The Nuclear Weapons Complexes: Meeting the Conversion Challenge -- A Proposal for Expanded Action

The Nuclear Weapons Complexes: Meeting the Conversion Challenge
A Proposal for Expanded Action

September 1997

I. Introduction

Since the end of the Cold War, the United States and Russia have undertaken a serious effort to convert their nuclear complexes to non-weapons work. However, it has been difficult to achieve significant progress toward this goal. Since the conversion process is very important for both countries, it seemed timely to review the successes and problems encountered to date and to evaluate and recommend new approaches for action. As a first step, the Russian-American Nuclear Security Advisory Council (RANSAC) sought to identify more effective methods of facilitating conversion activities at five key Russian nuclear facilities. These included the two nuclear weapon design laboratories, Arzamas-16 and Chelyabinsk-70, and the three plutonium production and separation facilities, Tomsk-7, Krasnoyarsk-26, and Chelyabinsk-65. A meeting on this subject was convened in Moscow on May 24 and 25, 1997.

The goal of the meeting was to generate new ideas that would allow the U.S. and Russian governments to build on existing conversion efforts, perhaps as part of a new initiative launched under the auspices of the Gore-Chernomyrdin Commission (GCC). The principal participants from Russia included the First Deputy Minister of the Ministry for Atomic Energy of the Russian Federation, the Directors of Arzamas-16, Chelyabinsk-70 and Tomsk-7, and the Chief Engineer of Krasnoyarsk-26. Additional details on the participants and the agenda are located in Annexes One and Two. A synopsis of the presentations made by the Russian participants is located in Annex Three.

II. Recommendations for Expanded Joint Cooperation

Based on the presentations made at the May meeting and subsequent discussions, RANSAC has concluded that there are three specific areas where additional U.S.-Russian cooperation could be useful.

1. Cooperative Nuclear Security. In this area, one important new initiative is the creation of dedicated arms control and non-proliferation analysis centers at Arzamas-16, Chelyabinsk-70 and the Kurchatov Institute. These centers would parallel the capabilities that exist at U.S. national laboratories. As a first step perhaps a small number of U.S. national laboratories and universities could fund fellows from the Russian nuclear complex to work on security issues in the U.S. These fellows could gain experience by working with similar centers at the U.S. labs, and also be exposed to the U.S. non-governmental national security community. Another proposal is the creation of a joint Russian-American research program on issues related to the transparency and irreversibility of the nuclear disarmament process. This can expand current efforts by

focusing on issues related to the trilateral initiative, verification of warhead dismantlement as called for in the Helsinki Statement, plutonium disposition and the data exchange.

2. Environmental Restoration. There is a small U.S.-Russian program of cooperation in this area that should be expanded. One way to facilitate expanded cooperation is to use the laboratory-to-laboratory approach that has been so successful in the nuclear security area. In this case, Mayak, Tomsk-7 and Kransnoyarsk-26 could form partnerships with Hanford, Oak Ridge and Savannah River. There are three steps that could be taken initially. One is to evaluate the progress that has been made in the many Russian clean-up technology projects that have been financed under the International Science and Technology Center (ISTC) and the Initiatives for Proliferation Prevention (IPP) program. Russian specialists should also become familiar with the technologies the U.S. has developed as part of its environmental restoration effort. And, U.S. and Russian experts should jointly develop technologies for cleaning up waste problems that both countries face. If initial efforts are successful, a portion of U.S. clean-up research and development could be contracted to Russian technologists. A related issue is to conduct an evaluation of a new technology for plutonium-contaminated waste immobilization developed at Krasnoyarsk-26. Finally, there is the question of whether Russian nuclear facilities would be willing to serve as test beds for the demonstration of new technologies developed in Russia and abroad.

3. Product Commercialization. This is obviously the most important area for the long-term transition of the complex, but it is also the most difficult to master. Perhaps the most important issue in the short term is to evaluate the commercial potential of the technologies put forth during and after the May meeting. One approach is to ask some combination of the ISTC, IPP, the Overseas Private Investment Corporation OPIC), and the Defense Enterprise Fund (DEF) to create a government-private industry committee to evaluate these proposals and select the most promising projects. Once selected, a commercialization "Tiger Team" could be formed for each project to assist with the development of business plans, market analyses and legal issues. This is similar to the approach being taken with the silicon plant planned for Krasnoyarsk-26. A related issue is the need to improve the business and financial training available to the specialists in the nuclear cities and to encourage the hiring of trained business experts. A number of initiatives are possible in this area, but one initial suggestion is to host Russian fellows at U.S. universities where they can be trained in relevant disciplines.

