” appears to extend into at least some of the individual complexes as well prompting scientists to question the rationale for spending money to clean up and clear out buildings only to have them lie unused.

Minatom also appears to be facing resistance from the Russian internal security apparatus to increasing U.S. demands for access to Russian nuclear facilities in exchange for continued U.S. assistance in securing Russian nuclear materials and helping convert its excess nuclear personnel. Minatom therefore continues to insist that NCI should not promote projects in the nuclear facilities themselves, but only in the cities surrounding them – as specified in the original NCI agreement.

In summary, the U.S. government cannot realistically expect Minatom to be an eager advocate of government-to-government commitments to shut down some of its warhead assembly/disassembly facilities. Certainly not in exchange for a conversion investment on the order of $5 million, the portion of the conditioned $10 million in the FY 2001 budget that will be available for expenditure in Russia after the U.S. national laboratories have charged the cost of their assistance in facilitating the effort. Such an amount appears insignificant in comparison to the estimated $200-250 million that it will take to clean out the two warhead assembly/disassembly facilities that it plans to close and create jobs for the 10,000 or so workers that they currently employ.

Nevertheless, we believe that, politically, the only way forward toward more robust U.S. assistance for the downsizing of the Russian nuclear-weapons-production complex must be through some kind of agreement along the lines required by the Congress. We have suggested that this could be in the form of an approach in which one Russian nuclear warhead assembly/disassembly facility (AVANGARD) is opened up step-by-step up in exchange for increments of effective U.S. job-creation, cleanup, and retirement-incentive assistance. Then the process could continue at the second assembly/disassembly facility (START) that Minatom plans to shut down.

However, the annual increments of assistance that the United States will have to provide to achieve this objective within the next five years will have to be closer to $100 million than $5 million – especially if the NCI is simultaneously to help create tens of thousands of jobs and help cleanup excess weapons facilities in *the rest* of the Russian nuclear-weapons-production complex. One hundred million dollars does not seem an unreasonable amount, given that the United States has been for the past decade spending hundreds of millions a year through the Department of Defense's Cooperative Threat Reduction program to fund the destruction of excess Russian nuclear missiles and launchers, to secure excess Russian weapons plutonium and other such purposes.[30]

The alternative is to let Minatom and its workers find their own path forward to survival after the Cold War. The resulting security costs to the United States and the world are likely, however, to dwarf the cost of conversion. Of course, money is the easy part. The more difficult part would be to muster the expertise to assure that the money is well spent and achieves the desired result. The only way to do that is to maintain a sustained focus on the problem and learn from the program's mistakes.

[30] The CTR website is www.dtra.mil/ctr/, but, as of November 6, 2000, it had not been updated for at least a year.

APPENDIX 1. POPULATIONS, EMPLOYMENT AND CONVERSION IN RUSSIA'S CLOSED NUCLEAR CITIES

by Oleg Bukharin

This Appendix updates information provided in Appendix 1 (*Downsizing Projections on a City-by-City Basis*) of the earlier report *Helping Russia Downsize its Nuclear Complex: A Focus on the Closed Nuclear Cities*. Facility-by-facility tables, that contain information on facility missions, current and projected employment at nuclear facilities, and defense conversion projects are updated and corrected based on new information, much of which was derived from presentations and discussions at the June 2000 workshop in Obninsk.[31] For seven of the cities, a brief discussion is also included of population trends, developments at the nuclear facilities, and approaches to defense conversion and social and economic development. The three cities not treated in this way are the cities hosting warhead assembly/disassembly facilities: Zarechny, Trekhgorny, and Lesnoy, which remain off-limits to international cooperation and were not represented at the Obninsk workshop.

The cities are identified both by their current names and (in parentheses) their Cold War postbox numbers when they had no names because their existence was supposed to be a secret.

Sarov (Arzamas-16)

Population

Sarov (Arzamas-16) currently has a population of 85,000 people (compared to 78,600 in 1989). Approximately 20 percent of the population are pensioners, half of whom continue working, and 19 percent are children less than 16 years of age. The working population is approximately 42,000, of which half work at the nuclear facilities. The rest are employed in the municipal sector, education, construction, local industries, and services. As of 2000, the city had approximately 1,100 registered unemployed persons.

Principal Nuclear Organizations

The principal nuclear organizations are the nuclear warhead assembly and disassembly plant (Electro-Mechanical Plant "AVANGARD") and the warhead R&D institute VNIIEF (Federal Nuclear Center-Institute of Experimental Physics).

VNIIEF will remain one of Russia's two primary warhead R&D centers. (The other is VNIITF in Snezhinsk.) According to Minatom's plans, VNIIEF's nuclear weapons workers will account for 25-30 percent of Minatom's nuclear weapons workforce in 2005. In contrast,

[31] Unless indicated otherwise, the information is based on the author's estimates and compilation of data from a variety of sources that are too numerous to list individually. These sources include Western and Russian publications, and presentations by and interviews of officials and experts. Current and projected defense-program workforces are estimated on the basis of the published current and projected total levels, reported data for some individual facilities, and employment levels at comparable U.S. facilities. The data vary in quality from relatively reliable (as in the case of Sarov) to "guesstimates."

AVANGARD is expected to largely phase out nuclear weapons work within the next 3 to 4 years. It, however, will likely continue limited manufacturing of certain non-nuclear components and subassemblies for nuclear warheads.

VNIIEF employment has decreased from approximately 25,000 in the early 1992 (when the reductions began) to 18,500 at present. These reductions occurred primarily in the mid-1990s when a number of social services, such as day-care facilities, and technical support units, such as power utilities and road-maintenance organizations, were transferred from the institute to municipal control. Further reductions to approximately 16,000 by 2005 are planned and will be accomplished primarily by retiring 2,000 older workers. Approximately 12,000 workers are to be supported by the defense program. The remaining 4,000 will work on commercial projects.

At the AVANGARD plant, the level of employment is projected to decrease from 3,300 at present to 2,900-3,000.[32] Approximately 300 workers are expected to retire. (In 2004, AVANGARD is projected to have 444 retirement-age persons.) Some workers will be transferred to VNIIEF. And approximately 200 workers will be laid off. Defense program employment is to decline from its current level of 2,700 to 900 in 2005, most of whom are expected to be working on conventional-weapon production (3-5 percent are presumed to work on nuclear weapons state orders).

Defense Conversion and Economic Development in Sarov

VNIIEF and AVANGARD say that they have already created approximately 2,500 and 600 civilian jobs respectively. Most newly-established non-weapons ventures, however, remain economically fragile and may not survive without additional support. Under NCI's auspices and in cooperation with Los Alamos National Laboratory, AVANGARD, VNIIEF, and the city administration developed a list of possible conversion projects (the Sarov Conversion Initiative) that are projected to create 2,036 and 1,100 jobs in VNIIEF and AVANGARD respectively. As of summer 2000, the two facilities were conducting detailed planning to determine the size of investment required to implement the initiative.

Defense conversion in Sarov began in the early 1990s but only limited progress was made initially because of the lack of governmental funding. However, the conversion process accelerated in the late 1990s as Minatom's financial support for conversion increased (RR 100 million or $4 million in 1999). Organizationally, some projects are undertaken within VNIIEF or AVANGARD (*e.g.* diamond cutting, production of explosive oil-well-casing perforators, and production of sulfur-hexafluoride (SF_6) insulated switches) and some involve mixed ownership (for example, manufacturing of titanium components and ultra-light airplanes). Eventually, all defense conversion projects are expected to become independent commercial enterprises.

Obstacles to defense conversion in Russia include inadequate financing, low demand for high-technology products in Russia, and difficulties of transferring state property to private ownership. Sarov also needs additional buildings and infrastructure to accommodate civilian ventures, many of which are currently located inside secure technical areas within VNIIEF

[32] "Alexander Orlov, 'Only a Bad Horse Starts a Race with Galloping'," *Gorodskoy Kuryer*, October 19, 2000.

and AVANGARD. Virtually all buildings outside of secure areas are already occupied. City officials believe that the problem could be tackled by establishing a technology park on the basis of AVANGARD's buildings that have specialized technical infrastructure and could be moved outside of the secure area.

The Sarov city administration has been working cooperatively with AVANGARD and VNIIEF to facilitate defense conversion and job creation. The city helped the primary facilities by rescheduling taxes, providing low-interest loans, and assuming responsibility for certain support services, day-care facilities, city transportation, and road maintenance services that were not profitable.

The Investment Zone of Sarov (IZS), established on February 4, 1997 by the Sarov City Duma, has been another key tool for defense conversion and economic development in Sarov (see Box 3: *The Investment Zone of Sarov*, in main text).

As of the summer of 2000, the Fund for Defense Conversion had accumulated RR 150 million. In 1998-2000, approximately 1,200 jobs were created or saved in Sarov through the city's efforts.

In 1999, the Russian government amended the Law on Closed Nuclear Cities. Under the new law, only Sarov and Snezhinsk are allowed to grant tax benefits. There is also an upper limit of approximately $40 million per year (divided by Arzamas-16 and Chelyabinsk-70 in the proportion of 3/2) on the amount of benefits the cities are allowed to provide.[33] To compensate for the loss of revenues the government promised to transfer to Sarov RR 50 million in 2000.[34] As of June 2000, Sarov had received none of the promised governmental funding.

[33] L. Saratova, "Special Regime Investment Zone," *Gorodskoy Kuryer*, No. 2, January 13, 2000.
[34] *RFYaTs -VNIIEF Information Bulletin*, Issue 3, VNIIEF Analytical Nonproliferation Center, Sarov, Fall 2000, p. 26.

VNIIEF Workforce

	1980s	**2000**	**2005** (projected)
Total	25,000	18,500	16,000
Weapons Programs	25,000	16,000	12,000

VNIIEF: Major Activities (* indicates proposed activities and projects[35])

Nuclear-Weapon Missions	**Non-Commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
Nuclear-weapons R&D Stockpile stewardship Non-nuclear component manufacturing	Basic research Emergency response Nonproliferation and arms control Environmental management (Integrated Treatment Center*)	Nuclear-power-plant (NPP) safety projects Stable-isotope separation	Oil and gas industry projects (liner perforators, instrumentation, and controls) Diamond cutting Production of SF_6 insulated electrical power (elegas) switches Production of ultralight airplanes Software development (Open Computing Center) Design bureau for fast prototype development Production of titanium and titanium parts Production of neutron-absorbing layers for protective containers Technology incubator Production of NPP instrumentation and controls* Production of auto electronics* Production of high-voltage generators* Conventional weapons R&D*

[35] A project or activity is defined as "proposed" if it is yet not active. For some projects (particularly those classified as "commercial non-nuclear") status information is not available. Such projects are presumed active.

