
# Future of the Nuclear Security Environment in 2015: Proceedings of a Russian-U.S. Workshop

ISBN
978-0-309-13144-5

309 pages
8 1/2 x 11
PAPERBACK (2009)

Ashot A. Sarkisov and Rose Gottemoeller, Editors; Joint Committees on the Future of the Nuclear Security Environment in 2015; in cooperation with the Russian Academy of Sciences; National Research Council

# FUTURE OF THE NUCLEAR SECURITY ENVIRONMENT IN 2015

## *Proceedings of a Russian—U.S. Workshop*

**Ashot A. Sarkisov and Rose Gottemoeller,** ***Editors***

**Joint Committees on the**
**Future of the Nuclear Security Environment in 2015**

**Committee on International Security and Arms Control**
**Policy and Global Affairs**

**In cooperation with the Russian Academy of Sciences**

NATIONAL ACADEMY OF SCIENCES
*THE NATIONAL ACADEMIES*

**THE NATIONAL ACADEMIES PRESS**
**Washington, D.C.**
**www.nap.edu**

**THE NATIONAL ACADEMIES PRESS 500 Fifth Street, N.W. Washington, DC 20001**

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

**This study was supported by Contract/Grant No. 31867 between the National Academy of Sciences and Battelle Memorial Institute, Pacific Northwest Division (for the U.S. Department of Energy's Pacific Northwest National Laboratory).** Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

International Standard Book Number 13: 978-309-13144-5
International Standard Book Number 10: 0-309-13144-8

A limited number of complimentary copies are available from the Committee on International Security and Arms Control, National Academy of Sciences, 500 Fifth Street, N.W., Washington, DC 20001; +202-334-2811.

Additional copies of this report are available from the National Academies Press, 500 Fifth Street, N.W., Lockbox 285, Washington, DC 20055; (800) 624-6242 or (202) 334-3313 (in the Washington metropolitan area); Internet, http://www.nap.edu.



Printed in the United States of America.

# THE NATIONAL ACADEMIES

*Advisers to the Nation on Science, Engineering, and Medicine*

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

**www.national-academies.org**

## COMMITTEE ON THE FUTURE OF THE NUCLEAR SECURITY ENVIRONMENT IN 2015
## THE U.S. NATIONAL ACADEMIES

ROSE GOTTEMOELLER, *Cochair*, Carnegie Moscow Center/Carnegie Endowment for International Peace
LINTON F. BROOKS, Independent National Security Consultant
MONA DREICER, Lawrence Livermore National Laboratory
JAMES FULLER, University of Washington, Seattle
RICHARD W. MIES, Independent National Security Consultant
CHERRY MURRAY, Lawrence Livermore National Laboratory
M. TERESA OLASCOAGA, Sandia National Laboratories

## COMMITTEE ON THE FUTURE OF THE NUCLEAR SECURITY ENVIRONMENT IN 2015
## RUSSIAN ACADEMY OF SCIENCES

VICE ADMIRAL ASHOT A. SARKISOV, *Cochair*, Russian Academy of Sciences (RAS)
REAR-ADMIRAL VYACHESLAV M. APANASENKO, Russian Academy of Rocket and Artillery Sciences
EVGENY N. AVRORIN, All-Russian Scientific Research Institute of Technical Physics
LEONID A. BOLSHOV, Nuclear Safety Institute, RAS
LEV D. RYABEV, Rosatom

***With the support of***
ANATOLY I. ANTONOV, Department of Security and Disarmament, Ministry of Foreign Affairs
ANDREY A. KOKOSHIN, Institute for International Security Problems, RAS

**National Research Council Staff**

ANNE M. HARRINGTON, Director, Committee on International Security and Arms Control
RITA S. GUENTHER, Senior Program Associate, Committee on International Security and Arms Control

**Russian Academy of Sciences Staff**

TATIANA POVETNIKOVA, Program Officer, Nuclear Safety Institute, RAS
OLGA KUZNETSOVA, Policy and Security Fellow, Nuclear Safety Institute, RAS
YURI SHIYAN, Director, Office for North American Scientific Cooperation, RAS

# PREFACE AND ACKNOWLEDGMENTS

In the nearly two decades of transition following the dissolution of the Soviet Union, the United States and the Russian Federation have jointly cooperated on several Cooperative Threat Reduction Programs designed to safely and securely manage Russia's nuclear weapons and the materials used to build them.[1] Through the joint implementation of these programs, U.S. and Russian experts have developed an effective working relationship, collaborating to improve the safety and security of nuclear materials across Russian civilian and military facilities, and to prevent the proliferation of these materials and associated expertise beyond Russia. As became particularly evident following the terrorist attacks of September 11, 2001, these programs are of vital importance to the security of the United States, the Russian Federation, and the international community.

Now, after years of productive cooperation, the relationship between the United States and Russia is evolving from one of assistance to one of partnership, which has demonstrated the potential to address a wide range of challenges facing the international nuclear security environment, including issues of non-proliferation, the global expansion of nuclear power, and nuclear terrorism. The two countries are therefore poised to carry their experience and expertise as advanced nuclear states into a new phase of partnership, leading efforts to strengthen nuclear security bilaterally and in broader regional and international contexts.

The formal basis, upon which that partnership now rests, the Cooperative Threat Reduction agreement between the United States and Russia, is scheduled to expire in 2013.[2] Following this date, the Russian Federation will assume full programmatic and financial responsibility for managing and securing vast quantities of nuclear materials. During the February 2005 summit in Bratislava, Slovakia, Presidents Vladimir V. Putin and George W. Bush confirmed their commitment to strengthening their partnership as a means of addressing not only existing challenges of nuclear security and counter-terrorism, but also the challenges of coming decades.[3]

This commitment to continued cooperation provided the context for the joint National Academies' (NAS)-Russian Academy of Sciences' (RAS) public workshop on the *Future of the Nuclear Security Environment in 2015*, held November 12-13, 2007, in Vienna, Austria, with the support of the U.S. Department of Energy and the International Atomic Energy Agency (IAEA). The papers contained in this proceedings were presented at this two-day workshop convened at

[1] For further information regarding the Cooperative Threat Reduction programs, see http://www.nti.org/db/nisprofs/russia/forasst/nunn_lug/overview.htm; accessed April 8, 2008.

[2] The Bob Stump National Defense Authorization Act of 2003 mandates that a sustainable materials protection, control, and accounting system be transferred to sole Russian Federation support no later than January 1, 2013. For further information regarding the Bob Stump Act, see http://www.army.mil/armybtkc/docs/PL%20107-314.pdf; accessed May 1, 2008.

[3] For further information regarding the "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation," of February 24, 2005, see http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html; accessed February 23, 2008. See also Appendix D for full text of this Joint Statement.

the Austria Center (see Appendix A for the workshop agenda). The workshop was held in Vienna as a means of placing the discussion in the larger context of international developments in nuclear security, many of which (e.g. safeguards and international access to peaceful energy) involve various aspects of the IAEA. Throughout the workshop, IAEA experts participated in the discussions and provided useful insights into areas of technical cooperation that would benefit from joint U.S.-Russian involvement (see Appendix B for the list of workshop participants). The workshop was organized by joint committees of the U.S. National Academies and the Russian Academy of Sciences, co-chaired by Rose Gottemoeller and Academician Ashot Sarkisov (see Appendix C for committee bios). The joint committees met in Washington, D.C. in June 2007, and in Moscow in August 2007, to plan the workshop and to seek the views and opinions of experts knowledgeable about the Cooperative Threat Reduction Programs and its potential for expanded cooperation and partnership.

Workshop presenters from the Russian Federation and the United States included employees of national laboratories of the two countries, former government officials of the two countries, a United Nations representative, independent consultants, academics, and those currently serving in private industries and non-governmental organizations.[4] Each was asked to address, in part or in full, the following questions:

- What do U.S. and Russian experts perceive as the main challenges to nuclear security in 2015, and how can they work over the next decade to address these challenges as partners?

- What factors might assist or obstruct the partners as they address those challenges?

- How can this partnership concretely and effectively assist mutual non-proliferation goals in other regions such as Asia and the Middle East, and/or in multi-lateral arrangements such as the provision of international fuel services and broader technology cooperation?

- How can the U.S. and Russia work to sustain the non-proliferation advances gained through more than a decade of material protection, control, and accounting and other cooperative efforts?

- In addition to sustaining existing efforts, how can new approaches such as public-private partnerships, strengthened legal structures, and effective management tools be successfully employed to address emerging challenges?