In order to expand the substantive areas of collaboration, both governments must tackle the difficult issue of financing. To improve the chances of securing U.S. financing it would be useful if Russia would cost share, or provide matching funds, for the new initiatives. One suggestion is for Russia to use a portion of the payments it receives from the U.S. under the highly-enriched uranium blend-down agreement as a potential source of funding for this initiative. As a first step it would be useful if Russia would consider making five percent of the total yearly income from this sale available for the nuclear complex conversion effort. For example, in 1998, when Russia will blend-down 24 tons of HEU, five percent of the income would amount to over $30 million. The U.S. could then seek to match this amount, perhaps by devoting a portion of the IPP budget to this agenda as well tapping other programs. A proposed first year budget is located in Annex Four.

In addition to financing, there are a number of additional issues that the U.S. and Russian governments should consider to help facilitate the transition of the nuclear complexes. On the U.S. side, the government needs to re-evaluate its existing domestic and international conversion programs and determine if they have the correct focus. A first step in this effort should be the convening of a U.S.-Russian conference on the lessons that the U.S. has learned during its nuclear complex conversion process. Also, the IPP program should be reviewed and perhaps directed to focus solely on the conversion of Russia's nuclear cities. Additionally, the U.S. has viewed its various nuclear safety and security collaborations with Russia as individual efforts, not part of an overall strategy for conversion and stabilization. This should change to some degree. While all activities should be implemented separately to maintain their effectiveness, their budgets and progress should be centrally tracked. This will allow both governments to have a clear idea of how much money is being spent on the conversion effort and how effectively the programs are performing. From the Russian side, it would be useful to have further information in three areas: (1) barriers to collaboration between the nuclear cities and the oil and gas industry; (2) the current tax structure and ideas for tax incentives for investment in the nuclear cities; and (3) legal issues that affect investment, including the rules regarding access to facilities. Perhaps all of these U.S. and Russian issues could be studied by a joint Russian-American team that is chartered by the GCC.

In considering the full range of proposals that were made at the May meeting, the members of RANSAC decided that it would not be productive to address the issues of expanded U.S-Russian cooperation on nuclear reactor technology development and utilization or on nuclear weapon stockpile stewardship in these initial recommendations. These issues are very controversial and could detract from the importance of expanded cooperation on conversion. However, these are issues of interest to RANSAC and future discussions on them will occur.

Also, experience has proven that Russian-American cooperation benefits both nations best when there are an agreed-upon set of milestones and means of measuring the success of new initiatives. In this case, progress could be monitored by requiring that a report be issued at each meeting of the Gore-Chernomyrdin Commission. The measurements in the report could include: a display of actual products produced under this initiative; before and after pictures and video tapes of projects; a statistical report on the number of contracts and number of new employees created by the initiative; and a catalog of private investment in individual commercial projects.

III. Initial Implementation Plan

Since it is often difficult to implement new projects, RANSAC believed that it would be useful to suggest some specific activities that could be taken as first steps in an expanded collaboration. The following is an attempt to lay out an initial implementation plan for the period of September 1997 to February 1998. These activities should be agreed upon at the September GCC and accomplished before the next GCC meeting in January or February 1998. The proposals encompass the three key areas of cooperation, non-proliferation, environmental restoration and product commercialization. Specific steps include:

- The convening of a conference on the U.S. experience on the conversion of its nuclear complex. This conference should be hosted by the U.S. laboratories and be held in the U.S. The Russian participation should be very broad, including the top officials of the nuclear facilities, and First Deputy Minister Ryabev should be invited to lead the Russian delegation. The conference should set aside time for a small group discussion between U.S. and Russian lab directors on what additional collaborations could be initiated. The outcome should be a specific list of potential future collaborations aimed at conversion.
- Two U.S. labs and two U.S. universities (perhaps Princeton and Harvard) should agree to host a fellow from Chelyabinsk-70 and Arzamas-16 for three months each. The purpose would be to expose this person to the workings of a national laboratory arms control and non-proliferation operation and a similar organization in the non-governmental sector. The Russian candidates must be of good quality (i.e. arms control and non-proliferation backgrounds and good English language skills). The outcome should be to create the catalyst for the formation of similar arms control and non-proliferation centers at the Russian labs.
- A conference should be held between officials from Tomsk-7, Krasnoyarsk-26, Mayak, Savanah River, Oak Ridge and Hanford on the common environmental problems that exist at these facilities and the existing and proposed methods for cleaning them up, including cooperative development efforts. The outcome should be to determine areas where the U.S. and Russia can expand collaboration on the development and use of technologies for environmental restoration.
- The Russian laboratories should be asked to give to the U.S. a list of their top potential commercial products. These proposals should be reviewed by a combined team, including members from the ISTC, IPP, DEF and OPIC offices. ISTC and IPP can comment on the soundness of the technology and OPIC and DEF on the possibility for financing. The outcome should be to choose the most promising commercial products and follow through with a joint Russian-American team of experts (government and non-government) that can see the process through to completion.
- In series with the ISTC/IPP/DEF/OPIC review, a conference should be convened on how to produce a business plan. All relevant Russian institutions should be invited. U.S. laboratories have already done substantial work in this area. The outcome should be that the Russian participants come away with an understanding of business plan development and its importance. Follow-up meetings could be scheduled.
- A Russian-American evaluation team should be formed to look at the proposals from Arzamas-16 and Chelyabinsk-70 related to the oil and gas industry and the impediments to their implementation. These proposals have included perforators for old wells, new monitoring and control systems for pipelines, and environmental protection technologies. The outcome should be to identify