AVANGARD Workforce

	1980s	**2000**	**2005** (projected)
Total	4,800	3,300	2,900-3,000
Weapons Programs	4,800	2,700	900 (mostly working on conventional weapons)

AVANGARD: Major Activities

Nuclear-Weapon Missions	**Non-Commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
Warhead assembly [PAST] Warhead disassembly [TO END IN 2003] Non-nuclear component manufacturing?	Environmental cleanup (Integrated Treatment Center*)	Polonium isotope production Radioisotope Thermal Generator production	Production of - MPC&A equipment - anti-terrorist equipment - milk-processing equipment - radio transmitters - consumer goods - conventional weapons - medical equipment (dialysis)* - SF_6 switches* - products for oil and gas industries* - safety systems (fire detection, etc.)* non-defense engineering center*

Snezhinsk (Chelyabinsk-70)

Population
Snezhinsk (Chelyabinsk-70) currently has a population of 48,925, an increase of 2,000 over the past two years. As of January 2000, there were 25,807 working people in the city. The employment situation is currently relatively good: the number of registered unemployed people declined from approximately 1,200 in 1998 to 300 (1.3 percent). There are 10,000 retirement-age people in Snezhinsk (not including those working at the nuclear weapons center).

Principal Nuclear Organization
The principal nuclear organization in Snezhinsk is the warhead R&D institute VNIITF (Russian Federal Center – Institute of Technical Physics). At present, its main mission is stockpile stewardship.

In the 1980s, VNIITF, in addition to primary R&D and production units, included power and transportation divisions, and child-care, athletic, and arts facilities. The social services have since been transferred to municipal control, and the power and transportation units have been separated to become independent enterprises. The institute has reduced its staff from 15,000 in the late 1980s to 9,500 at present. Further reductions of approximately 2,000-2,500 excess employees are projected. The institute has agreed not to release them, however, until jobs can be created for them. There is a concern that loss of some personnel could result in the institute losing important scientific capabilities. VNIITF therefore hopes to keep some specialists by using them in both defense and newly created civilian programs. Recruitment and training of young experts has also become a critical issue.

Defense Conversion and Economic Development in Snezhinsk
Defense conversion efforts at VNIITF date back to the late 1980s. The first defense conversion program was adopted in 1988 and included large projects selected at the federal level, including fiberoptics, medical tomographs, and copy machines. Because of inadequate financing, however, the objective of entering the market in 1992-93 was not achieved. In 1992, COCOM restrictions were removed and Russia gained access to Western-made fiber-optic cables and copy-machines with which VNIITF's products could not compete.

In 1995, the defense conversion program was revised. The new program relied on projects for industrial users in the Urals area (Chelyabinsk and Sverdlovsk regions). The identified users, however, were not willing to fund the necessary R&D. After VNIITF funded the R&D out of its own resources, it found that the users were not able to pay for their orders either.

At present, VNIITF's defense conversion activities are primarily supported by Minatom's internal funding. The ISTC, lab-to-lab programs, IPP, CRDF, and European contracts are also significant sources of funds. Finally, VNIITF benefits from Snezhinsk's closed-city status in the form of reduced taxes, and deferred tax payments and VNIITF personnel and their families receive social benefits including subsidized education and health services. These benefits, however, have not been used effectively to create new jobs in Snezhinsk.

In February 1999, VNIITF moved 400 of its employees into a newly established separate enterprise SPEKTR, intended to commercialize civilian products developed by the institute (for example, the production of explosive perforators for oil and gas-well liners). SPEKTR received support and funding from the city administration of Snezhinsk. In July 2000, however, VNIITF's director reportedly ordered most of SPEKTR employees back to VNIITF. One version of the story is that this decision was prompted by a shortage of qualified specialists required to fulfill the institute's defense orders. Another is that foreign assistance for conversion had not come through as quickly as had been hoped.

As a result of the accelerated conversion planning process sponsored by NCI and developed in cooperation with the Lawrence Livermore National Laboratory, SPEKTR proposed 20 projects that would require an estimated $11.5 million in funding and were projected to create 1,060 jobs. The city administration of Snezhinsk has also developed a list of approximately 15 projects estimated to require a total of $18-22 million in startup costs and projected to create 600-700 new jobs.

Snezhinsk has a shortage of buildings outside of its secure areas to accommodate new businesses. To resolve this problem, the institute has already given over to the city three buildings. As of June 2000, a transfer of an additional building and, possibly, of an entire technical area were under discussion.

VNIITF Workforce

	1980s	**2000**	**2005** (projected)
Total	15,000	9,500	9,000?
Weapons Programs	15,000?	9,000?	7,000?

VNIITF: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
Nuclear weapons R&D Stockpile stewardship Non-nuclear component manufacturing	Basic research Nonproliferation and arms control R&D Emergency response Environmental research	Development of container for spent fuel storage and transport	Oil and gas industry projects Conventional weapons R&D Production of oil-well-liner perforators* Production of fiber-optic cable* Super-plastic forming* Software development* R&D/production of medical equipment*

Ozersk (Chelyabinsk-65)

Population
Ozersk (Chelyabinsk-65) currently has a population of 86,000 people. In addition, 16,000 people live outside of the city but inside the surrounding security area. Approximately 50,000 Ozersk residents work. As of summer 2000, the level of unemployment was 1,600 persons, a reduction from 4,500 unemployed two years ago.

Principal Nuclear Organization
The principal nuclear organization is the Production Association Mayak. Mayak continues to be a key part of Russian's nuclear-weapons program. It is responsible for the production (in two production reactors) of tritium, purifying tritium of its decay products, and producing the tritium components of nuclear warheads. It also manufactures the plutonium and HEU components of nuclear warheads and manages stockpiles of these fissile materials. Mayak also operates spent fuel management and reprocessing facilities and an isotope production plant. Finally, it has the task of managing and disposing of civilian nuclear materials, and environmental cleanup and decommissioning of old defense facilities.

Mayak employs approximately 14,500 workers (including support personnel), a reduction of approximately 4,000 from the early 1990s. While Mayak managers admit that the workforce is oversized, they project this employment to remain at the current level for the foreseeable future.

Defense Conversion and Economic Development In Ozersk
The diversification of Mayak into non-weapons work occurred in the 1970s when the facility began reprocessing spent fuel of nuclear power reactors and producing radioactive isotopes. In the late 1980s, it initiated a number of additional non-nuclear defense conversion projects such as production of instrumentation and control equipment, food processing systems, and consumer goods.

Creation of jobs for excess Mayak workers is a priority task for the city's administration. During the past two years, it invested tens of million dollars in 20 investment projects that generated over 1,000 jobs. An additional 1,000+ jobs were created in small businesses by local entrepreneurs with support from private investors. The city is focusing its efforts on supporting its infrastructure and investing in enterprises providing communications services and construction materials, operating farms, and processing food. Currently active projects will require about $20 million in investments and are projected to create 300-400 jobs in the next two years and more in the out years.

The newly created businesses are in Ozersk's residential area outside of Mayak's security fence. The conversion of buildings inside Mayak's security areas is considered impractical because of radioactive contamination.

Mayak Workforce

	1980s	**2000**	**2005** (projected)
Total	18,000	14,500	14,500
Weapons Programs	12,000?	6,000?	4,000?

Mayak: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
Plutonium production for weapons [PAST] Fabrication of HEU and plutonium components Tritium production, purification and reservoir loading Fissile material storage and management?	Environmental cleanup and waste management Facility decommissioning Fissile material storage and management Plutonium disposition*	Reprocessing of spent power-reactor fuel HEU processing for downblending Production of medical and industrial radioisotopes Production of Pu-238 and other radioisotopes for electro-thermal generators Spent fuel storage Nuclear power plant construction and operation*	Production of - consumer goods - instrumentation and control equipment for nuclear, chemical, and oil/gas industries - vessels for food-processing and chemical industries - ion-exchange membranes - personal dosimeters - printed circuits - heat meters - vans - electrical instruments - strong rare-earth metal magnets - precision electrical motors - thermoelastic tubes and films - TV sets - polished silicon wafers* - fiber-optic cable*

Seversk (Tomsk-7)

Population
Seversk (Tomsk-7) currently has a population of 119,000. Approximately 59,000 people are economically active. The nuclear facility employs an estimated 15,000 workers. The city has over 17,000 pensioners. As of early 2000, the official level of unemployment in Tomsk-7 was 3.3 percent (1,970 persons).

Principal Nuclear Organization
The Siberian Chemical Combine (SKhK), the "city-forming" organization in Seversk, is Russia's largest fissile material production and processing center. In the mid-1980s, defense program activities, including the production of HEU and plutonium for weapons and fabrication of fissile material components for nuclear warheads, accounted for over 50 percent of its total output. The production of HEU and plutonium for weapons was terminated in 1988 and 1994 respectively, and fissile-component production ended recently. The facility will likely continue supporting the nuclear weapons program through fissile material storage and management operations, however.

Defense Conversion and Economic Development In Seversk
The economic stability of Seversk depends to a large extent on the situation at SKhK and its second largest industrial facility, Khimstroy, a company that produces construction materials and components and constructs residential buildings and industrial facilities. Khimstroy has laid off approximately 60 percent of its workers (presumably several thousands persons) since 1991.

SKhK's most difficult years were 1994 and 1995. In 1994, 5,000 workers became redundant as a result of a six-fold reductions in "defense orders," mostly due to the termination of Ministry of Defense orders for plutonium for weapons. In 1995, an additional 1,000 workers became *de-facto* redundant because of non-payments by SKhK customers. The city helped the nuclear complex to avoid massive layoffs, which would have created social instability, and the situation has stabilized somewhat. The facility is facing a new challenge, however. In 2000, the Russian government resolved to shut down the two currently-operating nuclear reactors and replace them with a fossil-fuel power plant. Approximately 4,000-5,000 workers could eventually become redundant as a result.

Current SKhK efforts to create jobs include the following:

- A "Siberian power uranium" program intended to create 420 jobs by 2007 by enhancing Tomsk-7's capability to produce and export low-enriched uranium for power reactors (including HEU downblending, the chemical cleansing of contaminated uranium, and the enrichment of uranium recovered from the commercial reprocessing of spent fuel in Western Europe).
- Construction of two AST-500 district heating reactor units to replace the plutonium reactors still in operation is another priority for the SKhK. The construction is scheduled to start in 2000 and finish in 2006. During its initial phase, the project would provide 250 new engineering and installation jobs for SKhK workers. However, the U.S. Department of Defense has agreed to provide funds to refurbish coal-fired plants to provide

replacement heat. It seems unreasonable that both projects will be completed but, if they were, Seversk could continue to export heat to the Tomsk district heating system.

- A boron isotope-separation facility (BOR-10) would produce relatively pure, reactor-quality neutron absorbing boron-10 (which makes up 20 percent of natural boron) and would create 150 jobs. The complex is being built at the reprocessing plant and is scheduled for operation in 2001.
- Production of bathroom fixtures, stainless steel kitchenware, and electrical-motor parts at the "repairs and mechanical plant" is to commence in 2000 and would create 125 jobs.
- Large numbers of nuclear workers are expected to transfer to the Tomsk Oil and Chemical Plant, which produces gasoline from crude oil for local use. At present, the plant employs 1,300 workers. If growth expectations are realized, its future employment is projected at 3,000-4,000.
- As the Russian economy improves, SKhK managers plan to scale-up the production of high-energy magnets, ultra-dispersed powders, and stable isotopes.

The city administration also supports projects that create jobs and promise additional revenues to the city budget. In 1998, for example, the city administration helped to establish an asphalt plant, bakery, and brewery. The city's development program to 2005 includes approximately ten projects outside of SKhK, including the production of agricultural equipment, valves, plastics, and concrete. An increasing number of people (6,500 in 1996) commute to work in the regional center of Tomsk.