In their written as well as oral remarks, participants expressed their own individual views and did not represent the views or positions of their governments or employers. This facilitated an open and frank discussion, and while no formal consensus among participants was sought, a surprising degree of agreement was articulated, particularly on the trends in the nuclear security environment, priorities for the U.S.-Russian partnership, and available tools to address future security challenges.

---

[4] For more general discussion of public-private partnerships and creative incorporation of private organizations into future bilateral and multi-lateral non-proliferation cooperation, see the paper by Vyacheslav Apanasenko in this volume.

The workshop was designed to explore various views on where our U.S.-Russian security relationship in 2015 could and perhaps should be, and various means of achieving an "ideal relationship," realizing that there are perhaps many "ideals." Therefore, authors drew variously on past and present experiences to form their arguments and descriptions of that "ideal" future relationship. Some articulated these steps more clearly than others, but we hope that as a whole the volume is able to provide a broad spectrum of ideas and views for the future relationship in 2015.

## TRENDS, PRIORITIES, AND TOOLS FOR EXPANDED PARTNERSHIP

An important trend identified by many workshop participants is that Russia and the United States are continuing the transition from an assistance relationship, which was prevalent during the 1990s, to a partnership relationship. A partnership relationship implies that the two countries are willing to share in setting priorities for cooperation, managing projects, and funding cooperative efforts. Priorities for this evolving partnership include both persistent challenges, such as further reductions in nuclear weapons in the pursuit of fulfilling Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons,[5] and new challenges such as the expansion of nuclear energy technologies, nuclear forensics, nuclear terrorism, and challenges which may arise in third countries. Several workshop participants identified a particularly promising area for full partnership in efforts to develop nuclear fuel assurances for those countries seeking to expand nuclear power without developing all aspects of the nuclear fuel cycle. By partnering to address this immediate global opportunity, Russia and America may continue to lead the international community not only in scientific and technical advances, but also in nuclear non-proliferation policy.

Fortunately, more than a decade of cooperation has provided a wide variety of tools to experts from both countries as they seek to address these priorities, including: government-to-government and non-governmental arrangements, systematic approaches such as that of Strategic Master Plans, and public-private partnerships. A solid yet flexible legal foundation for cooperation, political support at the highest levels, projects of appropriate size and scale for the tasks at hand and the resources of those involved, and sustained engagement by qualified and dedicated individuals are well-proven mechanisms for developing the mutual understanding, trust, and commitment required for Russia and the United States to remain productive partners. Much work remains, however, to ensure that a successful transition to full partnership is accomplished in the coming years, well before 2015.

Now the third in a very successful series of joint NAS-RAS projects on nuclear security, this workshop proceedings serves as the basis for exploring the possibility of a further joint NAS-RAS effort to provide concrete recommendations for both Moscow and Washington on how they may proceed in transitioning to full partnership, in which both Russia and the United States can serve as leaders bilaterally and internationally in responding to the difficult nuclear security challenges that face us all in the coming decades.

---

[5] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

# ACKNOWLEDGMENTS

This publication was made possible through the support of the U.S. Department of Energy. The Russian Academy of Sciences and the International Atomic Energy Agency also provided critical logistical and administrative support in both Moscow and Vienna, without which the preparatory meetings and workshop would not have been possible. Such generous support, whether in the form of financial contributions, visa invitations, administrative assistance, or transportation, is greatly appreciated.

This volume has been reviewed in draft form by individuals chosen for their technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for quality. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We wish to thank the following individuals for their review of this volume: Sergei Vyachaslavovich Astapov, Institute of Strategic Stability; Lewis Dunn, Science Applications International Corporation; Sergei Ruchkin, World Nuclear Association; Halvor Andre Undem, International Atomic Energy Agency; Ned Wogman, Pacific Northwest National Laboratory; and Sergei Aleksandrovich Zelentsov, Institute of Strategic Stability.

Although the reviewers listed above have provided constructive comments and suggestions, they were not asked to endorse the content of the individual papers. Responsibility for the final content of the papers rests with the individual authors.

We also wish to thank the following individuals for their cooperation and support, for their assistance in making the workshop possible, and subsequently for their assistance in producing these proceedings: Christopher A. Eldridge (IAEA), Eva Fritz (IAEA), Rita Guenther (Committee on International Security and Arms Control), Tatiana Povetnikova, (Nuclear Safety Institute, RAS), Yuri Shiyan (RAS), and Olga Smyshlyaeva (Nuclear Safety Institute, RAS). We are also grateful to Tariq Rauf (Office of the Director General, IAEA) for his participation in the workshop and the paper provided for this proceedings. Finally, we are grateful to Sergei Astapov and Sergei Zelentsov of the Institute of Strategic Stability for their comments on select papers.

Rose Gottemoeller
U.S. National Academies' Cochair

Academician Ashot A. Sarkisov
Russian Academy of Sciences' Cochair

# CONTENTS

# OVERVIEW OF U.S.—RUSSIAN PARTNERSHIP AND PERCEPTIONS OF THE THREAT ENVIRONMENT

+

# LEADERSHIP THROUGH PARTNERSHIP: A VISION FOR THE 2015 NUCLEAR SECURITY RELATIONSHIP BETWEEN THE UNITED STATES OF AMERICA AND THE RUSSIAN FEDERATION

Ambassador Linton F. Brooks,
*Independent Security Consultant*

This paper sets forth one American view of the ideal 2015 nuclear security relationship between the United States and the Russian Federation—a vision of partnership. Together with a companion paper written from a Russian perspective,[6] it is designed to help frame a discussion of the context for future cooperation in the area of nuclear security. The paper makes no attempt to prescribe specific steps to reach this ideal relationship or to analyze the (considerable) obstacles that must be overcome en route. Instead, it is based on the premise that we must first establish a set of goals before we can determine the path to reach those goals.

## U.S. PERCEPTIONS OF THE NUCLEAR THREAT DURING THE COLD WAR

Of the many potential areas for cooperation between the United States and the Russian Federation, nuclear security is particularly attractive to Americans because of the common threat that both countries face. U.S. perceptions of the nuclear threat have changed dramatically since the end of the Cold War. For decades, "nuclear threat" was a synonym for "threat from the Soviet Union." Soviet forces dominated nuclear planning, and improving stability in a crisis with the Soviet Union was a major motivation for U.S. arms control efforts. Some American specialists also worried about China, but it was generally assumed that dealing with China was a lesser-included case of dealing with the Soviet threat. Analysts occasionally worried about a future Chinese build up, but these concerns played no significant role in U.S. nuclear policy or force structure. While the United States worked diligently (often in cooperation with the Soviet Union) to prevent nuclear proliferation, such proliferation was not seen as an *immediate threat* to the United States. Nuclear terrorism played a very limited role in U.S. thinking.

[6] See the paper by Lev D. Ryabev in this volume.

## CURRENT U.S. THREAT PERCEPTIONS

In the post Cold-War world, and especially in the aftermath of the attacks of September 11, 2001, the U.S. threat perception has been totally reversed. The United States discounts any nuclear threat from Russia, despite the continued existence of a strong Russian strategic nuclear arsenal. Americans see no plausible source of armed conflict between themselves and Russia, and thus perceive no nuclear threat, except, perhaps, from miscalculation. This lack of concern is demonstrated by the 2001 Nuclear Posture Review conclusion that the United States no longer needed to plan its nuclear forces as if Russia presented an immediate threat, by the lack of U.S. interest in including traditional crisis stability measures in the 2002 Treaty of Moscow, and by the indifference with which the United States has responded to Russian hints that it might deploy multiple warheads on the Topol-M (SS-27) intercontinental ballistic missiles.[7]

China remains of concern, at least for some analysts and officials, because of the fear of a potential nuclear confrontation over Taiwan. These analysts fear that China would use its nuclear weapons in non-traditional ways, for example by using high-altitude bursts to generate electro-magnetic pulse as a counter to U.S. naval superiority. The United States has not, however, taken any action in response to this concern. Other analysts fear that China is on the verge of significant modernization that could increase the future nuclear threat to the U.S. homeland. The Nuclear Posture Review call to dissuade potential adversaries from trying to match U.S. capabilities clearly was drafted with China in mind. This policy has not, however, had any practical impact.

During the Cold War, nuclear proliferation was seen as a threat to international stability and a possible long-term threat to American security. In the post-Cold War world, proliferation, above all by Iran and North Korea, is seen as a direct, near-term threat to America. In the U.S. system, true policy is reflected not in rhetoric but in the budget. The U.S. deployment of ballistic missile defenses, narrowly designed to counter ballistic missiles from Iran and North Korea (although having an innate capability that concerns China and Russia) is a reflection of the degree to which Americans see nuclear-armed Iran or North Korea as a threat. While diplomacy is America's preferred method of reducing this threat, defenses—rather than deterrence—is seen as the appropriate course if diplomacy fails. This is not because such states are "undeterrable;" in principle deterrence can operate on any state. But many Americans are concerned that we may not understand the values, motives and decision-making style of the North Korean and Iranian leadership well enough for deterrence to be effective.