technologies that can be utilized by Russian and foreign oil and gas companies and identify impediments to their use in Russia. To get these initial activities underway the U.S. and Russia should split the financing. All together the six activities outlined above should not cost more than $3-5 million. The Russian money should come from the HEU purchase and the U.S. seed money should come from the Department of Energy (DoE). Progress can be measured by preparing a short report for the January/February 1998 GCC on the accomplishments of the last six months, the suggestions for next steps, and a proposed budget for the follow-on activities.

IV. Annexes

Annex One: List of Participants

Annex Two: Agenda for the Workshop

Annex Three: Presentations By the Minatom and the Nuclear Cities

Annex Four: First Year Budget Proposal

Annex Five: U.S.-Russian Cooperative Programs

Annex Six: Members of the Russian-American Nuclear Security Advisory Council

V. Acknowledgments

The members of the Russian-American Nuclear Security Advisory Council would like to thank the Ford Foundation, the W. Alton Jones Foundation, the John Merck Fund, and the Ploughshares Fund for their generous support. RANSAC would also like to thank the Federation of American Scientists for its support of the Moscow workshop.

ANNEX ONE
The Nuclear Weapons Complex: Meeting the Conversion Challenge
List of Participants

<u>From the U.S.</u>

1. Randy Beatty - International Science and Technology Center
2. Oleg Bukharin - Princeton University
3. Matthew Bunn - Harvard University
4. Robin Copeland - U.S. Embassy Moscow
5. William Dunlop - Lawrence Livermore National Laboratory
6. Kenneth Luongo - Princeton University
7. Steve Mladineo - Pacific Northwest National Laboratory

8. Frank von Hippel - Princeton University
9. Paul White - Los Alamos National Laboratory

From Russia

10. Yevgeny Avrorin - All-Russian Research Institute of Technical Physics
11. Anatoli Diakov - Moscow Institute of Physics and Technology
12. Radiy Ilkaev - All-Russian Research Institute of Experimental Physics
13. Gennadiy Khadorin - Siberian Chemical Combine
14. Nikolai Ponomarev-Stepnoi - Kurchatov Institute
15. Yuri Revenko - Mining and Chemical Combine
16. Lev Ryabev - Ministry of Atomic Energy
17. Vladimir Sukhoruchkin - Kurchatov Institute
18. Yuri Shors - Defense Council of the Russian Federation
19. Yevgeny Velikhov - Defense Council of the Russian Federation
20. Andrei Zobov - Carnegie Endowment, Moscow Office

Observers

21. Viacheslav Soloviov - All-Russian Research Institute of Experimental Physics
22. Aleksandr Chernishev - All-Russian Research Institute of Experimental Physics

ANNEX TWO
Agenda
The Nuclear Weapons Complex: Meeting the Conversion Challenge
A Workshop Convened by the Russian-American Nuclear Security Advisory Council
May 24-25, 1997
Russian Academy for State Service
Moscow

Saturday, May 24, 1997

9:30	Welcoming Remarks and Overview Kenneth Luongo, Executive Director Russian-American Nuclear Security Advisory Council Lev Ryabev, First Deputy Minister Ministry for Atomic Energy of the Russian Federation Yevgeny Velikhov, Member Defense Council of the Russian Federation

10:30	Presentation of Proposals Radiy Ilkaev, Director All-Russian Research Institute of Experimental Physics (Arzamas-16)
11:30	Break
11:45	Presentation of Proposals Yevgeny Avrorin, Director All-Russian Research Institute of Technical Physics (Chelyabinsk-70)
12:45	Lunch
2:00	Presentation of Proposals Gennadiy Khandorin, Director Siberian Chemical Combine (Tomsk-7)
3:00	Presentation of Proposals Yuri Revenko, Chief Engineer Mining and Chemical Combine (Krasnoyarsk-26)
3:30	Break
4:00	Presentation of Proposals Lev Ryabev Ministry of Atomic Energy
4:15	U.S. Perspectives Paul White Los Alamos National Laboratory William Dunlop Lawrence Livermore National Laboratory Steve Mladineo