Siberian Chemical Combine Workforce

	1980s	**2000**	**2005** (projected)
Total	20,000	15,000	?
Weapons Programs	?	5,000? (including plutonium production workers)	None ?

Siberian Chemical Combine: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
HEU production [PAST] Plutonium production for weapons [PAST] Fabrication of HEU and plutonium components [PAST] Fissile material storage and management?	Still operating two plutonium-production reactors to produce heat and power Environmental cleanup and management Facility decommissioning Disposition of enrichment tails Fissile material storage and management	HEU downblending Uranium (including reprocessed U) purification and enrichment Uranium conversion Stable-isotope (B^{10}) separation* Nuclear power plant construction and operation*	Oil refinery operation (Tomsk Oil and Chemical Combine) Electricity/ heat production Production of consumer goods Production of high-purity materials* Production of ultra-fine powders* Production of chemical power sources*

Zheleznogorsk (Krasnoyarsk-26)

Population

Zheleznogorsk (Krasnoyarsk-26) currently has a population of 102,000 persons, 2,000 more than in 1995. The working population is 52,000 and the number of retirees is 24,700. Approximately half of the working population is employed by three major enterprises: the Mining and Chemical Combine (MCC) nuclear complex, a satellite development and manufacturing facility (Production Association of Applied Mechanics), and the construction firm SibKhimStroy. At present, the three facilities employ respectively 9,500, 5,900, and 4,000 workers. During the past ten years, these three facilities lost approximately 10,000 workers. However, as of 2000, the city had 770 registered unemployed, 84 percent of whom were women.[36] Both the nuclear complex and the satellite facility presently employ more people than they need to meet their production requirements. The city needs to create an estimated 5,000-7,000 new jobs to absorb these and other excess workers.

Principal Nuclear Organization

The Mining and Chemical Combine (MCC) is one of Russia's three plutonium production centers. Two of its three plutonium production reactors were shutdown in 1992. A third reactor is kept in operation to provide heat and electricity for the nearby populations. The continued operation of this reactor produces now unwanted separated weapon-grade plutonium as a byproduct. Since October 1994, this plutonium has been placed in on-site storage. The U.S. Department of Defense and Minatom have launched a joint project to either replace the reactor with fossil-fueled plants or convert it to a fuel that can be stored without reprocessing. After this is achieved, plutonium storage (and later disposition) and environmental cleanup and waste management will be major missions for many years. The facility is also interested in being involved in a major new nuclear enterprise: the storage and disposition of foreign spent power-reactor fuel. Over 1,000 metric tons of spent fuel from Soviet designed Ukrainian and Russian 1000-MWe light-water reactors (VVER-1000s) are already stored in a partially-completed reprocessing facility on which construction was suspended in 1990. However, the law would have to be changed to allow Russia to import foreign radioactive waste and the United States opposes the reprocessing in Russia of foreign spent fuel, much of which is subject to U.S. "prior-consent" agreements.

Approximately half of MCC's 9,500 workers are involved in its plutonium-production operation. The shutdown of the first two reactors did not result in significant personnel reductions as many workers were transferred to reactor monitoring and disassembly operations or moved to other jobs in the nuclear complex. A shutdown of the third reactor is projected to result in a loss of over 2,600 jobs (within six years after shutdown) at the reactor and reprocessing plants. Additional jobs would likely be lost in the support divisions. Approximately 1,000 more jobs would be lost after the decommissioning of plutonium facilities.

[36] *RFYaTs -VNIIEF Information Bulletin*, Issue 3, VNIIEF Analytical Nonproliferation Center, Sarov, Fall 2000, p. 47. However, according to the statement of a city representative at the June 2000 Obninsk workshop, the number of unemployed persons was 4,000.

Defense Conversion and Economic Development In Zheleznogorsk

Strategic defense-conversion projects for the MCC, designed to prevent its shutdown, include a spent fuel storage facility, the Silicon of Siberia complex (to produce electronics- and solar-cell-grade pure silicon), and a new nuclear district heating plant. Smaller projects have been proposed to reduce social and economic burden on MCC by providing diverse jobs to excess workers. With encouragement from the NCI and in cooperation with Sandia National Laboratory, the MCC and the city administration have developed an accelerated conversion plan that could generate an estimated 1,000-2,000 jobs for an estimated $10.5 million investment.

The city administration has undertaken several steps to improve the social and economic situation in the city and to facilitate defense conversion. In 1998 and 1999, it provided tax breaks of RR 48 and RR 87 million respectively to the city's major facilities for the purpose of creating and saving jobs. (An estimated 1,800 jobs was saved as a result.) A special "City" fund was also set up to fund the development of the city's infrastructure and support job creation. It is expected that city-sponsored projects will create 1,000 jobs by 2004. Proposed city projects include the production of building materials, ceramic glaze, and food packaging materials; woodworking; and production and processing of food (bread, confectionery, diary products) and tobacco.

The city has sufficient buildings outside of MCC's secure area to accommodate both MCC defense conversion projects and other businesses. It is also proposed to establish a techno-park in Zheleznogorsk.

Mining and Chemical Combine Workforce

	1980s	**2000**	**2005** (projected)
Total	11,000	9,500	?
Weapons Programs	?	4,000? (including plutonium-production workers)	None ?

Mining and Chemical Combine: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
Plutonium production [PAST] Plutonium storage and management?	Still operates one plutonium-production reactor to produce heat and power Environmental cleanup and waste management Facility decommissioning Fissile material storage and management Plutonium disposition*	Spent fuel storage (wet) International spent fuel storage (dry)* Spent fuel reprocessing*	Production of: - rare-earth metals - pure aluminum - medical bandages - pharmaceutical products - equipment for aluminum industry - asbestos-silicate materials - mercury lamp recycle - thermo-electric modules - canola oil - forage grain - semiconductor silicon (Silicon of Siberia)* Creation of a city telecom network Atomlink Construction of a new nuclear power plant*

Novouralsk (Sverdlovsk-44)

Population
Novouralsk has a population of 96,000 people. As of April 2000, the city had 2,000 unemployed (down from 3,500 in 1999) or approximately 3.7 percent of the population.[37]

Principal Nuclear Organization
The Urals Electro-Chemical Combine (UEKhK) is Russia's largest enrichment facility. The combine comprises an enrichment sector, an equipment production sector, support units (including repairs, power, and transportation), and a social infrastructure. The equipment-production sector manufactures automatic and instrumentation and control equipment for all of Russia's isotope enrichment facilities.

The enrichment complex employs approximately 15,000 workers. No layoffs have occurred so far. There is, however, a problem of worker aging. As of June 2000, approximately 2,000 workers were of post-retirement age. An additional 1,000 workers are expected to reach retirement age by 2003.

Defense Conversion and Economic Development In Novouralsk
Defense conversion at UEKhK began in the late 1980s as the Soviet Union terminated the production of HEU for weapons. This process coincided with the transition of the Russian enrichment industry from gaseous diffusion to centrifuge enrichment technology. The facility's gaseous diffusion barrier manufacturing plant, the only facility of its kind in Russia, lost approximately 1,000 jobs. During the 1990's, orders from Russia's other enrichment plants for instrumentation and control equipment, which in the past accounted for up to 90 percent of equipment output, dropped to 15-25 percent of their earlier levels.

To address the problem of gaseous diffusion barrier workers, UEKhK established two plants that produce catalytic converters and batteries for the automobile industry and nickel-cadmium batteries. Another equipment-sector conversion project has been the production of food-processing equipment, including ice cream freezers and equipment to produce ice cream and soft cheeses.

A major source of unemployment in Novouralsk has been reductions in construction-industry employment from 12,500 workers to 4,000 workers.

The city's plans call for the creation of over 3,000 new jobs and preservation of over 8,000 existing jobs. It has developed a list of projects, including wood processing, production of construction materials and production of medical solutions, that require an estimated RR 442 million ($18 million) investments and would create an estimated 660 jobs in the first two to three years. The new businesses would be established outside of nuclear facility's secure area.

[37] *RFYaTs -VNIIEF Information Bulletin*, Issue 3, VNIIEF Analytical Nonproliferation Center, Sarov, Fall 2000, p. 47.

Urals Electro-Chemical Combine Workforce

	1980s	**2000**	**2005** (projected)
Total	15,000	15,000	15,000
Weapons Programs	10,000?	None	None

Urals Electro-Chemical Combine: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
HEU production [PAST] CURRENTLY NO DEFENSE MISSION	Environmental cleanup and waste management Disposition of enrichment tails Uranium storage	HEU downblending Uranium enrichment	Production of - fuel cells - instrumentation and control equipment - car batteries - compressors and power equipment - electrical equipment - catalytic converters - food processing equipment for ice cream and soft cheeses - farm products

Zelenogorsk (Krasnoyarsk-45)

Population
Zelenogorsk has a population of 70,000 people. Approximately 35,000 of them are of working age and the rest are children and pensioners. Pensioners account for a significant fraction of the population. As of April 2000, there were 1,083 registered unemployed persons or 3 percent. In addition to the enrichment facility, the city has a large hydro and fossil-fuel power plant GRES-2 (1.42 GW), and a chemical production complex (SibKhimVolokno). There are also 622 small businesses in the city, mostly joint-stock or privately owned.

Principal Nuclear Organization
The Electro-Chemical Plant (EKhZ) is Russia's second largest uranium enrichment facility. In 1989, the Soviet government terminated the production of HEU for weapons. In 1991, the combine shut down its last gaseous diffusion enrichment plant (which also was the HEU production cascade) and downsized some of the enrichment complex's support services.

The newer gas-centrifuge enrichment plant continues to produce enriched uranium for Russia's power plants, and SWU/LEU exports (including under the U.S.-Russian HEU agreement). The total employment at EKhZ is approximately 10,000 workers including those working in support and social services. Future employment is projected to remain at the current level.

Defense Conversion and Economic Development In Zelenogorsk
Approximately 200 enrichment workers, who previously worked at the gaseous diffusion plant, were reoriented to the dismantlement and decontamination of its production equipment and some of them have since retired. The gaseous diffusion building was subsequently converted to accommodate a video- and audio-tape manufacturing plant. This is the principal non-nuclear defense conversion project within the enrichment complex

In addition, the enrichment complex has assisted in the establishment of commercial enterprises in Zelenogorsk's residential area, including: production of electrical meters (with day and night scales), assembly of TV sets, and production of car parts for car-repair centers in the Krasnoyarsk region and surrounding areas. These enterprises provide jobs for excess workers (many of them women) from the EKhZ's support and social-services units. Altogether, approximately 1,200 jobs have been created.

The current problem of unemployment in Zelenogorsk is primarily due to the bankruptcy and closure of the SibKhimVolokno synthetic-cotton plant and difficulties in the construction combine. The SibKhimVolokno plant was established in the 1980s to produce synthetic cotton for the military. It employed approximately 4,000 workers. In the early 1990s, defense orders for SibKhimVolokno largely ceased and product was not competitive in the civilian market. SibKhimVolokno's bankruptcy affected approximately 12,000 people in Zelenogorsk (assuming a three-person family per worker).