---

[7]To read excerpts of the 2001 *Nuclear Posture Review*, see http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm; accessed April 6, 2008. For further information about the *Review*, see http://www.nti.org/e_research/e3_15a.html; accessed April 6, 2008. The text of the 2002 Treaty Between the United States of America and the Russian Federation on Strategic Offensive Reductions (Treaty of Moscow) is available at http://www.state.gov/t/ac/trt/18016.htm#1; accessed April 6, 2008. Further information on the Treaty is available at http://www.nti.org/e_research/e3_14a.html; accessed April 6, 2008.

## THE DOMINANT THREAT: NUCLEAR TERRORISM

Since September 11, 2001, however, Americans perceive that the greatest nuclear threat they face is nuclear terrorism. Indeed, some of the concern over North Korea and Iran is because of their potential to facilitate and support such terrorism. Both have been state sponsors of terrorist groups in the past. Americans fear that a nuclear-armed Iran, with its strong anti-Israel bias, might transfer materials or even weapons to a terrorist group for ideological or theological reasons, especially in response to a future conflict involving American support for Israel. North Korea gets much of its revenue from such illicit activities as drug smuggling and counterfeiting. Americans fear that if the price was right, the North Korean leadership might be willing to transfer materials, knowledge or, perhaps, even a complete weapon if they thought they could do so with impunity. The growing American interest in nuclear forensics is, in part, intended to deter such transfers by making it likely that the United States could ascertain the source of material intercepted or used in an attack.[8]

The American concern with nuclear terrorism is not limited to terrorists supported by a state. Americans believe that if a terrorist organization could acquire sufficient fissile material, especially highly enriched uranium (HEU), it could construct an improvised nuclear device.[9] Such a device would be crude, inefficient, and relatively large, but could still easily be transported by a small panel truck and could detonate with devastating physical effect and even more devastating psychological effect. There is solid evidence that Al Qaeda is seeking to acquire a nuclear weapons capability (although there is no evidence they have done so).[10]

This concern with terrorists stealing or otherwise acquiring a nuclear weapon or the material to construct an improvised nuclear device is the major motivation for such efforts as the Global Initiative to Counter Nuclear Terrorism,[11] the strong U.S. support for United Nations Security Council Resolution 1540 (UNSCR 1540),[12] the large sums spent to assist Russia in improving weapons and material security, the U.S. global efforts to convert research reactors to low-enriched uranium and to repatriate the HEU,[13] and for such port and border security efforts as Second Line of Defense, Megaports and the Container Security Initiative.[14] Indeed, President

---

[8] See the paper by Michael Kristo in this volume.

[9] The U.S. Department of Energy (DOE) defines an improvised nuclear device as "a device, incorporating fissile materials, designed or constructed outside of an official Government agency and which has, appears to have, or is claimed to have the capability to produce a nuclear explosion." DOE Order 457.1, approved February 7, 2006. For further information, see http://www.directives.doe.gov/pdfs/doe/doetext/neword/457/o4571.pdf; accessed May 1, 2008. An improvised nuclear devise using plutonium would be somewhat more difficult but is probably within the capability of at least some terrorist organizations.

[10] For further information regarding this issue, see the *National Intelligence Estimate: The Terrorist Threat to the US Homeland*, available at http://dni.gov/press_releases/20070717_release.pdf, and the *National Strategy for Homeland Security,* available at http://www.whitehouse.gov/infocus/homeland/nshs/2007/index.html; accessed May 1, 2008.

[11] For further information regarding the G8 Global Initiative to Counter Nuclear Terrorism, see http://www.g8.gc.ca/2002Kananaskis/gp_stat-en.pdf; accessed on April 6, 2008. See also, http://www.state.gov/t/us/rm/69124.htm; accessed May 1, 2008.

[12] To read the text of United Nations Security Council Resolution 1540, see http://daccessdds.un.org/doc/UNDOC/GEN/N04/328/43/PDF/N0432843.pdf?OpenElement; accessed April 6, 2008.

[13] See the paper by Philipp Bleek and Laura Holgate in this volume.

[14] Some of these programs are treated as non-proliferation efforts under the U.S. budgetary process, but they are more correctly thought of as counter-terrorist efforts. Improving security in Russia, for example, helps guard against

George W. Bush has repeatedly stated that thwarting nuclear terrorism is the highest U.S. national security priority. Americas thus see this area as an especially fruitful one for cooperation between the United States and the Russian Federation.

## THE PATH TO PARTNERSHIP

For the past 15 years, the United States and Russia have jointly engaged in a number of nuclear threat reduction programs. While they involved extensive cooperation, these programs did not represent a true partnership, since they were almost entirely funded by the United States.[15] Now this era of assistance is ending. By the end of 2008, the United States and Russia will have completed all the security improvements at Rosatom and Ministry of Defense nuclear facilities agreed upon at the February 2005 Bratislava summit (see Appendix D).[16] By the end of 2010, all Russian plutonium production reactors will have been shut down. G8 Global Partnership activities will end in 2012. The sustainability transition phase of U.S.-funded security improvements will be completed by 2013; thereafter funding for the maintenance of these improvements will be entirely the responsibility of the Russian Federation.[17]

The conclusion of the period of assistance opens the path to true partnership. For such a partnership to work, the two sides will need to have an equal voice in selecting and managing projects. Each should bear its own share of costs (as was historically true for scientific cooperation between the two countries prior to 1991). This new stage will demonstrate the maturity of the relationship, which will be reflected in a number of ways. Because in our preferred future each country will have confidence in the adequacy of the internal security of nuclear weapons and nuclear materials security in the other state, most partnership projects will take place in third countries, as Russia and the United States work together to improve global nuclear security. Eliminating a donor-recipient mentality will allow the best ideas of each country to be given appropriate consideration. While this new approach may result in fewer individual projects, it will also result in a stronger overall relationship. The challenge for the two countries in these waning years of assistance is to give more than rhetorical attention to the partnership concept and to devise the mechanisms for implementation of true partnership. In addition, it will be vital to identify individuals and institutions in each country who can serve as champions of cooperation and stewards of partnership.

---

theft of material that might find its way into terrorist hands but is irrelevant to Russia's strong non-proliferation record.

[15] Russia provided significant contributions in kind in many cases and has always been responsible for operations and implementation.

[16] For further information regarding the "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation," of February 24, 2005, see http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html; accessed February 23, 2008. See also Appendix D for full text of this Joint Statement.

[17] The Bob Stump National Defense Authorization Act of 2003 mandates that a sustainable materials protection, control, and accounting system be transferred to sole Russian Federation support no later than January 1, 2013. For further information regarding the Bob Stump Act, see http://www.army.mil/armybtkc/docs/PL%20107-314.pdf; accessed May 1, 2008.

## THE KEY ELEMENTS OF THE IDEAL FUTURE

The potential for nuclear proliferation, the danger of nuclear terrorism, and the challenges of the coming renaissance in nuclear energy all combine to make the nuclear security landscape of 2015 a complicated one. As Security Council members, technologically advanced nuclear weapon states, and states with deep involvement in nuclear energy, Russia and the United States are ideally positioned to provide global leadership during this crucial period. Their influence and effectiveness will be far greater to the degree they are able to act in consort. Thus, from an American perspective, the ideal over-arching characteristic of the 2015 nuclear security environment would be ***global leadership through a strong Russian-American partnership***. The components of this ideal nuclear security relationship are described in the remainder of this paper.

## PREREQUISITES FOR PARTNERSHIP: REDUCING MISUNDERSTANDING

In the ideal relationship of 2015, the two sides understand each other's perceptions of nuclear threats (although they may not completely agree with each other's threat perceptions), including the degree to which each feels threatened by the actions of the other. They have reached agreement on measures to prevent misunderstanding. These include provisions for U.S. notification of the operational launch of conventionally-armed Trident missiles far enough in advance of launch to avoid any confusion in the Russian warning system, improved sharing of ballistic missile warning information through the Joint Data Exchange Center, and some mechanism to integrate (or at least accommodate) the U.S. ballistic missile defense system now being deployed in Europe.