Pacific Northwest National Laboratory
Randy Beatty
International Science and Technology Center

5:00	General Discussion of Proposals
7:00	Dinner for all Participants Restaurant "U Pirosmany"

Sunday, May 25, 1997

10:00	Convening of RANSAC Meeting (RANSAC members)

ANNEX THREE
Presentations by the Ministry of Atomic Energy and the Nuclear Cities

View of the Ministry of Atomic Energy

The Ministry of Atomic Energy (Minatom) is a major industrial force in Russia that employs close to 800,000 workers in its numerous institutes, businesses and nuclear weapons complex. While still powerful, Minatom no longer commands the share of the federal budget that it was accorded during the Cold War. As a result, its workers are subject to the same wage delays that other large industries in Russia are experiencing. This situation is not likely to be reversed as long as the budget crisis in Russia persists.

The Ministry is trying to develop alternative sources of funding for its nuclear weapons complex and has generated a three-point plan for how the transition should proceed:
1. <u>Fundamental and Applied Science.</u> This includes high-energy physics, controlled fusion, nuclear physics, the physics of solids, and semiconductor science. Minatom hopes that this research will result in commercial products.

2. <u>Nuclear Power.</u> This work focuses on the development of a new generation of civilian nuclear reactors, safety upgrades at existing reactors, and the construction of new power plants. The new reactors, if built, will help to support the fuel manufacturing and machine building components of the Minatom complex.

3. Commercial Products. Numerous ideas for commercial products have been generated throughout the complex. Some have recently come to fruition at Chelyabinsk-70 and Krasnoyarsk-45.
Two additional areas discussed at the workshop, and of interest to the Ministry, are expansion of activities to facilitate the nuclear disarmament process and environmental clean-up.

The Ministry has two sources of funding for its conversion efforts. One source is mandated under the Law on Dangerous Radioactive Facilities. Under this legislation, 1.5% to 3% of facility revenues are to be directed to conversion activities. Unfortunately, this provision suffers from non-payment. The second source of revenue is exports of nuclear materials and equipment and international collaborations. In 1996, Minatom estimates that it brought in $2 billion from these activities, about one-third of its total budget. Under this category, Minatom has received permission from the government to use a portion of the proceeds from the HEU purchase agreement for conversion activities.

In general, the Ministry recognizes that Russia does not have the resources required to keep the existing nuclear complex fully funded, but little thought has been given to the idea of consolidating or closing down parts of the complex. Instead, Minatom would like to see most of its nuclear complex become self-sufficient by producing and selling commercial products.

All-Russian Institute of Experimental Physics (Arzamas-16)

Arzamas-16, located near the city of Nizhni Novgorod, is one of two major nuclear weapon design laboratories in Russia. At present the institute employs approximately 20,000 nuclear specialists. The institute's defense conversion philosophy is based on the premise that large-scale cutbacks in employment will not be pursued. The primary reasons given for this approach are the need to reduce the possibility of social problems and also to reduce the outflow of scientists who have specialized knowledge of military technologies. The objective of the Arzamas leadership, therefore, is to create jobs. The most important and interesting work in its view is scientific research, including large-scale science projects and industrial technology development.

At the May meeting, Arzamas-16's suggestions for future scientific research focused on: the expanded use of the laboratory's existing nuclear reactors; development of a nuclear reactor powered laser and laser driven inertial confinement fusion; development of tritium targets for ITER; and isotope separation. Other suggestions for new work included expanded activity related to the protection, control and accounting of nuclear materials; development of supercomputers based on parallel processing; technology development for emergency response to nuclear warhead accidents; restoration of radioactively contaminated areas; development of containers for chemical weapons, fissile material and spent nuclear fuel; activities related to the disposition of plutonium;

and issues related to the detection, use and disposal of high explosives. An area of commercial potential was cooperation with the oil and gas industry of Russia which has a need for better pipeline controls, monitoring, and reliability analysis and perforation technologies to intensify production. In June, Arzamas submitted further detail on some of these proposals and made additional suggestions for projects. These included the development of containers for the transportation and storage of silicon chips and the use of pulsed reactors and accelerometers to improve the safety of nuclear reactors.

The leadership of the institute is pessimistic that large-scale industrial production can work as a sole conversion strategy because it would require considerable investment and significant changes in employee psychology. However, the institute is interested in small-scale production activities. To this end, Arzamas-16 is working to establish cooperation with Russian institutes and companies as well as international entities. To date, the effort has been focused on the conversion of highly experienced experts and these scientists have established good contacts through the International Science and Technology Center and U.S.-sponsored lab-to-lab programs. Finding alternative employment for the workers and technicians at the institute is a more serious problem.