Economic difficulties also began for the city's construction company in the early 1990s, as the nuclear facility's construction projects were cut back. As a result, the construction

combine broke up into several smaller joint-stock enterprises. Many of them were unable to survive, however, and were taken over by the enrichment complex in order to prevent massive layoffs and social problems.

The city administration of Zelenogorsk has been relying primarily on EKhZ in its efforts to create new jobs. The enrichment complex also accounts for the lion's share of tax revenues for the city budget. In addition, the city administration has developed a program of job creation that would include the manufacture of medical products and services, coal cleaning, waste incineration, and bicycle production. This program would require an estimated $15 million in investment and is projected to create over 1,000 new jobs, which would eliminate the social and unemployment problems in Zelenogorsk within two or so years.

Electro-chemical Plant Workforce

	1980s	**2000**	**2005** (projected)
Total	10,000	10,000	10,000
Weapons Programs	?	None	None

Electro-chemical Plant: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
HEU production [PAST] CURRENTLY NO DEFENSE MISSION	Environmental cleanup and waste management Disposition of enrichment tails	HEU downblending Uranium enrichment Separation of stable isotopes	Production of - VCR and audio tapes - TV sets and consumer electronics - electric meters - telephones - car parts

Lesnoy (Sverdlovsk-45)

Population: 58,000
Primary Facility: Electrokhimpribor

Electrokhimpribor (Electrochemistry Combine) Workforce

	1980s	**2000**	**2005** (projected)
Total	10,000	10,000?	?
Weapons Programs	?	7,000-10,000?	5,000?

Electrokhimpribor: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
HEU production [PAST] Lithium-6 separation [PAST] Warhead assembly and disassembly Fissile material storage?	Environmental cleanup and waste management	Separation of stable isotopes	Production of - neutron generators for oil/gas industries down-well logging - consumer goods (bicycles etc) - valves for oil/gas industries - SF_6 power-switches - aluminum rims for car wheels - cutting tools coated with diamond-chromium powder - ultra-dispersed diamond powders - Gold Star TV sets (jointly with S. Korea)

Trekhgorny (Zlatoust-36)

Population: 33,000
Principal Nuclear Organization: Device-building Plant (PSZ)

Device-building Plant Workforce

	1980s	**2000**	**2005** (projected)
Total	6,400?	6,400	5,000
Weapons Programs	6,400?	3,600	2,800

Device-building Plant: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**
Warhead assembly and disassembly Fissile material storage?	Environmental cleanup and waste management	Depleted uranium processing and fabrication	Production of nuclear power-plant instrumentation and control equipment Production of ATS-400 phone switching stations Production of footwear Production of bathroom equipment Production of polyethylene pipes Reconditioning of electrical tram-cars Development of a ski-resort*

Zarechny (Penza-19)

Population: 64,000
Principal Nuclear Organization: PO START
Other Significant Organization: NIKIRET (branch of Eleron, Moscow, Minatom's leading designer and producer of physical security equipment)

START Workforce

	1980s	**2000**	**2005** (projected)
Total	11,000?	10,000	?
Weapons Programs	?	7,000-10,000	Several hundreds?

START: Major Activities

Nuclear-Weapon Missions	**Non-commercial**	**Commercial Nuclear**	**Commercial Non-nuclear**[38]
Warhead assembly [PAST] Warhead dismantlement [TO END IN 2003] Non-nuclear nuclear-weapon component manufacturing?			Production of - security equipment - car components (for GAZ plant) - lathe machines - instrumentation and control equipment for gas pipelines - communication equipment - energy-efficiency equipment - medical equipment - food - road construction

[38] In part based on communication with Anatoli Diakov, March 2000.

APPENDIX 2. DOWNSIZING RUSSIA'S NUCLEAR-WARHEAD-PRODUCTION INFRASTRUCTURE

By Oleg Bukharin

Over a period of 50 years, the Soviet Union built a giant infrastructure to design, manufacture, and maintain nuclear bombs and warheads for a wide variety of strategic and tactical nuclear weapons delivery systems (see Table A2-1). This nuclear-weapons-production complex was developed as a self-sufficient, vastly redundant, and integrated organization, which was managed centrally in a highly secretive fashion.

At present, the complex is managed by the Ministry of Atomic Energy (Minatom) and consists of 17 research institutes and manufacturing facilities (see Table A2-2).[39] The complex remains oversized and is still configured for the Cold War. The downsizing of the complex, however, is inevitable. The strategic rationale for maintaining such a massive weapons production infrastructure is gone and, in any case, Russia's economy is no longer capable of supporting the Cold War complex. In fact, its technical infrastructure has already been contracting because of aging and lack of maintenance, and its pool of scientific and technical talent has been shrinking due to economic retirements and the difficulty of recruiting high-quality talent.

Russia must therefore develop and implement a strategy for downsizing and consolidation of the weapons complex that:

- Maintains a continued ability of the complex to fulfill core missions;
- Synchronizes downsizing with nuclear-warhead stockpile reductions;
- Removes classified equipment and materials, cleans up as many facilities as possible to make them available for defense conversion or other forms of economic development; and
- Where complete demilitarization is not possible, separates defense and non-defense activities physically, and in the budget and management structure.

The alternative to such an orderly transition would be the complex's continuing decay without consolidation, which could eventually undermine Russia's nuclear capabilities, increase the likelihood of a major nuclear weapon or facility accident, and dim the prospects for economic development of the surrounding communities.

The trajectory of the Russian warhead production complex is also of critical importance to the United States and other western nations for a number of reasons:

[39] The weapon-complex facilities are managed by three Minatom departments: Nuclear Fuel Cycle (formerly 4th Main Directorate), Nuclear Weapons Development and Testing (formerly 5th Main Directorate), and Nuclear Weapons Production (formerly 6th Main Directorate). Another facility of the complex, the Novaya Zemlya Test Site, is managed by the Ministry of Defense.

- Keeping an oversized warhead production complex perpetuates the fear that, if political and economic circumstances change, Russia could rapidly rebuild its huge nuclear stockpile;
- A decaying massive complex undermines efforts to secure hundreds of tons of HEU and plutonium and increases risks of proliferation of nuclear weapons technologies and expertise; and
- Business development and nonproliferation cooperation remain impeded by restricted access and investment limitations.

The optimal configuration of the complex must be determined by Russia. In fact, the Russian government has reportedly developed a complex restructuring program.[40] It is likely, however, that the current plan is based on START II levels for strategic warheads. In reality, Russia's strategic weapons delivery capacity is expected to decline to much lower levels by 2005-2010 because of lack of funding for new strategic-weapons launchers and missiles; funding is likely to remain scarce for warheads as well. It is therefore important to start considering deeper reductions of Russia's-weapons production infrastructure.

Based on public information about Russia's weapons program, this Appendix discusses the complex's nuclear weapons missions and associated infrastructure requirements, reviews the developments in the complex to date, and outlines a possible long-term strategy for restructuring and consolidation (see Figure A2-1).

DOWNSIZING THE COMPLEX IN FOUR PHASES

The missions of the Russian warhead production complex after the Cold War may be summarized as follows:[41]

- Stockpile surveillance and refurbishment;
- Warhead life extension;
- Dismantlement of retired warheads;
- Weapon R&D to prevent surprise nuclear weapons science breakthroughs in foreign countries; and
- Support to arms control and non-proliferation initiatives.

The complex will not be able to execute these missions without specialized facilities for nuclear weapons R&D and non-nuclear testing, tritium production and processing, fissile material component manufacturing, and warhead assembly and disassembly.[42] These critical

[40] The future of the nuclear weapons complex is discussed in several documents, including the program of armaments (which discusses Minatom's responsibilities to 2005), the federal program of increasing safety of nuclear weapons, and the programs of development and restructuring of the nuclear weapons complex and defense conversion. ("We Must Save the Best [Press-Conference with L. Ryabev]," *Gorodskoy Kuryer* (Sarov), March 5, 1998.)

[41] See, for example: P. Sukharevsky, "Minatom's Science and Technology Council No. 2 is 40," *Atompressa*, 25, July 1999, p. 1.

[42] The production of automatic, electronic and other non-nuclear warhead components, as well as the production of specialized manufacturing equipment also take place at specialized facilities of the weapons complex.

infrastructure requirements will drive planning of the size and configuration of the future weapons complex. In most cases the existing infrastructure still has redundant capabilities in each area.

The process of complex downsizing is divided here into four phases (see Figure A2-1): the initial phase of complex contraction, which is already largely over; the current phase corresponding to Minatom's ongoing efforts to downsize the complex; and two hypothetical future phases associated with further stockpile reductions. The infrastructure reductions are synchronized with notional stockpile reductions: from 35,000 warheads during the Cold War to approximately 10,000 warheads at present, to 5,000 deployed and reserved weapons by 2010,[43] and to 500 warheads in the more distant future. The objective of the two future phases of complex reduction would be not only to optimize the complex for reduced warhead arsenals but also to facilitate rapid demilitarization of as many facilities and locations as possible to make them available for international cooperation, defense conversion, and business development.

Phase I: Initial Contraction (late 1980s – late 1990s)

The initial phase of downsizing encompassed approximately ten years and can be characterized by the following three developments: the termination of HEU and plutonium production for weapons, defense conversion without complex restructuring, and spontaneous contraction of the weapons capabilities.

Termination of defense orders for new fissile materials effectively expelled the uranium enrichment and plutonium production plants from the weapons program.[44] As a result, no nuclear weapons activities presently take place in three closed nuclear cities: Sverdlovsk-44, Krasnoyarsk-45, and Krasnoyarsk-26. They remain critical, however, to the mission of storing and managing hundreds of tons of fissile materials, some of which may be kept as a part of Russia's strategic reserves. (According to Minatom officials, the Krasnoyarsk-26 plutonium complex remains officially a part of the weapons complex.)

By the late 1980s, the Soviet government had become aware of the need to scale down the remainder of the nuclear-weapons program. It appears, however, that the initial plan was to downsize but not restructure the complex. In other words, defense activities were to continue at every facility but at a reduced level. Defense-conversion programs were developed to redirect excess workers and equipment to civilian work. Most defense-conversion efforts, however, failed because of insufficient investments, the collapse of

[43] This assumes 1,500 strategic, 3,000 tactical, and 500 reserve and spare warheads. Strategic reductions would occur due to the retirement of strategic delivery systems (such as ICBMs, bombers, and SSBNs). In the absence of new production, the tactical stockpile would also decline because no mass-production of tactical weapons has taken place since the late 1980s and because many warheads would reach the end of their service life of ten or so years.

[44] Instead, they provide uranium enrichment and spent fuel management services to domestic and foreign customers and are involved in a variety of other nuclear and non-nuclear commercial activities. All of these facilities, with the exception of the plutonium-production center in Krasnoyarsk-26, are also involved in the HEU downblending work under the 1993 U.S.-Russian HEU agreement.

Russia's domestic markets, lack of entrepreneurial and market skills, secrecy, inflexible institutional bureaucracies, and high production costs.

As a result, the reductions have been largely spontaneous as many younger workers left for commercial jobs and some capabilities degraded or were shut down due to inadequate maintenance and insufficient financing. Although infrastructure deterioration and personnel attrition have already made the complex much less capable, it remains oversized and, with the exception of the separation of the HEU and plutonium production facilities, it has not changed structurally.

