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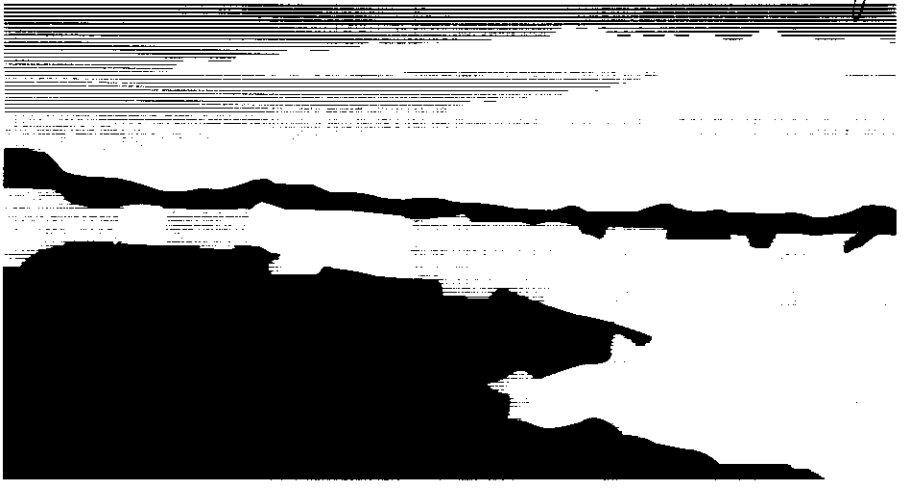

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LOS ALAMOS NATIONAL LABORATORY SCIENTIFIC INTERACTIONS WITH THE FORMER SOVIET UNION

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Introduction

The Los Alamos National Laboratory has a wide-ranging set of scientific interactions with technical institutes in the Former Soviet Union (FSU). Many of these collaborations, especially those in pure science, began long before the end of the Cold War and the breakup of the Soviet Union. This overview will, however, focus for the most part on those activities that were initiated in the last few years. This review may also serve both to indicate the broad spectrum of US government interests that are served, at least in part, through these laboratory initiatives, and to suggest ways in which additional collaborations with the FSU may be developed to serve similar mutual interests of the countries involved.

While most of the examples represent programs carried out by Los Alamos, they are also indicative of similar efforts by Lawrence Livermore National Laboratory and Sandia National Laboratories. There are indeed other Department of Energy (DOE) laboratories, and many of them have active collaborative programs with FSU institutes. However, the laboratories specifically identified above are those with special nuclear weapons responsibilities, and thus have unique technical capabilities to address certain issues of some importance to the continuing interests of the United States and the states of the Former Soviet Union.

Building on pre-collapse scientific collaborations and contacts, Los Alamos has used the shared language of science to build institutional and personal relationships and to pursue common interests. It is important to understand that Los Alamos, and the other DOE weapons laboratories are federal institutions, working with federal funds, and thus every undertaking has a definite relationship to some national objective. The fertile areas for collaboration are obviously those where US and Russian interests coincide. The following is a brief list of areas representing priorities for both governments.

Facilitate the dismantlement of nuclear weapons;

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Inhibit the proliferation of nuclear weapons technology;

Limit the likelihood of nuclear weapons accidents, and mitigate the consequences if any occur;

Encourage economic conversion and overall economic development;

Collaborate in the development of unique technologies; and

Build mutual confidence.

Overview of Los Alamos FSU Interactions

A wide network of collaborations in basic sciences in a broad range of topics continues to link scientists in Los Alamos with colleagues in the Former Soviet Union. As described below, this historical network has formed the basis for the somewhat more formal institutional contacts that now form the core of the Los Alamos interactions with the FSU. This program provides a framework for long-term collaborations in agreed areas of mutual interest, involving a large number of scientists, and in many cases including the funding of technical effort by Russian scientists. These areas of interaction are seen as building confidence in new forms of alliance and technical cooperation. Where these efforts involve scientists from Russian weapons institutes, they also serve mutual interests in inhibiting proliferation, and promote the involvement of these talented professionals in broader scientific activity outside of weapons programs. Efforts to channel this involvement towards economic development are the focus of the Industrial Partnering Program. This initiative involves State Department Aid for International Development (AID) funds, channeled through DOE laboratories for the support of Russian and US scientists pursuing the development of Russian technical ideas showing promise for transfer into commercial sectors.