Because of extensive dialogue, between today and 2015, Russia and the United States view each others' strategic forces with reduced concern. The two countries have agreed to replace both the Strategic Arms Reduction Treaty and the Treaty of Moscow with a formal mechanism for ensuring transparency and predictability of both strategic offensive and strategic defensive forces. This mechanism has been designed to meet the political and security concerns of both sides. The two countries maintain rough parity in their nuclear forces and continue to work together to reduce their nuclear stockpiles. Because of these elements of predictability and parity, neither side is concerned with asymmetries in internal force composition, leaving each free to shape its forces as it sees fit.

While in 2015 the two sides do not completely share a common nuclear threat perception, extensive discussions have brought their views closer to one another on both the threats from states such as Iran and North Korea, and the existence of other potential proliferator states. In addition, working through such mechanisms as the U.S.-Russian Counter Terrorism working group, the two sides have deepened their mutual understanding of the risk of nuclear terrorism and the threat from improvised nuclear devices.

## LEADERSHIP THROUGH PARTNERSHIP IN NON-PROLIFERATION

In this ideal future, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) remains in effect in its current form.[18] The United States and Russia have a common view of the importance of its implementation including the necessity for universal adherence to the Additional Protocol[19] and to the requirements of UNSCR 1540. While preserving the concept of sovereignty in treaty-making, the two sides have taken the lead within the international community to make it difficult for a state to withdraw from the NPT and to preclude states from retaining the benefits they have received from nuclear cooperation under Article IV should they withdraw. The two countries also actively develop innovative approaches toward countries not party to the NPT in order to limit proliferation and to move non-parties toward the implementation of NPT norms.

All plutonium and spent fuel in the Democratic People's Republic of Korea (DPRK) has been removed to Russia for reprocessing, with the cost burden borne equitably by all states whose security is enhanced by a nuclear-weapons free DPRK. The United States and Russia have worked jointly to play a leading role in verification of the elimination of the existing North Korean weapons program.

Iran has abandoned its plans for nuclear weapons due to consistent international pressure under joint U.S.–Russian leadership. Iran has implemented the Additional Protocol and developed commercial nuclear power under strict International Atomic Energy Agency (IAEA) safeguards using a fuel leasing approach with fuel supplied by Russia and spent fuel returned to Russia.

The United States and Russia have improved their diplomatic coordination and normally take coordinated, coherent and effective positions in international fora designed to inhibit proliferation. They consistently work together to strengthen export control mechanisms and other elements of the international regime to counter proliferation and nuclear terrorism. They have cooperated to ensure negotiation and implementation of an effective Fissile Material Cutoff Treaty with widespread (ideally universal) application.[20]

In 2015, the United States and Russia jointly take the lead to strengthen adherence to treaty commitments and international norms relating to nuclear security. Where states fail to comply with international non-proliferation and counter-terrorism regimes, the United States and Russia work jointly in the Security Council and elsewhere, to ensure adequate sanctions. They cooperate closely within the Proliferation Security Initiative and look for other innovative approaches to counter proliferation.[21]

In this ideal future, the United States and Russia both agree that the political conditions to permit the complete abolition of nuclear weapons are unlikely to exist for the immediate future. They also recognize that the technical ability to verify such abolition does not now exist, although scientists in both countries continue to work both independently and together to

[18] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

[19] For further information regarding the Additional Protocol, see http://www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html; accessed April 6, 2008.

[20] For further information regarding the Fissile Material Cutoff Treaty, see http://www.fas.org/nuke/control/fmct/index.html; accessed April 6, 2008.

[21] For further information regarding the Proliferation Security Initiative, see http://usinfo.state.gov/products/pubs/proliferation/; accessed May 1, 2008.

improve verification techniques. The two countries (and, if possible, the other NPT nuclear weapons states) have cooperated in disseminating honest analyses that demonstrate these facts. This openness, coupled with continued reductions in the total arsenals of Russia and the United States, and increased transparency concerning the size and composition of those arsenals, has significantly mitigated (although not eliminated) the pressure from non-nuclear weapons states for the nuclear weapons states to take additional action in response to Article VI of the NPT.

## LEADERSHIP THROUGH PARTNERSHIP IN NUCLEAR ENERGY

The world of 2015 is undergoing a renaissance in nuclear power generation. This renaissance is driven in part by the recognition that nuclear energy is indispensable if the world is to meet its growing energy requirements without the unacceptable contributions to global climate change resulting from increased fossil fuel emissions. To ensure that this renaissance does not create proliferation problems, the United States and Russia support a common vision of discouraging the spread of sensitive technology associated with the fuel cycle based on a harmonization of the current U.S., Russian, and IAEA proposals. This common vision does not enhance a sense of discrimination among the non-nuclear weapons states because it does not ask them to abandon their legal rights. Instead, it offers incentives that make it financially, technically and politically attractive for states to take advantage of fuel supply and take-back services offered by several states in commercial competition with one another. The two countries complement this effort by working together to create an international nuclear waste management regime.

Both countries recognize that a nuclear reactor accident anywhere in the world will bring this renaissance to a halt. Because they understand that a strong regulatory regime is a prerequisite for nuclear reactor safety, they work together to assist new reactor states in establishing such regimes. They also work with existing channels such as the IAEA, the World Nuclear Association, and the World Association of Nuclear Operators to help share nuclear safety best practices throughout the world, giving special attention to states with limited experience in operating reactors.

## LEADERSHIP THROUGH PARTNERSHIP IN PREVENTING NUCLEAR TERRORISM

In 2015, both the United States and Russia have confidence that the nuclear weapons and materials in the other country are secure against theft from either terrorist attack or insider diversion. They routinely exchange best practices concerning nuclear weapons and nuclear material security and have found a mechanism to share information on security that builds confidence while not revealing specific information that would cause either state concern. Both countries make the consistent investments needed to ensure long-term maintenance of weapons and material security. Through appropriate and well designed transparency measures, they demonstrate to the international community that their weapons remain safe and secure, thus providing leadership by example to other nuclear weapon possessing states.

The United States and Russia actively engage other states to encourage them to ensure that the security of nuclear materials and, where appropriate, nuclear weapons in these countries match the strong security in Russia and the United States. As part of this effort they work together to offer technical security improvements and the sharing of best practices to all states, working through the IAEA where feasible. They also work together to assist states in the effective implementation of both UNSCR 1540 and the Additional Protocol.

As part of this effort, the United States and Russia have worked—and continue to work—to eliminate the non-military use of highly enriched uranium, especially in research reactors, to complete the return all U.S.- and Russian- origin HEU from research reactors in third countries, and to eliminate stocks of such material in all non-nuclear weapons states. To set an example for the world, Russia and the United States convert all of their own research rectors to use only low-enriched uranium.

As one element in their broad technical collaboration on security, Russia and the United States take the lead in creating an international system of nuclear attribution based on a technical nuclear forensics capability. While recognizing the practical limits of nuclear forensics, they expect this system to help identify the origin of nuclear material seized from smugglers or terrorists as well as the origin of any device actually detonated. Both Russia and the United States make it clear that if a state assists terrorists in obtaining a nuclear weapon or the materials to construct an improvised nuclear device and terrorists subsequently detonate such a device, both the United States and Russia will have a high probability of knowing where the material originated. Both states make it clear that terrorist use of nuclear weapons or improvised nuclear devices anywhere in the world will inspire universal condemnation. They also each make it clear that they will regard nuclear terrorism within their respective states as justifying a response against the supplier of the weapon or material in accordance with the inherent right of self-defense cited in Article 51 of the United Nations charter.

This nuclear forensics and attribution effort is part of a continuing effort in organizing and leading the global community under the auspices of the Global Initiative to Combat Nuclear Terrorism. This joint U.S.-Russian initiative, involving 53 states as of the fall of 2007, has continued to grow and by 2015 is a leading vehicle for preventing nuclear and radiological terrorism.

## SCIENTIFIC COOPERATION IN SUPPORT OF PARTNERSHIP

In 2015, the United States and Russia have expanded and deepened their science and technology coordination in order to provide new technical tools for counter-terrorism, for verification of reductions in nuclear weapons and nuclear materials, for safeguards, for improving detection of nuclear weapons and materials, for materials protection, control and accounting, for reactor technology (including safety), and for spent fuel management. In the last two areas, they have built on the plan for nuclear energy cooperation they established jointly in 2006.[22] They work together to make these new tools available to other states and urge their

[22] *Report of the U.S.–Russian Civil Nuclear Working Group: A Bilateral Action Plan to Enhance Global and Bilateral Energy Cooperation*, transmitted by the U.S. Department of Energy Secretary Samuel Bodman and Rosatom Director Sergei Kirienko to their respective Presidents December 15, 2006.

widespread adoption. By doing so, the two countries seek to create an international strategy of continuous improvement in nuclear safety and security.