Phase II (Late 1998 – 2005): Minatom's 1998 Program

It was not until after the mid-1990s that Minatom and its facility managers accepted the fact that weapons program cutbacks were irreversible and that a serious downsizing effort was needed if the complex was to survive in the new environment. Such an effort was launched and it appears that its main objective is to reduce facility duplication, and spin off from the down-sized complex facilities that it no longer needs. A second, companion objective has been to create civilian jobs for excess defense personnel.

Minatom's plans were formalized in the program, "On Restructuring and Conversion of the Nuclear Weapons Complex in 1998-2000," adopted by the Russian government in June 1998 as a part of a broader plan to restructure Russia's defense industries. The program and other planning documents call on Minatom to:

- End warhead assembly at the Arzamas-16 and Penza-19 serial production facilities by 2000 and end warhead dismantlement at these same facilities in 2003;
- Transfer production of certain non-nuclear warhead components and assemblies to the pilot production plants of the warhead R&D institutes by 2000;
- Consolidate weapons work at the remaining non-nuclear component manufacturing facilities by 2000; and
- Phase out nuclear weapons work at one of the two fissile component production plants in 2003.

Downsizing is also planned for individual facilities and would involve defense personnel reductions and consolidation of weapons activities in fewer buildings and production areas. For example, the number of defense program personnel at the warhead assembly facility in Zlatoust-36 is expected to decrease from 5,766 in 1997 to 2,800 in 2001.[45] At the Urals Electro-Mechanical Plant in Yekaterinburg, which produces nuclear warhead electronic components, the plan is to split the facility into two separate entities.[46] The weapons part would be located in a single building and would retain about one third of the equipment and infrastructure. It would be supported exclusively by defense-order funding. The remainder of the plant would have to support itself by producing and selling

[45] "Trekhgorny's Plans," *Atompressa*, 13 (344) April 1999, p. 3.
[46] S. Sachkova, "Hopes of Defense Workers," *Atompressa*, No. 46 (377), December 1999, p. 3.

commercial products on the open market. The weapons program employment would decline from the Cold War level of 12,000 to 1,500.

Certain steps have already been taken. All research institutes and production plants of the weapons complex have developed and are working to implement facility-level restructuring programs. Essentially no weapons work is taking place at the Molnia plant in Moscow. The production association Sever in Novosibirsk, a nuclear warhead electronic components and subassemblies production facility, has already consolidated all weapons work in a single technical area and reduced defense program staff.[47] This facility is to be out of the weapons complex by 2005-07. Warhead assembly work has ended in the AVANGARD plant in Arzamas-16 and its primary weapons function at present is warhead dismantlement.[48] The Penza-19 facility reportedly has no defense orders and the closed city is on the verge of becoming open.[49] Tomsk-7 has also essentially become a civilian nuclear-technology center.

If successful, the implementation of Minatom's program would be a major step in the right direction. Nuclear weapons work would be concentrated in five closed cities: Arzamas-16, Chelyabinsk-70, Sverdlovsk-45, Zlatoust-36, and Chelyabinsk-65. The complex, however, would likely remain oversized relative to the projected 2005-2010 arsenal of 5,000 warheads. Also, compared to the United States, it would employ considerably more people and include twice as many sites (see Table A2-2). It should be noted, however, that there are significant differences in technical approaches and stockpile surveillance and management practices in the two countries (see Table A2-3). These differences help explain why the Russian complex requires more people and infrastructure to support a comparable-size stockpile. Given the much lower Russian labor costs and lack of funds for costly equipment, this may be rational.

Phase III (2005 – 2010): Complex 2010

The objective of the third phase of consolidation should be to create a complex that is optimized for supporting a stockpile of 5,000 warheads. Assuming a warhead life of 25 years, the complex would have a capacity to remanufacture approximately 200 warheads per year. Phase III would begin immediately after the current effort is completed and would likely require five to ten years to implement. A possible approach to Phase III reductions would be to:

- Consolidate warhead assembly and disassembly operations at one facility – most likely Sverdlovsk-45, Minatom's leading serial production facility; and
- Transfer the production of electronic, mechanical and other non-nuclear components and equipment to Sverdlovsk-45, as well as to the Institute of Automatics in Moscow and the federal weapons research centers in Arzamas-16 and Chelyabinsk-70.

[47] A. Gorb, "PO 'Sever' in the Program of Restructuring and Conversion of the Nuclear Industry," *Atompressa*, No. 1 (378) January 2000, p. 3.
[48] The assembly of the last warhead at the AVANGARD Plant was finished on December 30, 1997. Yuri Zavalishin *"Avangard" Atomic*, Krasny Oktyabr': Saransk, 1999, p. 292.
[49] L. Saratova, "How do You Live, the Weapons Plant?" *Gorodskoy Kuryer*, No. 3, January 23, 1999.

Because of tight budgets and reductions in the number of types of warheads (due to retirement of certain classes of delivery systems), the Russian government will likely remain under pressure to consolidate the R&D centers in Arzamas-16 and Chelyabinsk-70. Indeed, proposals to phase out defense work in Chelyabinsk-70 have already been made.

Closing down one of the two research centers could be counterproductive, however. Each has unique facilities and responsibility for its own set of warheads. For example, VNIITF in Chelyabinsk-70 has designed all Russia's gravity bombs and SLBM warheads, and VNIIEF in Arzamas-16 has designed the warhead carried by the single-warhead SS-25 and SS-27 missiles, the only ICBMs that Russia will retain after the implementation of START II. Moreover, the relative significance of the warhead design centers in the Russian nuclear weapons complex will increase in the down-sized complex if the relatively small-scale production of warhead components is transferred to the pilot production plants associated with the two institutes. The two federal centers could also assume responsibility for the weapons work that is currently performed at smaller R&D institutes in Moscow and other open cities.

Minatom should, however, work to increase cooperation between VNIITF and VNIIEF to reduce the duplication of experimental and research facilities. Minatom officials have already stated that most new facilities will be constructed in VNIIEF and would not be duplicated in VNIITF.[50]

If Phase II of complex downsizing is primarily intended to reduce the extent of duplication by shutting down excess capacity, Phase III would consolidate weapons activities at fewer core facilities by relocating certain weapons functions to these facilities and demilitarizing the donor facilities. As a result, nuclear-weapons activities would continue in only four closed cities and at a few facilities in open cities. At this scale, the Russian weapons complex would become roughly comparable to the U.S. nuclear-weapon complex (see Table A2-2).

Phase IV: Deep Reductions

Phase IV consolidation of the weapons infrastructure would occur some time in the future in response to stockpile reductions to a hypothetical level of 500 warheads. Such deep reductions would not be possible without an international arms control agreement between all nuclear weapons states that would require parallel and verifiable reductions of U.S. and Russian nuclear arsenals and the corresponding production infrastructures.

In Russia, Phase IV reductions could be implemented by consolidating all critical stockpile activities in Arzamas-16 and/or Chelyabinsk-70. (It might be necessary to maintain the tritium production capability in Chelyabinsk-65 but, with such deep cuts, the need in new production could be delayed almost indefinitely.) Both institutes are already well equipped for the mission. VNIITF in Chelyabinsk-70, for example, has both a tritium processing line

[50] "We Must Save the Best (Press-Conference with L. Ryabev)," *Gorodskoy Kuryer* (Sarov), March 5, 1998.

and fissile materials processing capabilities.[51] And its two pilot production plants are capable of producing high-explosive, beryllium, and various electronic and mechanical components, as well as assembling physics packages and warheads. Comparable capabilities presumably exist in VNIIEF in Arzamas-16 as well. The serial production facility in Sverdlovsk-45 would in this scenario be demilitarized and converted to civilian uses after completing the task of eliminating excess warheads.

GETTING IT DONE

The above description of phases III and IV lays out a rational approach of consolidating Russia's nuclear weapons-work in the smallest number of facilities possible, based on a cost-benefit analysis of the existing infrastructure, future missions, and stockpile and funding projections. In reality, however, there are a number of obstacles that could delay the downsizing and restructuring of the complex:

- The fate of the excess workers;
- Funding shortages;
- Political resistance; and
- Arms-control uncertainties.

The fate of the excess workers. The continuing crisis of the Russian economy and insufficient foreign investment will continue to make it difficult to create new non-weapons jobs in the nuclear facilities and promote economic development in the local communities.

Funding shortages. Workforce reductions due to retirement, personnel losses to the commercial sector, and minimizing new hiring could relieve the problem of excess workers in five to ten years. However, defense conversion and redirection of excess workers, health services and pensions for retirees, and consolidation of weapons activities in fewer facilities will all require considerable funding. Until the national economy recovers, the Russian government will not be able to finance complex downsizing activities at a sufficient scale.

Political resistance. Unless attractive non-military jobs are created, a decision to terminate defense orders at a large production facility, especially in a closed city, would be politically unpopular and would encounter opposition from facility workers, in the local communities, in the regions, and in the Russian Duma. Pressure from these groups, compounded by the creeping anti-Western sentiment and nationalism, is likely to slow down the downsizing process.

Arms control uncertainties. Conditions imposed on START II implementation by the Russian Duma and the U.S. Congress, and U.S. Senate's rejection of the CTBT create considerable uncertainties with respect to future stockpile reductions and complicate the planning of complex downsizing. In the absence of binding arms-reduction agreements, the Russian government would be pressed politically to maintain an option and the

[51] *Russian Federal Nuclear Center All-Russian NII of Technical Physics: Scientific and Information Review*, RFYaTs-VNIITF: Snezhinsk, 1998, p. 48.

corresponding warhead-production infrastructure for a buildup of its nuclear stockpile and weapons R&D in case of a "national emergency." There have already been proposals to develop and mass-produce new tactical weapons in response to the NATO expansion, and to initiate a weapons R&D effort aimed at countering the potential deployment of a U.S. national missile defense.

These difficulties are serious and, unless the Russian, U.S. and other governments provide strong leadership and political support and sufficient funding to facilitate nuclear reductions, the possibility that Russia's weapons complex continuation will continue its steady decay without down-sizing cannot be ruled out.

High-level policy support and technical cooperation by the United States in the areas of complex re-structuring must become an integral element of the down-sizing effort. The U.S.-Russian nuclear relationship will be a major determinant in the reshaping of Russia's warhead-production complex. Greater transparency of nuclear activities in both countries and expanded cooperation are thus critical for developing rational, post-Cold-War nuclear policies.