The Laboratory also offers significant technical support to the so-called "Nunn-Lugar" program of assistance to the Former Soviet Union in the safe dismantlement of nuclear weapons. Los Alamos efforts are focused largely on issues related to safety and material control and accounting. Los Alamos scientists and engineers also find themselves working with FSU colleagues to support the technical implementation of a variety of other governmental-to-government agreements related to nuclear weapon dismantlement, nuclear material control, and nonproliferation. Indeed, it is often the personal and professional relationships among scientists that enable effective progress towards the objectives of these other agreements.

Historic Scientific Interactions with the FSU

The interaction of scientists of the Los Alamos National Laboratory and other DOE nuclear weapons laboratories with colleagues in the FSU did not commence with the end of the Cold War. Scientists have met, and continue to meet regularly through

international scientific gatherings, and to communicate through both formal publications and personal mail. A few current examples serve to illustrate the sort of collaborations that have occurred; however, it should be kept in mind that these represent only a fraction of the total activity in many disciplines.

Space science and astrophysics are particularly rich fields of collaboration involving Los Alamos staff. The Soviet-American Gallium Experiment (SAGE) represents one such example. This is a cooperative effort with the Joint Institute for Nuclear Research at Dubna to monitor solar neutrinos using a large-scale gallium-based detector. In cooperation with NASA, over $1 M in US equipment has been provided, and Los Alamos scientists have participated in the experiments at Baksan with Russian colleagues since 1985. Other Los Alamos scientists have worked with Russian scientists on the development of the MOXE x-ray detectors for conducting full-sky surveys on future space launches. Joint work is also proceeding on gamma detectors to be flown on a Mars mission in 1996. These detectors will conduct measurements from deep-space sources, and will support chemical analysis of Martian soil using cosmic-ray backscattering.

Other areas of collaboration include studies of muon catalyzed fusion; evaluation of accelerator based conversion methods for nuclear waste; nuclear measurements at the Obninsk Institute of Physics and Power Engineering; and a joint program of plasma physics measurements at Troitsk.

Laboratory-to-Laboratory Exchanges

In recent years, Los Alamos has made an institutional commitment to supporting appropriate interactions with Russian and other FSU scientists in ways that move beyond individual scientific contacts. The Laboratory recognized and responded to an opportunity to establish professional and institutional relationships designed to serve mutual interests in the scientific conversion of nuclear weapons institutes, the commercialization of unique technologies, and the curbing of nuclear proliferation. Over the course of time, these activities have assumed significant proportion, with the political and fiscal support of the respective governments.

History

The direct contacts between weapons scientists of the US and the FSU began during what are now seen as the last days of the Cold War. The suspicion with which each side then viewed the other was typified by the US initiative to negotiate improved verification protocols to the Threshold Testban Treaty (TTBT) and the Peaceful Nuclear Explosions Treaty (PNET). It was President Reagan that coined the phrase "Trust but Verify." It was an unintended outcome that, during the negotiations to identify and confirm improved technical means for verification, weapons scientists from the two countries first began to know each other and to begin developing relationships of trust. Indeed, it was the development of this trust, based in part on parallel technical experience, that enabled

the successful conduct of two Joint Verification Experiments (JVEs), and the subsequent conclusion of the technically complex treaty protocols. Many aspects of the conduct of the JVEs during the summer of 1988 resembled more a large-scale international experimental collaboration than a politically-charged exercise by untrusting adversaries.

One aftermath of this experience was the invitation to Los Alamos scientists, who had played key roles in the negotiations and the JVEs, to visit the Soviet Nuclear Centers at Arzamas-16 and Chelyabinsk-70. These were the first such visits to these centers by any Western individuals, and this breakthrough was followed by a continuing series of informal contacts over the next several years.