At present the yearly budget for Arzamas-16 is $130 million and the yearly revenue is composed of funding from the state budget, international cooperation projects and commercial work for industry. The latter two categories each account for approximately 7% of the yearly revenue (15% total) and the goal is to increase the contributions from these areas three fold (to reach approximately 50% of the yearly revenues). Recently, salaries from the state have been running about one-half a year late and the institute has borrowed money to make up the budgetary shortfall.

All-Russian Research Institute of Technical Physics (Chelyabinsk-70)

Chelyabinsk-70, located between the cities of Yekaterinburg and Chelyabinsk, is Russia's other major nuclear weapons design laboratory. It has been in existence since 1955. At present Chelyabinsk-70 has approximately 15,000 employees. The Chelyabinsk-70 philosophy of conversion is to utilize the highly skilled technical employees and technical capabilities that exist at the institute. An area of particular interest for Chelyabinsk-70 is the expanded use of advanced computers for work in the areas of shock waves, detonations, turbulent mixing, technology testing (mechanical impact, vibration, climatic), and computational physics.

Like Arzamas-16, Chelyabink-70 expressed a clear preference for pursuing research at the laboratory as a substitute for weapons work. Suggestions included the development of environmental restoration technologies; plutonium disposition research; nuclear power plant safety enhancement; development of medical equipment; and the application of high-efficiency lasers.

Chelyabinsk-70 also presented a number of proposals that had potential commercial applications. Three that seemed most developed were superplastic forming of metal components, production of perforators for the oil industry and the production of quartz for use in fiber optic technologies. The superplastic forming technology has applications in the aerospace and automobile industries and is currently supported by the ISTC and IPP. The need for oil well perforators is well established, but there are questions about how Russian laws affect the extraction of oil from old wells. The production of fiber optic lines has gained the support of some Russian ministries and one bank. In particular, the railroad industry in Russia has indicated its interest in utilizing fiber optics and a small pilot factory for production has been set up at Chelyabinsk. It was estimated that fiber optic production alone could create 1,000 jobs at Chelyabinsk. In June, Chelyabinsk-70 submitted some more detailed proposals focused on environmental restoration and technologies for use in the oil and gas industry. It also suggested additional activities focused on the decontamination and dismantlement of nuclear reactors, and the production of antiseptics.

While some commercial projects seem within the grasp of Chelyabinsk-70, the leadership of laboratory expressed great frustration with the process of commercializing its promising technologies. The problems were both internal and external. Internally, the institute does not have the people with the right background or training for marketing and commercializing products. Externally, the laboratory is having great difficulty finding and interacting with key business people from Russia, the U.S. and elsewhere that might be interested in their products. If commercial activities could be arranged, they could be organized as joint stock operations or small enterprises that would be managed separately from the laboratory and the production line established in a location that did not require special permission for access. This is similar to the approach outlined by Arzamas-16.

The laboratory is also interested in expanding the amount of work that it does in the non-proliferation area. In particular the laboratory is interested in the design and development of its own detectors and software for use in the protection, control and accounting of nuclear materials; improving training in the weapons complex in the methodologies and technologies used in MPC&A; enhancing the transparency of the nuclear warhead dismantlement process; developing technologies for the detection of clandestine nuclear activities worldwide; and improving verification technologies for a Comprehensive Test Ban Treaty. Related to this area, was the suggestion by Chelyabinsk-70 that the laboratory create better contacts with U.S. universities to work on analytical issues related to arms control and non-proliferation issues. The leadership noted with regret that cooperation with the United States on the issues related to the safety and reliability of nuclear weapons was a possible area of growth, but that the results to date had been disappointing.

At present, the yearly budget for Chelyabinsk-70 is approximately $100 million, with revenue generated by the state budget (70%), sales of heat, communications capabilities, and transportation services to the population of Chelyabinsk-70 (20%) and international contracts (9%). Of the 15,000 employees at the laboratory, the Chelyabinsk-70 leadership expects only 5,000 to be actively employed in military-related activities by 2010. Therefore, the laboratory would like to see its dependency on the military budget decrease to about 33% of the revenue total and have another one-third generated by commercial projects, international cooperation and applied science activities. The laboratory would like to have the final one-third of the budget generated by fundamental science activities, but these historically have been financed by the state budget. Whether the funding for these activities will be available from past sources is uncertain.

Mining and Chemical Combine (Krasnoyarsk-26)

Kransoyarsk-26 is a major plutonium production, processing and storage facility that is located near the city of Krasnoyarsk. At present the facility employs approximately 9,400 workers at its plutonium production reactors, radiochemical plant and supporting infrastructure. Its yearly budget is estimated at $30 million. The primary conversion focus of the institute had been to complete the construction of the RT-2 nuclear fuel reprocessing plant, but this project now seems unlikely to proceed. A revised approach has three elements. The most immediate is the conversion of the core of the one operating plutonium production reactor and the ultimate replacement of this reactor. Another is the eventual shut down of the existing radiochemical plant when its reprocessing and waste processing missions are completed. The third element is the creation of viable commercial products.