Table A2-1. **The Soviet Union's Nuclear Weapons Production Complex in the Mid-1980s**

Facility/ Location	Nuclear-Weapons-Production Functions
Minatom's Nuclear Fuel Cycle Department (formerly 4th Main Directorate)	
Siberian Chemical Combine in Seversk (formerly Tomsk-7)	Plutonium production HEU production Fabrication of HEU and plutonium weapon components
Production Association "Mayak" in Ozersk (Chelyabinsk-65)	Plutonium Production Tritium production of Fabrication of HEU and plutonium weapon components
Mining and Chemical Combine in Zheleznogorsk (Krasnoyarsk-26)	Plutonium production
Urals Electro-Chemical Combine in Novouralsk (Sverdlovsk-44)	HEU production
Electro-Chemical Plant in Zelenogorsk (Krasnoyarsk-45)	HEU production
Minatom's Nuclear Weapon Development and Testing Department (5th Main Directorate)	
Institute of Experimental Physics, VNIIEF in Sarov (Arzamas-16)	Nuclear warhead design Stockpile support
Institute of Technical Physics, VNIITF in Snezhinsk (Chelyabinsk-70)	Nuclear warhead design Stockpile support
Institute of Automatics, VNIIA in Moscow	Design of non-nuclear components, Warhead engineering
Institute of Impulse Technologies, VNII IT In Moscow	Nuclear test diagnostics
Institute of Measurement Systems, NII IS in Nizhni Novgorod	Design of non-nuclear components
Design Bureau of Road Equipment, KB ATO in Mytischy, Moscow region	Nuclear warhead transportation and handling equipment
Minatom's Department of Nuclear Weapons Production (6th Main Directorate)	
Electrochimpribor in Lesnoy (Sverdlovsk-45)	Nuclear warhead assembly/disassembly
Electromechanical Plant "AVANGARD" in Sarov (Arzamas-16)	Nuclear warhead assembly/disassembly
Production Association "START" in Zarechny (Penza-19)	Nuclear warhead assembly/disassembly
Device-Building Plant in Trekhgorny (Zlatoust-36)	Nuclear warhead assembly/disassembly
Production Association "Sever" in Novosibirsk	Production of non-nuclear components
Production Association "Molnia" in Moscow	Production of non-nuclear components
Urals Electromechanical Plant in Yekaterinburg	Production of non-nuclear components
Nizhneturinsky Mechanical Plant in Nizhnyaya Tura	Production of non-nuclear components and support equipment
Kuznetsk Machine-Building Plant in Kuznetsk	Production of support equipment and non-nuclear components

Table A2-2. **U.S. and Russian Nuclear Weapon Production Complexes**

	U.S. DOE Weapons Complex Today[52]	**Russian Weapons Complex Today**	**Russian Complex In 2005-2010** (after Phase II)	**Russian Complex In 2010-2015** (after Phase III)	**Russian Complex After Deep Reductions** (after Phase IV)
Nuclear Weapons R&D	LANL LLNL SNL	VNIIEF/A-16 VNIITF/C-70 VNIIA KB ATO NII IS NII IT	VNIIEF/A-16 VNIITF/C-70 VNIIA KB ATO NII IS NII IT	VNIIEF/A-16 VNIITF/C-70 VNIIA	VNIIEF/A-16 and/or VNIITF/C-70
Tritium Production and Processing	SRS/ stockpile drawdown	C-65 + stockpile drawdown	C-65 + stockpile drawdown	C-65 + stockpile drawdown	VNIIEF/A-16 and/or VNIITF/C-70 + stockpile drawdown
HEU and Plutonium Component Manufacture	Oak Ridge Y-12 LANL	C-65 T-7[53]	C-65	C-65	VNIIEF/A-16 and/or VNIITF/C-70
Warhead Assembly/ Disassembly	Pantex	AVANGARD/ A-16 P-19 S-45 Z-36	S-45 Z-36	S-45	VNIIEF/A-16 and/or VNIITF/C-70
Production of Non-nuclear Components	KCP SNL LANL Pantex	Molnia UEMZ Sever N.Tura Plant AVANGARD/ A-16 P-19 S-45 Z-36	UEMZ AVANGARD/ A-16 P-19 S-45 Z-36	S-45 VNIIEF/A-16 VNIITF/C-70 VNIIA	VNIIEF/A-16 and/or VNIITF/C-70
Testing	NTS	NZTS	NZTS	NZTS	NZTS
Weapons Program Employment[54]	25,000	75,000	40,000	30,000	15,000-20,000

[52] Abbreviations for U.S. facilities: LANL (Los Alamos National Laboratory); LLNL (Lawrence Livermore National Laboratory); SNL (Sandia National Laboratory); KCP (Kansas City Plant); SRS (Savannah River Site); NTS (Nevada Test Site).

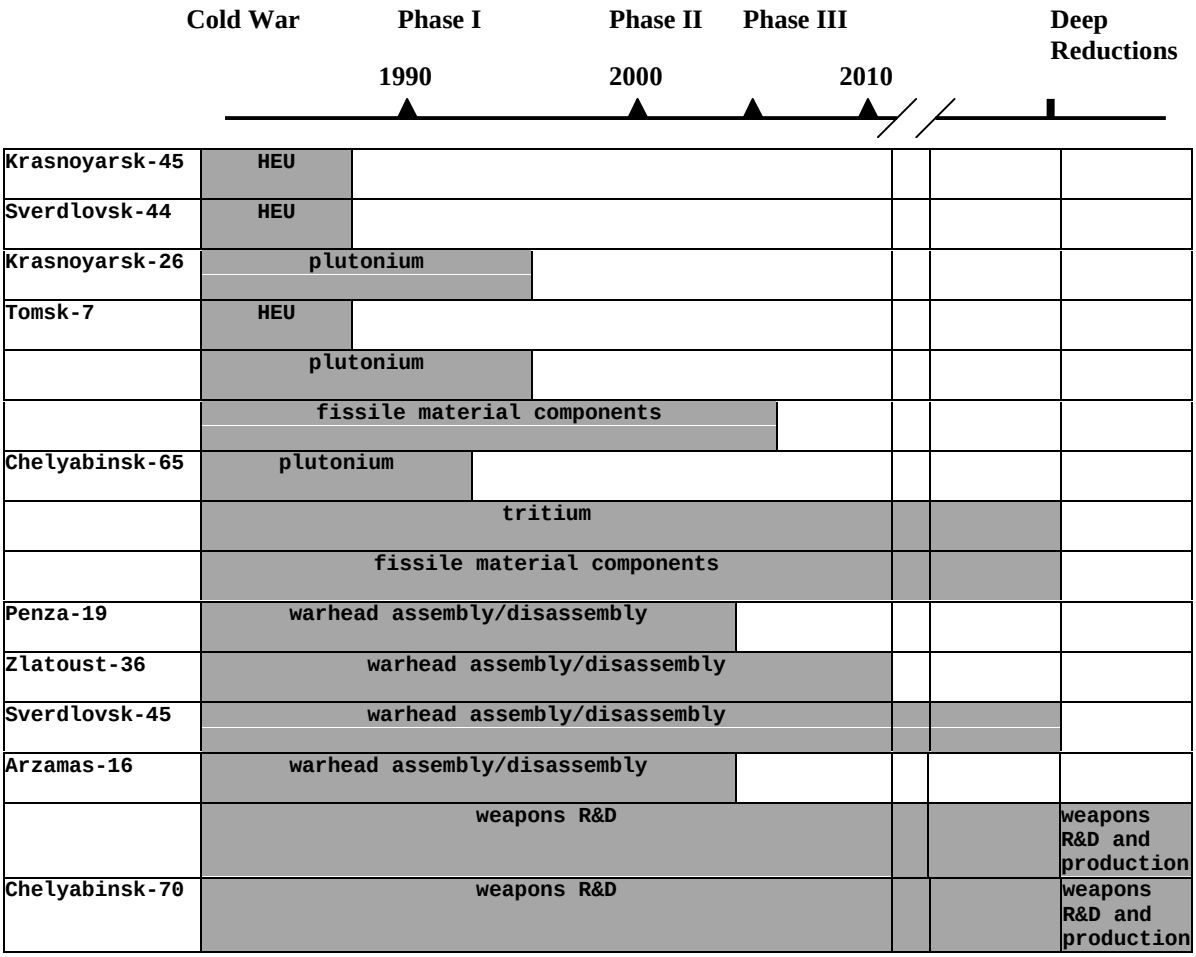
[53] Officially, Krasnoyarsk-26 also remains a part of the weapons complex. Presumably, its weapons mission is the management of strategic stocks of plutonium. It is, however, possible that the continuing operation of plutonium production reactors and reprocessing plants in Krasnoyarsk-26 and Tomsk-7 is listed by Minatom as defense-related work even if the new plutonium produced is not used in nuclear weapons.

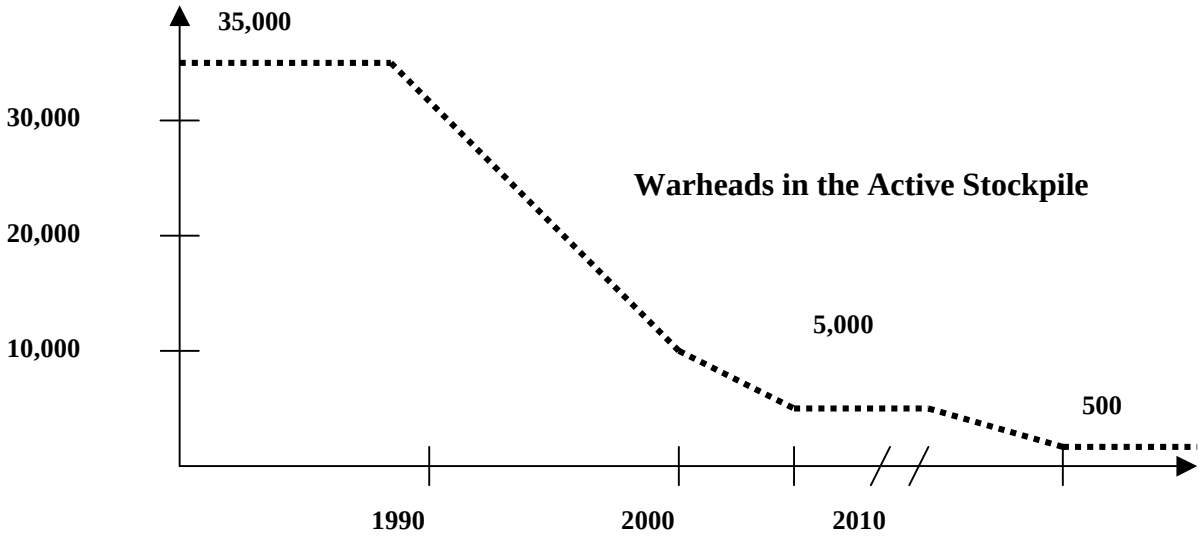
[54] Weapons program employment levels for the Russian complex after Phase III and Phase IV reductions are based on estimates for 2005 facility employment levels.