As the Cold War drew to a close with a series of historic arms reduction agreements, and political changes in, and the subsequent collapse of the Soviet Union, Los Alamos recognized an historic opportunity. Los Alamos and the other DOE nuclear weapons laboratories could play a unique role in building personal and institutional relationships with FSU colleagues that could help stabilize many of the changes then occurring. A plan was outlined and approved for developing such relationships. Communicating through the scientific channels established earlier, invitations were issued for the Directors of the All-Russian Scientific Research Institute of Experimental Physics (Arzamas-16) and the All-Russian Scientific Research Institute of Technical Physics (Chelyabinsk-70) to visit Los Alamos and Livermore National Laboratories during February 1992. Reciprocal visits by the US laboratory Directors to Arzamas and Chelyabinsk occurred later that month.

The discussions that took place during these visits established a framework for future scientific collaborations in areas of mutual interest. The easiest areas to identify were ones related to pure science. However, with the concurrence of the Department of Energy and the Department of State, it was agreed to pursue certain additional topics related to safety and nonproliferation. Over the next several months, laboratory and institute representatives held a series of meetings to agree on those areas of cooperation to be pursued with the highest priority.

In the ensuing months, Los Alamos has pursued a wide range of technical interactions on a laboratory-to-laboratory basis. These activities have included technical meetings, symposia, joint experimental work, and commissioned scientific studies. Topics have ranged from computational science, environmental remediation, accelerator transmutation of waste, approaches to technology commercialization, and a broad selection of topics in fundamental science.

A number of interchanges have focused on the joint development of proposals to the International Science and Technology Center (ISTC) in Moscow. At this time, Los Alamos is a partner in about 8 ISTC-approved projects with Russian institutes. While these cover a range of subjects, the largest Los Alamos project involves work with nine

Russian institutes to examine the feasibility of, and explore technology related to accelerator transmutation of nuclear waste (ATW).

In order to facilitate cooperation with Russian laboratories, Los Alamos has established streamlined contracting procedures with a number of facilities. These umbrella agreements have the virtue of dealing with most of the administrative matters on a one-time basis, and allowing scientists to focus on specific technical statements of work for individual cooperative ventures. This approach was pioneered by Los Alamos and Arzamas-16, and within the framework agreement, these laboratories are pursuing joint research in such areas as the physics of colliding plasmas, computational physics, magnetized target fusion, nuclear reactor safety, and experimental diagnostic instrumentation development. A major area of collaboration has developed in the field of high explosive pulsed power and the utilization of such sources for the study of ultrahigh magnetic fields and associated physical phenomena. This effort is described in more detail in the following section.

Los Alamos - Arzamas-16 Collaboration in Pulsed Power and High Energy-Density Physics

Russian work on high-explosive pulsed power has for years attracted some of the finest minds of Russian science. Research in this area expressed Andrei Sakharov's "fondest wish," and engaged the personal attention of Yuli Khariton, the "Soviet Oppenheimer." The center of excellence for this research emerged at the All-Russian Scientific Research Institute for Experimental Physics (VNIIEF), or Arzamas-16, and the effort was led by Academician Aleksandr Pavlovski until his death in February 1993. A similar program was pursued at Los Alamos, under the leadership of Max Fowler, and limited technical communication occurred through participation in international conferences.

With the thawing of superpower relations, and the exchange of visits by laboratory directors and technical experts in 1992, Los Alamos and Arzamas seized on the opportunity to develop a direct collaboration in this field. The collaboration would build on the Russian excellence in high-explosive flux compression generator design and the US capabilities in computational modeling and experimental diagnostics. The agreed approach followed a pattern that has proven to be a model for cooperation of this sort. It began with exchanges of reprints, preprints and data from past research, and soon progressed to agreed analysis of simple physical problems in plasma physics. By late 1992, the two laboratories were planning joint magnetic flux compression generator experiments. The first of these, using Los Alamos diagnostics and a unique Russian high current generator, was conducted at VNIIEF on September 22, 1993, with the two countries' scientists working side-by-side as equals. The generator dumped 20 megamperes into an aluminum liner, resulting in a highly symmetric axial implosion.