The expanded scientific cooperation in support of nuclear security is part of a broad overall program of scientific cooperation, built around strong relationships between the various U.S. and Russian national laboratories. Russia and the United States both recognize the scientific benefits available from more extensive collaboration. As a result, while carefully protecting access to national security information, they have worked to expand overall scientific and technical cooperation, including joint projects and exchanges of personnel.

Both countries are committed to facilitating these scientific exchanges through the timely review and issuance of visas. They have explored the potential of a special visa regime for key scientists whose expertise may be needed in the event of a nuclear crisis.

## POSSIBLE INHIBITIONS TO COOPERATION

Relations in the area of nuclear security will inevitably reflect the overall political relationship between the two states. Both Russia and the United States have consistently expressed a desire for close, collegial working relations based on partnership and mutual respect. Both seek to maintain and deepen their ties. Leaders of both Russia and the United States have repeatedly stated that if their two countries are not yet allies, both are determined to avoid once again becoming adversaries.

Yet it would be unrealistic to ignore the probability that significant political strains will remain in 2015. While both countries will work to reduce current tensions, they may not be completely successful. While political conditions could improve, they may remain the same or even deteriorate. It is possible, and perhaps likely, that in 2015 the United States will be concerned, as it is today, with an apparent Russian drift toward authoritarianism and away from pluralism. If so, Russia will regard, as it does today, U.S. pressure as an inappropriate interference in Russian internal affairs based on a failure to appreciate the special character of the Russian political system and the difficulties of Russia's post-Soviet transition. Similarly, in 2015, Americans will continue to regard the continuation and expansion of NATO as a way to draw all European states into a 21st century international regime and will assert that Russia should not find this threatening. Russians will continue to ask who such a military alliance is aimed at and will have difficulty accepting that many European states formerly allied with (or part of) the Soviet Union seek military ties to the United States and links to its extended nuclear deterrent because they fear a future return of an expansionist Russia. Americans will continue to seek ballistic missile defenses aimed at Iran and North Korea, while Russians will fear such defenses could (and may be intended to) weaken the Russian nuclear deterrent. In 2015, Americans will continue to look askance at periodic apparent Russian nostalgia for a Soviet-era past that Americans see as marked by despotism and aggression. Russians will continue to recall the international respect they gained as one of the two superpowers more clearly than they recall the accompanying problems of that bygone era. And no amount of desire for partnership can alter the fact that two major powers with global interests will sometimes find that their national interests are in conflict.

Sound analysis and wise policy demand that the two sides not ignore these enduring tensions. Nor should they fail to recognize that political developments within Russia might make cooperation more difficult in the coming decade. But it would be a serious error of both analysis and policy to believe that either internal political developments or the existence of such tensions precludes strengthened cooperation in the area of nuclear security. Even at the height of the Cold War, when military planners on both sides thought that nuclear war was a real possibility, the United States and the then-Soviet Union cooperated to help create the international non-proliferation regime that, despite the challenges it faces today, has served humanity well. The challenge for today's policy makers and analysts is to find those areas where cooperation is possible and build on them to strengthen the overall relationship.

## THE NATIONAL ACADEMIES-RUSSIAN ACADEMY OF SCIENCES EFFORT AS A STEP TOWARD PARTNERSHIP

Finding areas where cooperation is possible is a major purpose of the current project. There have been many studies, articles, and papers calling for improved cooperation between the United States and the Russian Federation. Most of their recommendations have not been implemented. Thus, the task facing us is not to generate bold new ideas for cooperation, but rather to focus on two types of ideas. The first are those where the conditions for implementation (including political acceptability) exist now. These ideas should be seized upon and implemented to help create the future world of partnership, even if the specific ideas are relatively modest. In building a true partnership over the next several years, it will be far better to succeed in small areas than to fail in big ones.

The second important set of ideas is that which are crucial to a true partnership but where the time is not yet ripe for implementation, whether for political or technical reasons. Here the task will be to identify the obstacles and assess whether they can be removed and if so, how. This aspect of building a true partnership will be time-consuming and, often, frustrating, but the long term benefits to security and stability of a world in which Russia and the United States exercise global leadership in nuclear security through a truly equal partnership will be worth the effort.

## CONCLUSION

The vision set forth in this paper is demanding. It will almost certainly be impossible to reach all of the goals set forth above by 2015 or by any fixed date. That is the nature of visions. Further, much will depend on factors outside the control of the nuclear community in either Russia or the United States. Mutual suspicion, political issues, and commercial conflicts could impede progress. There will doubtless be setbacks and difficulties. But no single item described in this paper is impossible. The closer the two states and the two nuclear communities can come to this vision, the greater will be the security of both the United States and the Russian Federation and the greater will be the stability of the global nuclear regime.

# FUNDAMENTAL PRINCIPLES OF RUSSIAN – U.S. COOPERATION IN THE NUCLEAR ARENA: A REVIEW OF OPPORTUNITIES AND THREATS

Lev D. Ryabev,
*Rosatom*

## NUCLEAR DISARMAMENT

A standoff between the United States and the U.S.S.R. was the main motif in global security from the end of WWII through the early 1990s. A nuclear arms race that began soon after the first nuclear bomb was detonated in 1945, led to the accumulation by the United States and the former U.S.S.R. of tens of thousands of nuclear munitions. It also produced some new nuclear weapons states.

In the 1970s, parity was reached between the United States and Soviet nuclear stockpiles. Each side could retaliate against the other by inflicting unacceptable damage from which no anti-ballistic missile (ABM) defense system could protect. The nuclear arsenals that had been accumulated could lead to the mutual destruction of the two countries. Military equilibrium became an insurance policy against possible aggression. Gradually, an understanding was reached that neither side could win this race, and different (i.e., not force-based) foundations of international relations had to be found.

At the same time, it was clear that the enormous nuclear stockpiles could not provide a long-term basis for international security. It is in this environment that a series of negotiations regarding reductions in the numbers of nuclear and other weapons began between the United States and the U.S.S.R., eventually leading to several arms control treaties.

This initial period of nuclear disarmament coincided with the collapse of the Soviet Union. With respect to all military nuclear activities, Russia became the legal successor of the U.S.S.R. In the early 1990s, the economic situation in Russia was grim. Industrial production fell; there was not enough funding to resolve even the most urgent problems; people were not paid salaries for months on end; and government control was weak. Those years were also characterized by lax export control and a never-seen-before threat of theft of nuclear materials by individuals employed in the nuclear weapons complex. A trend was developing for nuclear weapons experts to leave the country and move elsewhere. Indeed, the situation in the Russian nuclear weapons complex was worrisome both to the Russian political leadership and to the United States.

In 1992, the Cooperative Threat Reduction (CTR) program – also known as the Nunn-Lugar program – was established to help Russia reduce its arsenals by providing it with necessary financial assistance.[23] Russia was also fully aware of its own responsibility for the safety and security of its nuclear arsenals and took a number of effective steps to ensure this. Specifically, Russia:

- developed and implemented an up-to-date regulatory regime
- implemented a government-administered nuclear materials accounting and control system
- improved physical security at nuclear facilities
- commissioned storage facilities for nuclear materials and munitions that were built to the most stringent specifications
- adopted a new export control law and reassessed the dual-purpose item list
- consolidated nuclear materials at a smaller number of facilities
- introduced safe containers for transporting and storing special items and materials
- improved the living standards of nuclear weaponeers

Within the framework of the CTR program, Russia received assistance with:

- destruction of strategic offensive arms
- transportation and containers to move nuclear munitions and materials
- construction at the Mayak site of a modern storage facility for de-weaponized fissile materials
- provision of equipment to ensure physical protection of storage facilities for nuclear munitions and nuclear materials
- funding to replace the power-generating capacity of three breeder reactors in Seversk and Zheleznogorsk so that they could be shut down

In addition, hundreds of tons of weapons-grade uranium have been converted for use in commercial power reactors following the 1992 Russian-U.S. Highly Enriched Uranium (HEU) Agreement.[24] Activities to dispose of excess weapons-grade plutonium are still ongoing. Bilateral collaboration has been raised to a new level thanks to the 2002 Global Partnership Initiative.[25] Its primary objective is to provide financial assistance—mostly to Russia—to prevent the spread of weapons and materials of mass destruction. The initiative has been instrumental in the elimination of chemical weapons, as well as the disposition of nuclear-powered submarines and weapons-grade materials.

Activities continue, and they are becoming increasingly routine in nature. For example, political, technological, and logistical issues in the field of nuclear submarine disposition have been resolved; a wealth of experience has been accumulated; the overall scope and timeline of activities are clearly understood; the completion of this work is near.