The replacement of the existing plutonium production reactor has been a long-term Russian objective that has been incorporated into a Russian-American joint effort. This project is currently focused on converting the core of the reactor as a first step toward the goal of ending the production of weapon-grade plutonium. But a replacement for the reactor ultimately must be found. Replacement is essential because the reactor produces heat for the surrounding area. At present there are two alternatives. The option preferred by the Ministry of Atomic Energy is to build a new VK-300 reactor, though this would cost billions. The other alternative, preferred by the local government, is to complete the Sosnovoborsk fossil fuel plant, which would cost approximately $200 million. Much attention recently has been focused on the conversion effort, but the replacement of the reactor and its decommissioning is an important issue for the future.

The radiochemical plant became operational in 1964 and is designed to reprocess spent nuclear fuel from the plutonium production reactors. This plant was to be replaced by the RT-2 radiochemical plant which was designed for the storage and reprocessing of VVER-1000 power reactor fuel. At present, only the spent fuel storage pools of the RT-2 plant have been built.

Given the large volume of radioactive waste that the facility has to manage, Krasnoyarsk-26 has developed a new technology for the immobilization of plutonium sludge. It is based on a porous ceramic matrix that would then be embedded in glass. Experiments on this technology have been started and the process holds some potential for the disposition of excess weapons plutonium.

Another very promising area of conversion activity is the production of superpure and semiconducting materials for the electronics industry. One key project in this area is the collaboration of Krasnoyarsk-26 with the U.S. under the IPP and Defense Enterprise Fund on the ultimate construction of a 1,000 metric ton per year polycrystalline silicon factory. Pure, electronics grade silicon is a base material for the construction of semiconductors. Today Japan controls approximately 75 percent of the world production of silicon, with Germany supplying the remainder. Named the "Silicon of Siberia" project, this effort could establish Russia as a significant producer of silicon for its internal market and for export. It could also employ an estimated 1,000-3,000 workers at Krasnoyark-26. Other substances that Kransnoyarsk-26 is interested in producing include niobium, aluminum, and pure tellurium. In addition, the facility is working on the production of new electrical contacts, use of liquid CO2 at high pressure to extract nutrients from plants, and energy efficiency and conservation efforts.

Siberian Chemical Combine (Tomsk-7)

Tomsk-7 is a major plutonium production and uranium enrichment facility located near the city of Tomsk. It was founded in 1951 and currently employs approximately 15,000 workers. It has a yearly budget estimated at $50 million. Tomsk-7 production levels have actually risen about 30% over the low point experienced in 1994. The conversion philosophy of the Tomsk-7 leadership is primarily focused on utilizing its existing nuclear capabilities for peaceful purposes. This strategy is supplemented by the development of some non-nuclear technologies.

Like Krasnoyarsk-26, Tomsk-7 still operates plutonium production reactors. There are two at this location. The conversion of the cores of these reactors is one area of new work. But the reactors will eventually have to be shut down. Since three similar reactors have already been shut down at Tomsk, there is considerable experience at the facility in safe decommissioning and preparation for long-term storage of plutonium production reactors. The plan is that the reactors would be conserved for 100 years (and possibly stored forever). Tomsk-7 has no goal of returning the reactors sites to "green fields".

Since the two production reactors still produce heat and electricity for the region, replacement sources of energy must be found. There is a "Plan on Nuclear Power Development in Tomsk-7" which outlines a strategy for new nuclear reactors to be built in two phases. The first is a district heating plant of a VK-300 type. Second would be construction of a high temperature gas-cooled reactor. The

HTGR would be connected to Russia's plutonium disposition efforts because Tomsk-7 plans to fabricate the HTGR MOX fuel from plutonium. However, sufficient funding is not yet available to implement these reactor plans.

Tomsk-7 also has plans to change the operation of its radiochemical plant over time. At present, the plant processes the spent fuel that is discharged from the two plutonium production reactors. When this mission, and other waste processing related activities, are completed (sometime after the reactor cores are converted) the plant will be shutdown. The decommissioning of this facility will be very difficult. A non-radioactive part of the facility would then be used to extract rare-earth metals from a mine in Kuzbass. Under this proposal the workforce at the radiochemical plant would be cut by a factor of two. There were no proposals related to clean-up of irradiated sites or treatment of the radioactive waste that has been injected into the ground. The Tomsk-7 leadership is convinced that the injected liquid waste is safely contained underground.