The following winter, the collaboration conducted experiments at Los Alamos to investigate ultra high magnetic fields and high temperature superconductor properties.

This series of four experiments verified generator performance, produced a US-record nine megagauss magnetic field, and provided the first detailed measurement of the upper critical field of YBCO. The program has continued with a series of joint experiments on the compression of magnetized plasmas. The overall program represents a true collaboration, with each partner providing unique scientific capability, and contributing to mutual benefit in the pursuit of new science. The teams work together, live in each other's towns during the conduct of an experimental program, and share equally in the experimental results. A high degree of mutual respect and trust has developed through this mode of interaction, and the program has been a model for the development of similar collaborative programs in other technical areas.

Industrial Partnership Program

These personal and institutional relationships have not only assisted in stabilizing some scientific programs at Russian nuclear weapons centers. They have also enabled the launching of a broader program to engage weapons scientists in the development of technologies with commercial potential. A small number of partnerships involving FSU and US laboratories, and US and occasionally FSU industry developed naturally out of individual collaborations. However, a systematic effort was enabled in 1994 by US congressional action. This initiative, known as the Industrial Partnership Program (IPP), set aside US Department of State Aid for International Development funds for the commercialization of appropriate FSU science and engineering applications. Of the $35 M total authorization, $20†M was for jump-starting the initiative by promoting DOE laboratory partnerships with FSU institutes to pursue the development of technologies with potential for commercial development. Additional funds were committed to the establishment of a US Industrial Coalition for competitively identifying technologies for further commercialization. The intent is to encourage links between FSU institutes and US industries, with appropriate protection of intellectual property rights.

As the program progresses, it is expected that the balance will shift from emphasis on laboratory-based initiatives towards greater emphasis in industrial involvement. The DOE laboratory projects are reviewed and selected competitively by an Interlaboratory Steering Group, currently chaired by Los Alamos. Over 180 individual projects have been approved in areas ranging from materials science and processing to computational algorithms. Some specific examples of joint projects with commercial possibilities are: superplastic forming of metals; modeling of recovery in marginal oil-fields; large-scale database tools for massively parallel computation; mechanical response of structural materials to shocks; production of high-conductivity, high-strength wire; and dielectric coating development and production.

The DOE laboratories can play a number of different roles in these collaborations with industry. One representative joint initiative involves the (US) National Center for Material Science (NCMS), Los Alamos, and the Paton Institute in Ukraine. The Paton Institute had developed a class of very high-power, compact gyrotrons that did not meet

US industrial standards, e.g., for safety. Los Alamos purchased several gyrotrons, and working with Paton has modified them for compliance with US standards. Four gyrotrons are now being evaluated at Los Alamos by NCMS member industries for prototyping. In this manner, the laboratory role has been to use its relationship with Paton, and its experience with high-power microwaves, to reduce the risk to US industry for commercialization of an FSU technology. The resulting products will benefit both the FSU developers and US industry.

Nuclear Material Protection, Control and Accountability: a Multi-Laboratory Initiative

Control of nuclear materials has always been a centerpiece of US and international efforts to inhibit the proliferation of nuclear weapons. Related technologies were therefore a natural component of interchanges between US and Russian nuclear weapons institutes. At an informal, purely scientific level, the laboratories exchanged information on basic technologies and instrumentation useful for nuclear material control and accounting. In more formal governmental negotiations under the umbrella of the Cooperative Threat Reduction Program, also known as the Safe and Secure Dismantlement (SSD) or Nunn-Lugar Program, the US and the countries of the FSU reached agreement on assistance in the establishment of states systems of material control and accountability (MC&A). These programs are described in more detail below. However, there occurred during 1993-94 a continuing series of nuclear material smuggling incidents, which led to growing concern that formal MC&A efforts were not moving fast enough to be effective. In response, and building on the trust developed in laboratory-to-laboratory collaborations, Los Alamos initiated a program to infuse material control technology and methods into Russia from the bottom up, by working directly with key technical institutes having nuclear material expertise and responsibility.