---

[23] For further information regarding the Cooperative Threat Reduction programs, see http://www.nti.org/db/nisprofs/russia/forasst/nunn_lug/overview.htm; accessed April 8, 2008.

[24] For further information regarding the HEU Agreement, see http://www.nti.org/db/nisprofs/russia/fissmat/heudeal/heudeal.htm; accessed April 6, 2008.

[25] For further information regarding the G8 Global Initiative to Counter Nuclear Terrorism, see http://www.g8.gc.ca/2002Kananaskis/gp_stat-en.pdf; accessed on April 6, 2008. See also, http://www.state.gov/t/us/rm/69124.htm; accessed May 1, 2008.

Today, we can already summarize some of the results of the enormous amount of work that has been done to reduce weapons stockpiles. From 1990 through December 2001, the number of delivery vehicles for strategic offensive weapons has been reduced from 2,500 in the former Soviet Union and 2,246 in the United States to 1,600 on either side. The number of warheads has been cut from approximately 10,000 to 6,000. According to public Strategic Arms Reduction Treaty (START I) strategic data exchange information, in January 2006, Russia had 771 delivery vehicles and 3,319 nuclear munitions in its strategic nuclear triad, and the United States had 1,079 delivery vehicles and 4,986 nuclear munitions.[26] Many hundreds of missiles (specifically, 1,846 in Russia and 846 in the United States) have been eliminated in compliance with the Treaty on Intermediate-Range Nuclear Forces.[27] A large number of nuclear-powered submarines (148) have been dismantled in Russia.

Additionally,

- nuclear stockpiles, including tactical nuclear weapons, have been dramatically reduced
- further accumulation of nuclear weapons materials (uranium and plutonium) has been stopped
- production of nuclear munitions has been reduced by a factor of more than 10 in Russia and has been suspended altogether in the United States
- five hundred tons of Russian weapons-grade uranium has been de-weaponized, along with 34 tons of plutonium on each side
- a portion of weapons-grade materials has been downblended to non-weapons grade material
- nuclear testing has been banned
- several production facilities in the nuclear weapons complex have been shut down
- personnel of the military industrial complex have been significantly reduced

We are seeing tangible results of the joint efforts to eliminate the accumulated military capabilities. These efforts have been based on mutual interest and funding by the United States and other countries. This work will be completed in 2012.

In 2003, the Treaty on Strategic Offensive Reductions entered into force between the United States and Russia.[28] It calls for strategic offensive reductions to 1,700 to 2,200 warheads on either side by 2012. Unfortunately, however, the treaty has no clear schedules, interim milestones, or verification provisions. This is the first treaty that does not call for a commensurate reduction in delivery vehicles and does preserve (for the United States) the warheads which can easily be returned to operationally deployed status. In 2009, START I and its verification mechanisms are scheduled to expire, and so far no steps have been taken to extend them. All of this is reversible at any time. The United States has clearly lost interest in future steps to reduce nuclear weapons stockpiles. At the same time, it has become abundantly clear that even the 1,700 to 2,200 warheads that will be left on either side in 2012 are still

---

[26] To read the text of the Strategic Arms Reduction Treaty (START I), see http://www.fas.org/nuke/control/start1/text/index.html; accessed April 6, 2008.

[27] To read the text of the INF Treaty, see http://www.state.gov/www/global/arms/treaties/inf2.html; accessed April 6, 2008.

[28] To read the text of the Treaty on Strategic Offensive Reductions see http://www.whitehouse.gov/news/releases/2002/05/20020524-3.html; accessed April 6, 2008.

excessive for the purposes of national defense and can only be used by the United States and Russia to target the opposite side. On several occasions, Russia has introduced proposals to reduce the stockpiles to as few as 1,000 warheads on either side.

The principle of mutual deterrence that serves as the underpinning of U.S.-Russian security relations will remain in place, albeit at a lower quantitative level. Although a full-scale nuclear war is no longer a viable prospect, it is still a serious risk factor.

Stagnation in the realm of disarmament is unacceptable because it can lead to potentially hazardous destabilization of international relations. With such huge nuclear arsenals, incidents cannot be ruled out. For example, in August 2007, a U.S. bomber made an unauthorized flight with nuclear weapons onboard. There has also been rhetoric invoking the possibility of WWIII if Iran were to succeed in acquiring nuclear weapons.

So, what is it, exactly, that gives us grounds for concern?

1. Absent clear mutual arms agreements among countries, technological progress, if left to its own devices, leads to the development of new means of destruction. Several examples come to mind. Precision-guided munitions are increasingly emphasized. Cruise missiles of different kinds of basing are assigned more and more combat functions. Proposals are floated to look at the use of intercontinental ballistic missiles tipped with conventional warheads so that rapid worldwide target coverage will be assured. Restrictions on the development of a ballistic missile shield have been lifted. Space deployment of weapons is back on the agenda again.

We see that technological progress has changed the relationship between offensive and defensive weapons. In the new version of the U.S. Nuclear Strategy, a new strategic triad was unveiled.[29] It is different from the classic triad of intercontinental ballistic missiles, submarine-launched ballistic missiles, and heavy bombers in that it also includes an offensive non-nuclear component, active and passive defenses including an ABM defense, and a responsive defense infrastructure.

This bespeaks a clear desire on the part of the world's most powerful country to secure a technological breakthrough in new weapons systems. Since these weapons systems are not subject to arms control, this brings an element of unpredictability and uncertainty into the picture.

2. Further, the United States has taken several unilateral military and political steps:

- While the Warsaw Pact no longer exists, NATO continues to expand eastward opening doors to more and more countries, including some former Soviet republics, and is getting closer and closer to the Russian border. There is, however, no clarity as to what the threats are from which NATO will be defending Europe.
- The ABM Treaty,[30] which Russia considered a cornerstone of strategic stability, has been annulled.
- The decision has been made to deploy ballistic missile interceptor defenses in Poland and the Czech Republic. This was done without any prior discussion with Russia and clearly impacts Russia's interests—in contravention of the spirit of the 2002 U.S.-Russian Declaration on New Strategic Relations.[31]

---

[29] Alexei Arbatov and Vladimir Dvorkin, eds., *Nuclear Weapons After the Cold War,* Carnegie Moscow Center (Moscow: ROSSPEN, 2006). Available at: www.carnegie.ru/en/pubs/books/74780.htm; accessed July 13, 2008.

[30] To read the text of the AMB Treaty, see http://www.state.gov/www/global/arms/treaties/abm/abm2.html; accessed, April 8, 2008.

[31] Arbatov and Dvorkin, eds.

- The hard-to-explain unwillingness of the United States to ratify the Comprehensive Test Ban Treaty (CTBT)[32] is very disappointing.
- The Fissile Material Cutoff Treaty[33] has been stalled.

Such unilateral actions speak to a lack of trust between our two countries and symbolize a disregard for earlier agreements.

3. Changes have been introduced to military doctrines. In the Russian doctrine of 2000, for example, the role of nuclear weapons was defined as that of a tool deterring aggression, ensuring security of Russia and its allies, and maintaining international peace and security. In other words, nuclear weapons are still looked to as the main guarantors of national security. Further, waiving of the no-first-use pledge is also a prospect. Some other themes under discussion in the United States also present a cause for concern. They are the:

- lowering of the nuclear threshold, which means, in effect, that nuclear weapons are turning into usable battlefield weapons (e.g., very low-yield nuclear munitions)
- possibility of using nuclear weapons in non-nuclear conflicts
- possibility of using nuclear weapons to deliver a preventive or preemptive strike

A new foreign policy doctrine is being shaped. In one of his speeches, President George W. Bush rejected the strategy of deterrence as incapable of coping with threats of terrorism and weapons of mass destruction (WMD) proliferation. He declared his determination to "take the fight to the enemy, foil its plans, and counter the most serious threats before they even materialize."[34] As Zbigniew Brzezinski has noted, "in effect, the United States has monopolized the right to identify the adversary and deal the first strike without bothering to build an international consensus regarding the nature of the threat."[35] This creates "a situation of strategic unpredictability."[36]

One must not think that Russia will not step up its weapons systems development efforts in response. It would be appropriate to provide a quote from President Vladimir V. Putin's statement of November 2004: "I am confident that in the near future they[37] will be delivered to our military. These are products that other nuclear weapons states do not have now and will not have in the foreseeable future."[38]

Russia's responses are based on the military threats to its national security with which it is faced. These threats were defined in a speech by the Chairman of the General Staff of the Russian Armed Forces, General Yuri Baluyevsky in early 2007.[39] In his opinion, the most tangible military threats to the national security of the Russian Federation in the near future will continue to be dominated by the following factors:

---

[32] To read the text of the Comprehensive Test Ban Treaty, see http://www.ctbto.org/; accessed April 6, 2008.
[33] For further information regarding the Fissile Material Cutoff Treaty, see http://www.fas.org/nuke/control/fmct/index.html; accessed April 6, 2008.
[34] Z. Brzezinski, *The Choice: Global Domination or Global Leadership*, (New York: Basic Books, 2004) p. 7.
[35] Ibid, p. 57.
[36] Ibid, p. 270.
[37] President Vladimir V. Putin was referring to new nuclear missile systems.
[38] Statement by President Vladimir V. Putin, November 2004.
[39] General Yuri Baluyevsky, "Index bezopasnosti [The Security Index]," *Scientific and Research Magazine of the Russian Center for Political Studies*, V. 13, N. 1, 2007, p. 81.