One area of conversion that is producing results today is the blending down of highly-enriched uranium from Russian nuclear weapons under the U.S.-Russian agreement to turn 500 metric tons of HEU into low-enriched nuclear reactor fuel. This activity has been a major generator of jobs at the facility and it was estimated that 80% of the capacity of the weapons plant is occupied with this task. The Tomsk-7 leadership stated that no state funding is being provided to carry out this work but that considerable income was being derived for Tomsk-7 from this activity. In addition, Tomsk-7 has substantial foreign contracts for uranium processing which have been a source of job growth.

In the non-nuclear area, Tomsk has developed a number of technologies that potentially could be commercialized. These include plasma technologies to produce ultra-fine powders of metals for use in ceramic products, the creation of strong magnets, and the production of salts for use in rechargeable batteries. A small ceramics plant has been established but international cooperation and funding are required for the project to advance.

Mayak Production Association (Chelyabinsk-65)

The Mayak Production Association is one of Russia's primary plutonium processing and storage facilities. It is located near the city of Chelyabinsk and is estimated to employ approximately 18,000 people. Its yearly budget is estimated to be $60 million. The conversion plan for Mayak is based on the continuation of its plutonium processing and storage activities and the construction of reactors and facilities for use in the disposition of excess weapons plutonium.

A major activity at Mayak is the reprocessing of spent nuclear fuel fromVVER-440 reactors. This plant employs approximately 1,500 people. To date this activity has separated about 30 tons of reactor-grade plutonium. The Mayak leadership plans to reprocess VVER-440 fuel into the future.

Another primary activity of Mayak is storage of plutonium, highly-enriched uranium and spent nuclear fuel. The reactor-grade plutonium that has been separated by the facilities' reprocessing activities is in storage at the site. While security improvements are being made, a better storage facility would be welcomed and could be a first step toward the placement of this material under International Atomic Energy Agency safeguards. The plant is also in the process of constructing a storage facility for the spent fuel from naval nuclear reactors. This facility will allow one-third of the naval nuclear fuel to be stored at Mayak but it will cost about $10 million to complete. Mayak, in conjunction with the United States, is also constructing a new storage facility for the plutonium and highly-enriched uranium components from dismantled warheads. This facility will hold approximately 50,000 containers of warhead components.

Because of the storage of large amounts of plutonium at Mayak, the plant is focused on constructing reactors and facilities to aid in the disposition of the plutonium that is declared excess. One element of the plan is to construct three BN-800 fast neutron reactors that could burn plutonium fuel. This is on hold because of lack of funds and disputes with the local authorities. The other major component is to construct a mixed oxide (MOX) fuel fabrication plant under a cooperative arrangement with France and Germany. At present this plant is not fully funded.

Outside of its plutonium operations, Mayak has some other conversion activities underway. These include the production of isotopes, technologies for environmental clean-up and possible cooperation with Chelyabinsk-70 on the production of fiber optic cables.

ANNEX FOUR
Activities Recommended for First Year Joint Funding

The following is a proposal for activities that should be funded in the first year of a new initiative on converting the nuclear weapons complex.

Expand Nuclear Security Cooperation

- Establish non-proliferation centers at 3 locations
- Develop cooperative technical means of monitoring warheads, components and fissile material
- Reconstruct past fissile material and warhead production and report on totals
- Expand plutonium disposition cooperation, including conversion of plutonium pits
- Establish laboratory and university fellowships
- Convene conference on the lessons learned from the U.S. nuclear complex conversion effort

Total ----------------- $21 million

Cooperate on Environmental Restoration

- Evaluate ISTC & IPP funded projects
- Expand joint R&D efforts
- Analyze U.S. developed technologies
- Assess Krasnoyarsk-26 immobilization technology
- Utilize Russian Test Beds
- Convene conference to discuss common environmental problems

Total ----------------- $24 million

Support Technology Evaluation and Commercialization

- Evaluate Russian-proposed technologies
- Create commercial project Tiger Teams
- Train new business and commercialization specialists
- Create joint issues review team
- Establish basis for initial capitalization

Total ----------------- $15 million

Total First Year Funding -------------------- $ 60 million

ANNEX FIVE
U.S.-Russian Cooperative Programs

Since 1991, the U.S. and Russia have initiated a number of cooperative programs focused on non-proliferation and the conversion of the defense complex. The cumulative U.S. funding for these efforts is approximately $2.7 billion. A brief description of these programs are listed below.

Cooperative Threat Reduction: Also known as the Nunn-Lugar program, this Department of Defense financed effort to assist in reducing and controlling weapons of mass destruction in the Former Soviet Union, has a few projects focused on the closed nuclear cities. Most prominent are the construction of a new fissile material storage facility at Mayak and the provision of funding for the conversion of the cores of the remaining plutonium production reactors.