In the ensuing months, this program has blossomed into a major effort involving a number of DOE laboratories: Los Alamos (Lead), Livermore, Sandia, Brookhaven, Oak Ridge, and Pacific Northwest. The objective is to make rapid improvements in the protection, control and accounting of nuclear materials, with emphasis on weapons-usable materials, by working directly and cooperatively with Russian laboratories and institutes. Implementation of improved methods at operating nuclear facilities, many of which are highly sensitive and inaccessible to foreigners, will be carried out by the Russian laboratories with technical assistance from US laboratories.

The technical focus is on the development of material protection, control and accountability (MPC&A) systems that will be effective at Russian facilities and within Russian administrative systems. This program is coordinated with the more formal, top-down SSD programs. Key Russian institutes will develop demonstration MPC&A systems that integrate Russian administrative approaches and equipment with appropriate US technology and methods. In turn, these methods, procedures and equipment will be demonstrated to a broad cross-section of Russian nuclear specialists from operating

facilities, institutes and ministries. The demonstrations will set the stage for widespread implementation of improved MPC&A systems at operating nuclear facilities. The US has already made significant strides in the first phases of this program with such institutes as Arzamas-16, the Kurchatov Institute, Eleron, the Institute of Physics and Power Engineering (Obninsk), and Chelyabinsk-70. The first integral demonstrations are anticipated for the winter of 1994-95.

Safe and Secure Dismantlement of FSU Nuclear Weapons

Los Alamos and other DOE laboratories are playing a supporting role in several other programs intended to facilitate the dismantlement of nuclear weapons and curb the potential proliferation of nuclear weapons capability. The largest such program is the so-called "Nunn-Lugar" initiative to support the safe and secure dismantlement (SSD) of nuclear weapons. In 1991 congress passed the "Soviet Threat Reduction Act, sponsored by Senators Sam Nunn and Richard Lugar, and providing authorization for $400 M to facilitate the transportation, storage, safe-guarding, and destruction of nuclear and other weapons in the Soviet Union. In subsequent years, similar legislation, known variously as the "Former Soviet Union Demilitarization Act" and the "Cooperative Threat Reduction Act," provided additional funds, and extended the scope of the program to cover defense industry conversion, environmental remediation, housing for former military personnel and limited non-proliferation-related activity. Implementation of this program has been through the negotiation of some 37 (as of April, 1994) bi-lateral agreements between the US and the four FSU republics that have, or have had nuclear weapons on their territories.

The US Department of Defense is the designated administrative agency for this program, and it has solicited the support of other agencies as appropriate. The bulk of the funds have been restricted to expenditure in the US, or through US contractors, with equipment and services delivered to the FSU. Two exceptions have been the $25 M in funding to the International Science and Technology Center in Moscow, and the $10 M for the similar center in Ukraine. The DOE nuclear weapons laboratories have provided expert technical support in the areas of nuclear weapons safety and security, emergency response capability, and nuclear materials handling, control and accounting.

Nuclear Weapons Safety & Security Technology

The experience of DOE laboratories with nuclear weapons made them a natural source of expertise in the provision of equipment, training and other assistance to the FSU to enhance the safety and security of nuclear weapons dismantlement operations. Specific assistance agreements have been, or are being implemented in a number of related areas intended to protect warheads during transshipment for dismantlement or storage, and to provide for safe and secure storage of warhead components. Los Alamos, Lawrence Livermore and Sandia National Laboratories are working with the Department of Energy and the DoD to fulfill these agreements. Flexible armored blankets were designed,

manufactured, delivered and used by Russia to protect warheads from small-arms fire during transportation. Modification kits were developed, produced and delivered for the improving the safety and security of the Russian MoD railcars used for warhead transportation. Nuclear material storage containers are being designed and produced for the shipment and storage of warhead components obtained from dismantlement. In particular, these containers will be used for the storage of components in a new fissile material storage facility being designed and constructed with US assistance. Los Alamos scientists are working closely with Russian experts in the assessment of safety features of this design. The US DoD and the Army Corps of Engineers is providing other construction assistance, including the delivery of specific construction equipment.