- U.S. policies aimed at preserving American global superiority and expanding its economic, political, and military presence in regions of traditional Russian influence
- implementation of plans for continuing NATO expansion
- the western practice of taking military and force-based actions in contravention of generally recognized principles and norms of international law
- existing and potential hot spots of local wars and armed conflicts (primarily those in the immediate vicinity of the Russian national border)
- possibility of an upset in strategic stability through the violation of international arms control and reduction agreements, be that in the form of qualitative or quantitative buildups by other states
- proliferation of nuclear and other kinds of WMD, their means of delivery, and new military industrial capabilities in conjunction with attempts by certain countries, organizations, and terrorist groups to bring to fruition their military and political aspirations
- challenges to Russia's military and security interests through expansion of military blocs and alliances
- territorial claims of other states vis-à-vis the Russian Federation and its allies
- competition for access to energy resources
- international terrorism
- unlawful activities by nationalist, separatist, and other organizations seeking to destabilize the domestic situation in the Russian Federation
- hostile information operations against Russia and its allies

There must be certain guiding principles that apply to arms control work. First, the dialogue between the United States and Russia must be ongoing and uninterrupted. Then, we need to jointly discuss and analyze all threats that drive the concerns on each side (that of the United States and Russia) and identify these concerns. It would not be a bad idea to jointly study how the deployment by the U.S. of missile defense components in Europe may impact U.S. and Russian security at various points in time. This would make it possible to determine whether or not the two countries share any common denominators with respect to defense from third countries. Finally, it is no less important to analyze military doctrines as well.

Further, we need to proceed in compliance with the principle of equal security, keeping in mind both the nuclear and non-nuclear aspects of the picture, the placement of elements of forward base deployment, and the presence or absence of any hostile states at the border.

As far as our two countries are concerned, future steps toward disarmament and greater security may actually end up being progressively asymmetrical in nature. At first glance, it would seem that of all countries, the United States needs nuclear weapons least of all. It could take additional nuclear disarmament steps without jeopardizing its security. This would serve as an example to other countries. In contrast, Russia with its geopolitical concerns, fledgling economy, and weak non-nuclear forces may be best suited by taking a different approach. Most certainly, this complicates the process of disarmament and requires that special confidence-building measures be put in place. What is important is that the balance of security must not be upset. Both countries must be interested in this. Only an open and unbiased discussion of our disagreements can direct us onto the right path.

When the United States and the Soviet Union had piles of weapons, the disarmament process moved forward on a neck-and-neck basis. In the future, when the two countries reduce their arsenals to, perhaps, 1,000 warheads each, all subsequent nuclear weapons reductions must be viewed in the context of the overall security posture of each of the two countries.

The sequence of future steps to be taken toward nuclear disarmament matter a great deal as well. So too does the content of these steps, including transparency and verification. In studying these issues and providing appropriate recommendations, an ever-increasing role belongs to non-governmental organizations and academic institutions.

The role of nuclear weapons in today's world appears to be a worthwhile subject for a joint study. While we attempt to convince other countries not to have nuclear weapons it would be instructive to try to understand why it is that the United States and Russia do need these weapons and others do not. Is it possible to suffice without nuclear weapons? What must happen for this to become a reality? There can be only one explanation for the significant U.S. and Russian stockpiles that will still exist in 2012: they will continue to serve the purpose of mutual deterrence.

To summarize, the process of nuclear disarmament has somewhat stalled, security- and confidence-building measures have been insufficient. Ultimately, this jeopardizes the effectiveness of steps seeking to strengthen the nuclear non-proliferation regime.

## NON-PROLIFERATION OF NUCLEAR WEAPONS

The Treaty on Non-proliferation of Nuclear Weapons (NPT) entered into force in 1970 and continues to be a positive influence in the context of resolving issues of nuclear security.[40] Over the last 35 years, however, its drawbacks have become visible as well.

1. The NPT has failed to completely stop the process of nuclear proliferation. India and Pakistan have since become nuclear weapons states. It is generally believed that Israel also possesses an unacknowledged nuclear weapons program. Some other countries are suspected of being engaged in some proscribed nuclear activities. So why is it that some countries still insist on possessing nuclear weapons?

Possessing nuclear weapons is still a matter of political prestige. By having them, a state increases its outward political status. The state of international uncertainty—is the world to be multipolar or unipolar?—creates new opportunities and piques interest toward the preservation or acquisition of the status of a nuclear weapons state. Some countries simply do not feel completely secure when new global threats continue to emerge and replace old ones.

To this day, there is no international security system that would guarantee a country's security in the face of external threats. At the initial stages of nuclear weapons development, they were the prerogative of economically and technologically powerful states. Today, given the current spread of nuclear technology and knowledge, even poor countries can afford them if they make a political decision to "go nuclear." So, by obtaining nuclear weapons, countries acquire at least an additional insurance policy against pressure from outside. It is doubtful that the United States and its allies would dare to attack Iran if the latter possessed nuclear weapons.

Many of us do not like particular regimes that are currently in power in certain countries. This is not, however, a justification for eliminating these regimes using outside force unless, of course, they commit an act of aggression against some other state. Increasing reliance on the use

[40] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

of force, especially military force, in settling international disputes outside of the legal framework of the United Nations Security Council only adds to the determination of a number of states to acquire nuclear weapons. It is not quite clear why the United States and others would not, for example, engage in direct contacts with Iran or provide it with security guarantees in exchange for steps in the direction of openness, transparency, and predictability in its peaceful nuclear sector.

2. The very question of nuclear weapons non-proliferation is fraught with controversy vis-à-vis the enormous nuclear arsenals of the five nuclear weapons states. This rift causes resentment among non-nuclear weapons states, undermines any attempts to strengthen the nuclear non-proliferation regime, makes this regime unstable, and leads to delays in implementation of Article VI of the NPT (i.e., negotiations regarding nuclear disarmament). The large nuclear capabilities are not compatible with commitments made by the nuclear weapons states at the time of entering into the NPT. Nuclear weapons states have preserved the role of nuclear weapons as a deterrent of aggression and guarantor of military security in their military doctrines. Other countries may well decide to put forth the same argument.

In the mid-1990s, when the draft of the CTBT was being discussed in Geneva, the Indian ambassador voiced sharp criticism directed at the nuclear weapons states because they called upon others to forego nuclear weapons but did not lead by example. Today, it is evident that nuclear weapons states are compromising their leadership position and initiative with respect to nuclear disarmament. At the same time, nuclear disarmament is part and parcel of non-proliferation, threat reduction, and greater security. Nuclear weapons states are still a long way away from resolving the issue of nuclear disarmament so that the end objective – complete elimination of these weapons – could be pursued (Article VI of the NPT).

What is worse, this issue is not even on the agenda. No possible steps toward a world free of nuclear weapons are being examined or discussed. Meanwhile, in 2015, the world will have lived with nuclear weapons for 70 years and with the NPT for 45 years.

3. As the number of countries pursuing peaceful nuclear activities increases, scientific and technological conditions arise for the development of nuclear weapons. This is especially true for the closed nuclear fuel cycle.[41] As capabilities grow, so too does the quantity of nuclear materials in circulation. This, in turn, increases the probability of theft. Finally, the spread of knowledge is conducive to allowing a large number of countries to gain mastery of nuclear technologies at minimum expense.