Table A2-3. **Some Differences Between the U.S. and Russian Nuclear-weapons Complexes**

Area of Differences	United States	Russia
Technology	Warheads more sophisticated; Pit and warhead lives are relatively long (possibly 50 and 25 yrs respectively)	Warhead designs less complex and more conservative (more fissile materials? and explosives) Warheads more maintenance-intensive Pit and warhead lives are relatively short (10-15 yrs)
Stockpile Management	Emphasis on surveillance and replacement of components as needed.	Emphasis on complete periodic re-manufacturing of nuclear warheads before problems of aging occur
Use of Commercial Off-The-Shelf Technologies	Significant for non-nuclear components (electronics, mechanical, materials)	Virtually 100 percent production of non-nuclear components and manufacturing equipment internally
Commercial vs Defense Programs	Separated	Integrated
Structure of Principal R&D Facilities	DOE national laboratories are primarily R&D centers with modest production capacities.	VNIIEF (Arzamas-16), VNIITF (Chelyabinsk-70), and VNIIA (Moscow) have pilot production plants that employ thousands of workers
Technology vs Labor	Reliance on computing and advanced technologies	Reliance on labor-intensive processes (e.g., greater role of analytical models and large manpower

Figure A2-1. **Closed City Demilitarization Timeline**





APPENDIX 3: WHAT ARE RUSSIA'S CLOSED NUCLEAR CITIES?

by Oleg Bukharin

The core elements of the Soviet nuclear weapons production infrastructure are situated in ten closed nuclear cities that were built for this purpose in the late 1940s-1960s. Five cities (Ozersk, Seversk, Zheleznogorsk, Novouralsk, and Zelenogorsk) were involved in the production and processing of plutonium and highly-enriched uranium (HEU) for the Soviet nuclear weapons program.[55] The other five (Sarov, Snezhinsk, Lesnoy, Zarechny, and Trekhgorny) were established to design and mass-produce nuclear weapons. As of 1998, in addition to ten Minatom's cities, there were 36 closed cities most of which were associated with Ministry of Defense's (MOD's) naval and missile bases, nuclear weapons storage facilities, space operations centers, and other sensitive installations.[56]

The closed cities were developed as self-sufficient communities that were managed by the nuclear facilities and had priority access to centralized sources of supply. In addition to specialized nuclear shops and laboratories, the facilities had farms, electric power and heating plants, specialized construction units, and education and training institutes. The nuclear facilities also provided social services: schools, healthcare, day-care, public transportation, and housing. Because the nuclear facilities and cities were built in a short period and according to a comprehensive construction plan, the residential areas were compact and well-planned. The original residential areas still contain wooden single and two-family houses built for senior scientists and officials as well as solid 3-story apartment buildings. However, many later developed areas of high-rise Soviet blocks similar to those found at other Russian cities.

With the end of the Cold War and the dramatic downsizing of Russia's nuclear weapons stockpile, some cities no longer have military tasks. For example, the weapons production mission for the fissile material production complexes in Novouralsk, Zelenogorsk, Zheleznogorsk and Seversk has essentially ended. They, however, will be responsible for storing, processing and disposing of the hundreds of tons of HEU and plutonium, and environmental cleanup and decommissioning of old defense facilities. Other cities will remain responsible for defense missions including the maintenance of Russia's reduced nuclear weapons stockpile and its nuclear-weapons expertise, dismantlement of retired nuclear warheads, and production of new ones. However, the level of their activities will be much reduced. For example, two of the four warhead assembly/disassembly facilities are to be shut down.

The Cold War rational for building closed nuclear cities was to prevent attacks by foreign militaries and to protect the secrets of sensitive nuclear installations. The existence of the cities was not officially made public until 1992. In 1992, the cities received new names and the Russian parliament passed the law on closed cities. Under the law, the cities received

[55] Another uranium enrichment complex was built in Angarsk, which is an open city. This facility did not produce HEU for nuclear weapons.

[56] Richard Rowland, "Secret Cities of Russia and Kazakhstan in 1998," *Post-Soviet Geography and Economics*, 1999, 40, No. 4, pp. 281-304.

a status of independent, federally-controlled "closed territorial-administrative units" (in Russian, ZATO).

The Law on ZATOs establishes that:[57]

- The closed cities are managed by the local governments (with federal control of the nuclear facilities);
- A special security regime establishes restricted and secure areas, access and residency limitations, and overflight restrictions;
- There are special arrangements for financing the cities; and
- There are social protection measures for their residents (for example, uniform health and property insurance against accidents at nuclear facilities).

The new rational for maintaining the closed status of the cities is to:

- Prevent crime and terrorism;
- Provide a secure environment for sensitive national defense activities;
- Protect state and military secrets;
- Prevent leakage of nuclear weapons expertise, materials, and technologies; and
- Assure public safety and environmental protection.

The phenomenon of closed cities is unique to Russia. An understanding of the special features of these cities – access limitations, population and employment patterns, financing arrangements, and governance – is essential to U.S.-Russian and international cooperation in the areas of arms control, non-proliferation, and regional and economic development.

SPECIAL SECURITY REGIME

The organization of and access control arrangements in the closed nuclear cities reflect the sensitive and hazardous nature of nuclear activities in these locations. The fissile material production complexes operate chemical engineering facilities, manage fissile and radioactive materials, and generate large amounts of radioactive waste. The nuclear-warhead research and production facilities store and handle special nuclear materials, explosives, nuclear warhead subassemblies, and intact nuclear weapons. Many facilities (especially the plutonium production complexes) are contaminated with radioactive materials and dangerous chemicals.

The closed nuclear cities represent an integral part of the layered system of safety and security around nuclear weapons facilities. Most cities are situated in remote locations, separated from regional centers and other large cities. Each city occupies a large restricted area (for example, 232 square kilometers in the case of Sarov) that is surrounded by double fences and is guarded by troops of the Ministry of Internal Affairs (MVD). Inside the

[57] See, for example, Vladimir Annenkov, Igor Zhidkov, Boris Pevnitskiy, and Dmitri Sladkov, "Legal Basis for Russia's Closed Cities," presented at Pugwash Conference, Sarov, July 17-18, 1998.

restricted area is a town for the facility workforce, large wooded areas, and several isolated technical areas that house primary research and production facilities, testing areas, and a support infrastructure. Technical areas within the restricted area are surrounded by their own double or triple fences patrolled by armed guards.

Access limitations have always been a significant feature of closed cities. Originally, only weapons-program personnel could visit the cities. It was not until in the 1950s that closed cities' residents were allowed to leave the cities for vacation or family business. Over the years, access restrictions have been somewhat relaxed. Local residents now have special passes and can travel in and out of their city at will including to their weekend "dachas" (cottages with garden plots or in the forest) and to the farmer's markets that spring up outside the city gates on weekends.

Article 4, Section 2 of the Law on ZATOs

Local ZATO government organs, with the agreement of federal security organs, have the right to permit citizens to enter and exit ZATOs, excluding the territory on which the facilities and other objects are located.

The number of outside visitors, including those coming for cultural, business and sports activities, has increased dramatically. For example, 27,000 persons visited Sarov in 1997 as compared to 7,000 in 1990.[58] Since 1989, most cities have been visited by foreigners. However, as of 1999, no foreigners have visited the serial warhead production sites of Trekhgorny and Lesnoy.[59]

Access limitations, however, remain. Specific access guidelines, which are developed by Minatom and federal security agencies, are not publicly available. It appears, however, that the following general rules apply:

- Visitor identities are checked and vehicles are searched for contraband at city-perimeter access control points.
- Visitor permits are issued by the city administration and are subject to approval by the Federal Security Service (FSB).
- Applications for a visitor permit by Russian citizens are usually processed in one day.
- A person can be granted residency only if he/she is hired by the primary facility or is a close relative of city resident. The residency permit must be approved by the FSB.
- Foreigners typically have to apply 45 days in advance to receive a permission to enter a closed city. In certain cases foreign visitors can be granted a multiple-entry permit and be admitted to the city on a two-week notice thereafter.
- Foreigners must be escorted at all times.[60]

[58] L. Saratova, "Freedom for the Free; Regime for Sarov," *Gorodskoy Kuryer,* April 2, 1998.
[59] Representatives of the Sandia National Laboratories have visited the physical protection design institute NIKIRET (a branch of the Moscow-based Eleron facility) in Zarechny.
[60] In some cities, this restriction has been relaxed and foreigners are allowed to move on their own within a limited area within the city's center.

The security regime also limits economic activities in the closed cities.[61] Under Article 3, Section 1 of the Law on ZATO:

> "the special regime for the safe functioning of enterprises or objects in ZATO includes… limitations on the right to conduct economic and entrepreneurial activity, on ownership of land, natural resources and real estate; these limitations are based on the need to control entry and residency."

The principal purpose of access-limitation today is to prevent terrorist attacks against and protect secrecy of nuclear weapons activities. Russia's officials have stressed that the cities cannot become open unless the security of "technical areas" is strengthened.

The outer fence around the city and its access-control limitations are also important to protect nuclear materials and weapons in transit between technical areas within the cities. Currently the intra-site transportation infrastructure is virtually unprotected.

Finally, local citizens favor separation from the surrounding populations as a measure of protection against the crime which has become rampant in Russia.

The access limitations to the closed cities are a major impediment to outside investment and collaborations, however. The cities must therefore develop streamlined access procedures and move toward opening up entirely. In parallel, the security of technical areas with sensitive activities must be upgraded. During his March 2000 visit to Snezhinsk, President Putin supported movement in this direction, remarking that

> "…many things, including security systems, must become technology-oriented. And if we do it gradually but with determination, we would be able to resolve the problem of opening the cities. I think that we should move in this direction."[62]

POPULATIONS AND EMPLOYMENT

Approximately 762,000 people currently live in the closed cities, an increase of over 50,000 since 1989. The population has increased as a result of the immigration of family members from non-Russian republics and from less safe and economically stable regions of Russia, and the return of young people after graduation from universities in large cities. Many choose to come to the closed cities because of their low crime, and because of better housing, schools, healthcare, and public services.

The population growth has been greatest in Novouralsk and Zelenogorsk, cities that contain relatively prosperous fuel cycle facilities with access to foreign markets. In contrast, the

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[61] Jill Cetina, Oleg Bukharin, Frank von Hippel, *Defense Conversion and Small Business Development: A Proposal for Two IFC Projects in Three of Russia's Closed Nuclear Cities,* PU/CEES Report No. 306, March 1998.

[62] V. Putin, Closing remarks at Minatom's Collegium, March 31, 2000, Snezhinsk (See: http://president.kremlin.ru/events/23.html).

growth has been slower or negative in more isolated cities such as Lesnoy and Trekhgorny which host the warhead-assembly facilities.

Approximately 400,000 people in the closed cities are economically active.[63] The level of unemployment is three percent (down from 5 percent in 1999).[64] In several cities, unemployment indicators are higher. For example, as of 2000, the unemployment rate in Zarechny was 5.4 percent (down from 8.3 percent in 1999). In reality, the situation is worse because of the massive underemployment of nuclear workers.

Approximately 120,000 workers in the closed nuclear cities work at nuclear facilities. The nuclear workforce has declined substantially from its Cold War level: for example, employment in the weapons research centers in Sarov and Snezhinsk has diminished respectively from 25,000 and 15,000 in the mid-1980s to 18,500 and 9,500 at present. To a significant extent, however, these reductions have been achieved by transferring support divisions (transportation, power generation, utilities, etc.) and social services to the cities or turning them into independent organizations. Further personnel cuts are needed to bring the employment in line with reduced defense requirements and budgets.

Demographic Situation In Sarov

As of the year 2000, the total population of Sarov was 84,600, an increase from 78,600 in 1989. Approximately 20 percent of the population are of post-retirement age, half of whom continue working, and 19 percent are children below the age of 16. The working population is approximately 42,000. Of them, half work at the nuclear warhead assembly and disassembly plant AVANGARD and the warhead R&D institute VNIIEF. The rest are employed in the municipal sector, education, construction, local industries, and services. As of 1999, the city had approximately 1,000 registered unemployed persons.