Nuclear Weapons Emergency Response Capability

Both the US and the Russian Federation have established systematic and careful procedures for the handling, transport and storage of nuclear warheads. Accidents involving warheads are extremely unlikely. However, the unprecedented formal and informal agreements between the two countries for nuclear disarmament and warhead dismantlement will, for the short-term, increase the exposure of warheads to possible mishap. Each country has procedures and personnel trained and ready to respond in the unlikely event of an accident. However, it would be imprudent not to improve such preparedness in appropriate ways. The US is providing Russia with a variety of modern equipment for responding to an accident, for assessing the condition of weapons and weapon components involved in any such accident, and for stabilizing them for safe transport to appropriate handling facilities. The DOE weapons laboratories are providing specialized radiation monitoring equipment, protective clothing, and a variety of equipment, including fiberscopes and mobile x-ray machines, for examining the internal condition of damaged weapons or components. In additional equipment being supplied includes a liquid-abrasive-cutter for severing parts without risking the detonation of any high explosives, and a mobile laboratory for evaluating the nature and likely extent of any radioactive contamination.

Subsets of this equipment also have been, or are being provided to Belarus, Ukraine and Kasakhstan to improve their ability to respond to other kinds of accidental releases of radioactivity. In all cases the laboratories are providing the end users with extensive documentation and training in the deployment, use and maintenance of the provided equipment.

Nuclear Material Control and Accounting

As indicated above, the control of nuclear material is an essential ingredient in efforts to control the proliferation of nuclear weapons technology. A number of SSD agreements are being implemented in pursuit of this objective, and the DOE laboratories are working with FSU counterparts to support these efforts by applying their expertise in nuclear materials, and nuclear materials control and accounting techniques.

Under one agreement, the US agreed to purchase 500 metric tons of highly enriched uranium extracted from nuclear warheads. Russia will blend the material down to low enriched uranium before transfer of ownership to the US Los Alamos has provided technical advice on monitoring this process as the material moves from Russian military programs to the US for peaceful applications under IAEA safeguards. In addition, Los Alamos scientists have been working with Russian scientists to design and evaluate the material control and accounting systems that will be implemented in the Russian fissile material storage facility for nuclear components from warhead dismantlement.

The US has also negotiated a series of agreements with Russia, Belarus, Ukraine and Kasakhstan for assistance in the development of state systems of material control and accounting for civilian nuclear materials. Under a separate understanding reached in the Gore-Chernomyrdin Commission, the US and Russia will seek to extend the civilian system to encompass military materials as well. Under the civilian program, DOE laboratories, including Los Alamos, have been working with nuclear facility operators in the designated FSU countries to evaluate material handling and processing cycles. Based on these evaluations, appropriate equipment, computer software and training are identified and provided. As in all of these SSD initiatives, the quality and effectiveness of these programs has been significantly enhanced because of the personal and institutional relationships established in other areas of cooperation.

Other National Security-Related Technical Interchange Programs

There are other situations in which the DOE national laboratories have been able to use their technical resources to support US initiatives with the FSU. In some instances, this support has been to formal exchanges between governments; in others, the interactions have been more informal, but equally supportive of the mutual interests of the countries.

Surety Technology Exchanges with Russian Nuclear Weapons Institutes

One example of a more informal interaction involves a series of Surety[2] Technology Exchanges (STE) between the three US nuclear weapons laboratories and their equivalent institutions in the Russian Federation. In the US, these are the Los Alamos, Lawrence Livermore and Sandia National Laboratories, and Russia, they are All-Russian Scientific Research Institutes of Experimental Physics (Arzamas-16) and Technical Physics (Chelyabinsk-70). The purpose of these exchanges has been to share technical information concerning the safe and secure handling of hazardous materials. It was understood by both governments that, while all information discussed in these exchanges

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[2] In this context, the term surety applies collectively to the concepts of safety and security. In Russian there is a single word that encompasses both concepts. However, in English the terms sometimes have distinguishable meanings. To avoid confusion, the words physical protection are used to describe the appropriate concept of security.

would be unclassified and not weapons-specific, the ability of both sides to ensure safe and secure handling of nuclear weapons would be improved through the sharing of basic scientific approaches and experience in dealing with hazardous materials. The basic framework for these interchanges was agreed in July 1993 during meetings among representatives of the participating institutions. Within the US, a DOE/Laboratory Steering Group provides overall guidance and coordination for all technical exchanges under this program.