Defense Enterprise Fund: The DEF is an independent, not-for-profit U.S. corporation that was created in 1994 by the Department of Defense through CTR funds. DEF assists in the conversion and privatization process of excess military industrial capacity by providing financial assistance for U.S.-FSU business partnerships. At present, DEF is involved in one major project at a closed city. It is the development of the business plan and financing for the silicon purification facility at Krasnoyarsk-26.

International Science and Technology Center: The ISTC is the largest program focused on the redirection of weapons scientists to peaceful activities. Funded by the European Union, the United States and Japan, the ISTC provides short-term, tax free grants to scientists to engage in peaceful, non-weapons work. At present Russian scientists at closed nuclear cities are working on over 140 projects under ISTC grants and approximately $29 million has been allocated to projects in the five closed cities covered by the RANSAC recommendations.

Laboratory-to-Laboratory Program: There are a variety of laboratory-to-laboratory interactions between the U.S. and Russia and most are overseen by the Department of Energy. The most prominent activity to date is the joint laboratory effort to improve the protection, control and accounting of weapon-usable nuclear materials. This program has established collaborations with all the closed nuclear cities in Russia, except those solely devoted to the dismantlement of nuclear warheads.

Initiatives for Proliferation Prevention: The IPP was created to foster partnerships between U.S. industry, the U.S. national laboratories and the science and engineering institutes of the FSU. IPP supports a number of projects at the closed nuclear cities, with the silicon fabrication plant at Krasnoyarsk-26 being the most prominent. To date, IPP has allocated over $11 million for projects in the five closed cities covered by the RANSAC recommendations. The program is administered by the Department of Energy.

Purchase of Excess Weapon-Grade Uranium: Under this agreement the U.S. has committed to purchase 500 tons of weapon grade uranium from Russia. This material is blended down to low enriched uranium before shipment to the U.S. and is ultimately used as fuel in commercial nuclear reactors. This agreement is worth $12 billion and is providing substantial work for a few of the closed nuclear cities including Tomsk-7, Chelyabinsk-65, Krasnoyarsk-45 and Sverdlovsk-44.

Cooperative Environmental Management: This small program, managed by the Department of Energy, is focused on generating cooperation with Russian scientific institutes on the development of environmental management technologies. It works with a small number of the closed nuclear cities.

Business Information Service for the Newly Independent States: This Department of Commerce program uses funding from the Agency for International Development to assist small and large U.S. companies that are interested in doing business in the NIS. A major contribution is the publication of information on many sectors of the NIS economies. The program does not figure prominently in the nuclear cities conversion effort.

American Business Centers: This program, managed by the Department of Commerce, has eleven locations in Russia which provide logistical and secretarial assistance to small and medium sized firms. These areas include Nizhny

Novgorod, Chelyabinsk and Yekaterinburg, though little work has been done with the nuclear cities in these areas.

Special American Business Internship Training: SABIT provides grants to American companies to help defray the cost of hosting NIS managers and scientists for three to six months of training in the United States. The goal is to introduce Russians to western business practices, a process useful in the nuclear cities conversion process. The program is managed by the Department of Commerce.

Russian Defense Business Directories: The goal of this Department of Commerce publication is to disseminate information about Russian enterprises to U.S. firms interested in investing in Russia. The directory has entries on many of the closed nuclear cities.

Overseas Private Investment Corporation: This independent U.S. federal agency encourages U.S. investment in the NIS by extending loans, insuring investors against political risks, and conducting investment missions that allow enterprises to meet potential U.S. investors. To date, OPIC has not provided any funding for the conversion of the closed nuclear cities.

Trade and Development Agency: This is another independent U.S. federal agency that seeks to assist U.S. companies in seeking business opportunities in the NIS and other countries. TDA has funded a feasibility study related to the fossil energy sources that could replace the closed plutonium production reactors at Tomsk-7 and Krasnoyarsk-26.

ANNEX SIX
Members of the Russian-American Nuclear Security Advisory Council

From Russia

Evgeny Avrorin
Director, Russian Federal Nuclear Center Institute of Technical Physics (Chelyabinsk-70)

Anatoly Diakov
Director, Center for Arms Control, Energy and Environmental Studies
Moscow Institute of Physics and Technology

Nikolai Ponomarev-Stepnoi
Deputy Director, Russian Research Center, Kurchatov Institute

Evgeny Velikhov
Member, Defense Council of the Russian Federation

Vladimir Sukhoruchkin
Senior Advisor to the Council and
Moscow Office Director

From the United States

Matthew Bunn
Assistant Director, Science, Technology and Public Policy Program
Harvard University

Kenneth Luongo (Executive Director)
Senior Visiting Fellow, Princeton University

Hazel R. O'Leary
President, O'Leary and Associates, Inc.

Frank von Hippel
Professor of Public and International Affairs, Princeton University