In the longer term, however, the complex could experience shortages of workers in certain critical skill areas due to the progressive aging of its workforce. Many workers have already reached the retirement age (55 for women and 60 for men in Russia) but continue working because of the small size of state pensions. Retirement-age workers, for example, reportedly account for approximately 20 percent of VNIIEF's workforce in Sarov.[65] At the same time, according to weapon-institutes directors "there is a massive outflow of highly-qualified specialists whereas the flow of young personnel to nuclear weapons facilities has virtually ceased."[66] The exodus of younger specialists (most of them below 40) to the local commercial and services industries peaked in 1996 and was facilitated by comparatively low salaries in the nuclear sector (see below).

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[63] Presentation by V. Starosotnikov at the Princeton Conference, March 2000.
[64] *RFYaTs -VNIIEF Information Bulletin*, Issue 3, VNIIEF Analytical Nonproliferation Center, Sarov, Fall 2000, p. 47.
[65] Olga Zaguskina "E. Adamov, 'The Nuclear Industry Created More Problems Than It Resolved,'" *Gorodskoy Kuryer* (Sarov), September 2, 1999.
[66] Statements made at the December 15, 1998 Duma Hearings on the situation in the nuclear weapons complex. ("Members of Parliament Discuss Problems of the Nuclear Weapons Complex," *Atompressa* (Electorstal), No. 46-47 (330-331), 1998, p. 6.)

These demographic trends could eventually disrupt the continuity of Russia's nuclear weapons competence, undermine the stability of the complex, and jeopardize its core missions. The problem was summed up at a 1999 meeting of the Association of the Unions of the nuclear-weapons complex:

> "The [personnel] situation is aggravated by a large number of pensioners working in the weapons complex. Taking away from them jobs and salaries, especially in the closed cities, would be a crime and could lead to unforeseen social consequences. Naturally, under these circumstances, hiring new specialists is problematic. Eventually, this could result in a serious problem for the nuclear weapons complex."[67]

FINANCING THE CITIES

With a few exceptions, the economy in each closed nuclear city was developed around a single nuclear defense facility with a highly-specialized R&D and/or production function. In Soviet times, all economic and social needs were funded in a centralized fashion, mostly out of the budgets of nuclear facilities. Today, the closed cities are financed by tax revenues from the nuclear facilities and other economic actors on their territories. These tax revenues are supplemented by federal subsidies.

Nuclear Facilities

Although municipal authorities in many cities now have control of most social services, the economic well-being of the local communities remains linked to the financial health of the nuclear facilities in two important ways:

1. Tax contributions by the nuclear facilities are a major source of funds for the municipal budgets – especially after the cancellation of or reduction in tax benefits for outside enterprises which moved (legally at least) to the closed cities (see below). Even with tax revenues from such "off-shore" enterprises, the tax contribution of VNIIEF and AVANGARD accounted for 21.2 percent of the total 1998 tax revenues in Sarov.[68] Personal income taxes from nuclear workers is also a significant source of revenues for the cities.

2. The purchasing power of nuclear workers has a significant impact on the development of local businesses and services.

The income of the nuclear facilities comes from several sources, including the federal budget, Minatom's commercial earnings, direct commercial activities, and international programs. The warhead R&D and production facilities remain heavily dependent on Minatom and the state budget for funding. While hard budget data is unavailable, it is clear that, for the past several years, these sources have been insufficient to pay the cost of facility

[67] "Problems of the Complex were Discussed in Trekhgorny," *Atompressa*, No. 21 (352), June 1999, p. 3.
[68] *RFYaTs-VNIEF Quarterly Information Bulletin*, Issue 1, March 2000, p. 43.

operations and maintenance. Under these circumstances, international cooperative programs (MPC&A, ISTC, IPP and others) have become important supplementary sources of income – especially for the two nuclear-weapons R&D institutes, VNIIEF in Sarov and VNIITF in Snezhinsk

Some fuel-cycle facilities – in particular those in Novouralsk, Zelenogorsk, Seversk, and Ozersk – have substantial revenues from foreign contracts. The activities financed by the 1993 U.S.-Russian HEU agreement are perhaps the most significant, generating hundreds of million dollars annually. The exports of uranium enrichment and processing services, radioisotopes, and spent fuel management and reprocessing services are also significant and may also cumulatively be worth hundreds of millions dollars a year. It should be noted, however, that the export revenues do not all go to the facilities doing the work. A large fraction of funds are used by the federal government and Minatom to finance other programs. For example, some of the funds from the HEU deal go to finance conversion programs throughout the complex.

Overall, the drop in "defense orders" and reduced budget allocations for nuclear facilities in the 1990s had a depressive impact on the closed cities. Over much of the past decade, most nuclear facilities were not able to pay taxes. Salary delays impoverished their workers. The collapse of the command economy disrupted the centralized supply of low-cost food and consumer goods, further decreasing living standards.

Although, during 1999, salary delays were essentially eliminated, the average level of salaries remains low (see Table 1).[69] Of course, many workers receive salaries that are below even these averages (see Table 2). These salaries are inadequate to live on. As a result, a large fraction of nuclear workers have taken second jobs outside of the nuclear facilities. Often these jobs pay more than their nuclear job but, even with this supplement, the average income remains below the level of $160 per month at which, according to a recent survey of nuclear "specialists," a "reasonable subsistence" is possible.[70]

[69] According to Minatom's 2001 budget, the average monthly salary for defense workers is projected to increased to RR 6000 ($240). Whether Minatom will be able to find the required funding remains uncertain.
[70] Valentin Tikhonov, *Russia's Missile and Nuclear Complexes: Personnel Mobility and Security*, Working Paper, No. 1, Moscow Carnegie Center, 2000, Figs. 5-2 -- 5-5.

Table 1: Average Monthly Salaries at Selected Facilities (1999)[71]

Facility/ City	Average monthly salary, US$
Electrokhimpribor/ Sverdlovsk-45 (Lesnoy)	96[72]
PO START/ Penza-19 (Zarechny)	37.8[73]
Device-Building Plant / Zlatoust-36 (Trekhorny)	88[7]
Siberian Chemical Combine/ Tomsk-7 (Seversk)	160[7]
AVANGARD/ Arzamas-16 (Sarov)	88
Urals Electrkhemichal Combine/ Sverdlovsk-44 (Novouralsk)	220[74]

Table 2: Monthly Salary Distribution in Selected Cities (1999)[75]

Range of mounth salary (US$)	Percentage of total employees	
	Arzamas-16 (Sarov) and Penza-19 (Zarechny)	Tomsk-7 (Seversk)
$20 – $50	60	25
$50 –$75	25	50
$75 – $100	10	20
$100 –$150	3	5

Tax Revenues and Contributions from the Federal Budget

In order to maintain social stability and facilitate defense conversion in the closed cities, Article 5 of the Law on Closed Cities specified that all taxes collected in the closed cities would remain there in support of the city budgets. In addition, city budget deficits would be covered by direct subsidies from the federal budget.

On November 28, 1996, the Duma added to Article 5 considerable tax benefits to enterprises registered in the closed cities.[76] It was hoped that such tax benefits would make the closed cities attractive for investors and facilitate the development there of new businesses to provide jobs for excess nuclear workers.

[71] Presentation by A. Diakov at the Princeton Conference, March 2000.
[72] "Salary pays in time. But it's level remains very low", *Atompressa*, No. 34 (365), October 1999
[73] M. Lukovnikova, "Payment only for them who are working," *Zarechie*, August 18, 1999, Zarechinsk.
[74] Estimates are based on the value of tariffs at the PO "Start" (*Atompressa*, No. 34 (365), October 1999) and at the Urals Electro-Chemical Combine (*Atompressa*, No. 45 (376), December 1999).
[75] Presentation by A. Diakov at the Princeton Conference, March 2000.
[76] Initially, the tax benefits were 50-52 percent. Subsequently, the benefits increased to "70-80-90-99(!)%." (L. Saratova, "Special Regime Investment Zone," *Gorodskoy Kuryer*, No. 2, January 13, 2000.)

The implementation of the new amendment differed from one city to another. For example, in Sarov the local government established an Investment Zone (see, in the main text of the report, Box 3: *The Investment Zone of Sarov*).

Overall, the amendment was very beneficial for the closed cities. With combined city government budgets of $120 million a year, the cities received $300 million in 1998(?) from companies registered on their territories. As a result, the municipal infrastructure and social services in the cities improved. The city administration in Snezhinsk, for example, began providing free lunches in schools. Some cities were able to subsidize the nuclear facilities by rescheduling their tax payments and providing additional social benefits to nuclear workers.

This arrangement remained in force until spring 1999, when the government recognized a new problem. Many companies registered in the closed cities were receiving considerable tax benefits but were not investing in business development in the closed cities. The closed cities thus became financial "black holes." As a result, according to the Russian Ministry of Finances, the state budget lost $625 million in tax revenues in 1998 and $800 million in the first six months in 1999 (presumably from tax-shelter operations in both Minatom's and the Ministry of Defense's closed cities).[77]

The law was therefore changed again in April 1999. It was decided that only companies that had at least 90 percent of their assets and 70 percent of their personnel located inside the closed cities would be eligible for tax benefits. The law was further tightened in January 2000. Only two nuclear cities (Sarov and Snezhinsk) now have the privilege of providing tax benefits to commercial companies. There is also an upper limit of approximately $40 million per year (divided by Sarov and Snezhinsk in the proportion of 3/2) on the amount of benefits.[78]

To compensate the closed cities for the resulting revenue losses, the government allocated additional funds in the federal budget to support their social and municipal infrastructure, to provide for capital investment and job creation, and to pay for resettlement of those wishing to leave the cities. These allocations are expected to total tens of millions of dollars annually. (In 2000, for example, a total of RR 2 billion was allocated for the ten closed nuclear cities.) Many in the closed cities believe, however, that these budget funds will not be provided in full and/or in a timely fashion. As a result, the social and economic situation in the closed cities is expected to deteriorate.

GOVERNANCE

In the past, the closed cities were run by governmental decrees and the nuclear facilities were responsible for supporting their social and municipal infrastructure. At present, as directed by the Law on ZATO, each city has an elected local government, which consists of the city administration (headed by mayor) and the city Duma.

[77] A. Diakov, presentation.
[78] L. Saratova, "Special Regime Investment Zone," *Gorodskoy Kuryer*, No. 2, January 13, 2000.

In coordination with the nuclear facility, the local government exercises a number of important functions in the area of public safety, access, emergency planning and environmental monitoring. It is also responsible for maintaining and improving the municipal infrastructure and providing healthcare, education and other social services. The city government collects taxes and facilitates economic and business development by providing loans and tax benefits, and with programs to retrain and reemploy unemployed persons. Recently, the city governments in Sarov and Snezhinsk also initiated programs under which the nuclear facilities provide long-term housing loans to its workers in exchange for various benefits from the city government.

The collapse of government's centralized supply system of food and consumer goods for the closed cities in the early 1990s required an urgent effort to develop local production and distribution networks. The city governments had to negotiate with FSB and Minatom relaxed access rules for vendors and goods-delivery services. Snezhinsk, which used the construction company from Ozersk, established a construction capability of its own to build new residential housing and support municipal needs. Finally, the local governments had to develop relationships with the regional authorities as well as the nuclear facilities.