A major element of the STE Program has been a series of technical symposia involving all of the participating institutions. The topics for these symposia have been Risk Assessment; Response of Engineered Systems to Abnormal Environments; Transportation Surety; Accident Resistant Containers; Processing and Cleanup of Hazardous Materials; and Handling and Properties of Energetic Materials. In each case, the meetings have included technical presentations, poster sessions, and extensive informal discussion. Many areas of cooperative technical work have been identified through these interchanges, and in a number of such areas, US laboratories have established technical contracts with the Russian institutes for the conduct of additional scientific work. Both sides have increased their understanding of the technical state of the art in surety technology, and have expanded the foundation of experience on which sound procedures are based.

Technical Support for Government-to-Government in Other Topics Related to Nuclear Weapons and Disarmament

Laboratory technical expertise has been called upon in numerous other situations to support formal government initiatives to facilitate disarmament or promote the objectives of nonproliferation. For example, the US and the Russian Federation have agreed that the cessation of production of nuclear materials for weapons is an important step in limiting its availability to potential proliferants, as well as demonstrating commitment to reduced reliance on nuclear weapons. The US has already ceased such production unilaterally. Russia, which has a significant reliance on nuclear reactors for some of its energy needs, and has less distinction between its civil and military reactor programs, has committed to an eventual cutoff. Experts from the two countries are working together to devise technical means to verify such cutoffs, and to examine alternative ways to meet future energy requirements. Solutions will require both ingenuity and cooperation.

Another example may be found in the steps the governments are taking to improve confidence in progress towards the disarmament goals that have been agreed. In particular, "[T]he two sides intend to conclude an agreement on the means of confirming the plutonium and highly enriched uranium inventories from nuclear disarmament."[3]

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[3] "Joint Statement on Inspection of Facilities Containing Fissile Materials Removed from Nuclear Weapons," Secretary Hazel O'Leary and Minister Victor Mikhailov, March 16, 1994.

Experts from the nuclear weapons laboratories of both countries have been key participants in meetings and demonstrations of technology in pursuit of this goal. A particular challenge is for each side to enable access to enough data for the other to be assured of progress in weapons dismantlement, while still protecting sensitive information regarding weapons design. Once again, these technical challenges are being addressed by experts who have already established relationships of mutual respect and cooperation through the interactions of their institutes. These are but two examples from among many that are becoming more and more common as the former Cold War adversaries seek both formal and informal ways to work together.

Conclusions

Los Alamos National Laboratory has found many ways in which to have science serve as a bridge to its sister institutes in the Former Soviet Union. Sometimes scientists have offered their services to their government to pursue formal national security objectives. At other times, they have worked more independently through their laboratories. But in all cases scientists have followed a careful, step-by-step approach that has treated colleague individuals and institutions with respect.

One has to begin by recognizing the inherent difficulties of operating in Eastern Europe or the Former Soviet Union. These can include problems with travel, with communication, or in moving equipment and other resources between countries. With a clear understanding of these potential obstacles, one must always set realistic goals for collaboration, usually marking progress in terms of small steps. It is imperative to identify objectives and deliverables clearly, to agree on when these goals are expected to be achieved, and to have a clear understanding of how results will be shared, published or made available for commercialization. Above all, the collaboration must be as equals. This is an approach to collaboration that has been very productive and effective for Los Alamos National Laboratory as it seeks to work with new partners in promoting common objectives for international security. Indeed, the personal and institutional relationships established through these collaborations will likely transcend any specific programs, and even the foreseeable evolution of political interests.[4]

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