Of course, the non-proliferation regime continues to improve. We now have the Additional Protocol to the NPT, providing the International Atomic Energy Agency (IAEA) with strengthened mechanisms for monitoring and verifying the use of nuclear materials and technologies.[42] The Protocol expands the contents of the verification "toolbox." Some other important measures have been implemented as well. As far as practical approaches to non-proliferation are concerned, however, the two leading nuclear weapons states, the United States and Russia, often hold diametrically opposed views. This results in uncoordinated actions. There is no single universal non-proliferation approach applicable to all countries, which is to

[41] The Russian Corporation TVEL notes that "(t)he closed nuclear cycle envisages transportation of irradiated fuel assemblies to radiochemical plants to extract unburned uranium rather than transportation to disposal site. Recoverable uranium could amount up to 95 percent of initial uranium mass. Then, this material is subject to same processing stages as the one mined." Presently the majority of countries use an open fuel cycle. For more information, see http://www.tvel.ru/en/nuclear_power/nuclear_fuel_cycle/; accessed April 6, 2008.

[42] For further information regarding the Additional Protocol, see http://www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html; accessed April 6, 2008.

say that double standards have prevailed and countries have, in effect, been divided into "good" ones and "bad" ones although they all have subscribed to the same NPT obligations.

Iran is a typical example. Iran has signed the NPT, accepted the Additional Protocol that allows the IAEA to visit any facility at any time without prior notice, placed its facilities under IAEA safeguards and pledged, alongside Russia, to return spent nuclear fuel to Russia. The United States does not find these commitments sufficient and demands that Iran shut down its nuclear program completely, suspecting it of nuclear weapons ambitions. Iranian domestic and foreign policy is probably also a contributing factor, but so far it has not been officially characterized as such. Ultimately, someone does not like the existing Iranian regime.

Besides, the United States believes that Iran does not need nuclear energy because the country is rich in oil and gas. The U.S. demands extended to Iran go far beyond the NPT and the Additional Protocol. This implies that compliance with the NPT and the Additional Protocol no longer serves as an ironclad guarantee of Iran's inability to produce nuclear weapons. These demands are accompanied by threats, sanctions, and declarations of possible use of force – perhaps even to bring about regime change.

In contrast, no such demands have been extended to Brazil, a country that is also developing its nuclear energy sector and pursuing an indigenous nuclear fuel cycle, including uranium enrichment.

Also, the United States has a whole different attitude toward countries that have not signed the NPT and have developed nuclear weapons (e.g., India and Israel). The United States is even prepared to enter into full-fledged nuclear cooperation with India. To justify a more stern approach to a selected few countries, first of all to Iran, there is talk of their past clandestine nuclear activities. Without doubt, these instances have to be investigated, but in this regard Iran is definitely not the only culprit (e.g., North Korea). It is also important to understand the reasons for the behavior of some states.[43]

So, on the one hand, there is a need to make the NPT regime more stringent, and on the other hand, the existing international agreements are being weakened. Norms and rules of non-proliferation must be universal for all and must be based on a commitment by states to disrupt any and all terrorist activities on their territory. Terrorists exist outside the NPT framework, and some of them are attempting to acquire nuclear weapons and materials. In recent years, the 'black market' for nuclear materials and technologies has expanded to include a number of private companies and individuals who possess nuclear weapons-related knowledge and expertise.

The U.S. initiative to interdict illegal transfers of weapons and materials is therefore commendable and deserves international support. We also need to have a more in-depth study of a variety of other situations as well. The fact of the matter is, experience tells us that even an NPT member state can come very close to developing nuclear weapons. After acquiring the nuclear technology within the NPT regime, a state can withdraw from the NPT and suffer no consequences for it. Put differently, the right of a country to withdraw from the NPT if extraordinary events jeopardize its supreme interest (Article X) is also in need of revision.

There is no confidence in the effectiveness of measures taken vis-à-vis an NPT member state suspected of weapons-related nuclear activities. In what cases and under what conditions can we switch from economic and other sanctions to military action? It has become apparent that we need to review whether it would make sense to switch from voluntary to mandatory (with

---

[43] Z. Brzezinski and W. Odom, "Reasonable Approach to Iran Problem," *Sankt-Peterburgskie Vedomosti*, N. 101, June 4, 2008.

an element of coercion, if necessary) compliance with non-proliferation commitments. There is also no legal provision should a non-NPT country be engaged in nuclear activities or even seeks to obtain nuclear weapons.

Perhaps, new norms of behavior have to be established now that the world community is equipped with these potentially hazardous technologies. Perhaps the NPT no longer meets today's requirements, and perhaps some additional conditions must be put in place to ensure that peaceful nuclear activities are safeguarded against the possibility of diversion for military use. In the most general terms, we are talking about a new system of international relations as we move away from the Cold War era and its rigid bipolar world order. The NPT has to be adjusted to fit the new security environment.

In effect, the United States has deployed a new strategy with respect to WMD proliferation. It reaches well beyond the NPT framework and includes unilateral preventive and preemptive strikes with global coverage. We have not, however, done anything to discuss or study this new strategy, much less think through what international agreements could be warranted or what roles the IAEA or the United Nations could play in their implementation. All these issues could be put on the agenda for U.S. and Russian working groups to discuss via non-governmental channels.

For many years now, the United States and Russia have been engaged in close cooperation on non-proliferation. Relevant bilateral agreements have been concluded. First, they had to do with measures to strengthen the non-proliferation regime in Russia (e.g., physical protection, export control, control and accounting of nuclear materials, etc.). Russia has done a lot in the course of these years to instill order in its nuclear complex and has proven by deeds that it is a responsible country (there have been no recorded cases of theft or loss of weapons-grade nuclear materials—much less nuclear munitions—or leaks of nuclear experts or technologies). It has had nothing to do with India's, Pakistan's, or Israel's nuclear weapons capabilities or with North Korea's or Libya's nuclear ambitions. In particular, now that terrorism is increasing, the west still chooses to embrace its consistent views about proliferation threats emanating from Russia. For example, Senator Richard Lugar stated in his interview with *Izvestiia* on January 12, 2005, "Of great importance is not only the control over (Russia's) nuclear-tipped missiles, but also over … tactical nuclear warheads, which can fall prey to terrorists."[44] Based on such argumentation, the main thrust of U.S.-Russian cooperative non-proliferation programs was directed at the countries of the former Soviet Union – for the most part, Russia.

At the same time, Russia's National Security Concept, adopted in 2000, characterizes the need to strengthen the non-proliferation regime with respect to WMD as one of the main national security objectives.[45] This issue has been receiving, and will continue to receive, the priority attention that it deserves by Russia.[46]

In recent years, interest in collaboration between U.S. and Russian national laboratories has unfortunately waned. Meanwhile, these organizations could significantly contribute to the science and technology aspects of non-proliferation activities, including efforts to combat

---

[44] "Ukraine is Not a Field for Battle between the U.S. and Russia," *Izvestiia*, January 12, 2005. Available at www.izvestia.ru/comment/article993435; accessed July 13, 2008.

[45] *Russia's National Security Concept*. Approved by Order No. 1300 of the President of the Russian Federation, December 17, 1997 (as amended by Order No. 24 of the President of the Russian Federation, January 10, 2000). Available at www.iss.niiit.ru/doktrins/doktr01.htm, accessed July 13, 2008.

[46] To an increasing degree, cooperation in the area of non-proliferation will be aimed at solving this problem worldwide.

nuclear terrorism and resolve other salient nuclear security issues. During meetings of the heads of national laboratories, there have been numerous proposals made to increase collaboration along these lines. In particular, the following opportunities for joint work have been identified:

- development of means of detecting signs of undeclared nuclear activities
- development of technical means to combat terrorism
- design of highly sensitive devices to monitor small quantities of nuclear materials and explosives
- development of instruments for remote monitoring of reactors and nuclear fuel cycle facilities
- risk assessment with respect to the proliferation of nuclear technologies
- identification of nuclear material
- other specific proposals

Additionally, lab-to lab collaboration could expand to include other counties and take on such areas of research as nuclear fusion, computers and programming, laser technologies, and nanomaterials. This could also contribute to the building of trust and goodwill among weapons scientists and the redirection of their activities to peaceful pursuits.

Non-proliferation cooperation between the United States and Russia must be comprehensive and have an international dimension. The problem of non-proliferation cannot be unilaterally resolved even by the most powerful country in the world. It has to be coordinated at the level of the entire international community. A special cooperation program led by the two most influential nuclear states has to be developed. Priority has to be assigned not to force-based methods of conflict resolution, but to overall improvement of the international climate and to threat reduction measures.

## NUCLEAR ENERGY AND NON-PROLIFERATION PROBLEMS

The author does not believe that it would be helpful to reduce U.S.-Russian partnership and cooperation to just nuclear arms reduction and non-proliferation. The United States, Russia, and other countries should be seeking opportunities for constructive collaboration. The energy sector, including nuclear energy, could be one of the most prominent areas for cooperation. In the future, energy demands will rise and nuclear energy will play a significant role in meeting these demands. This will be especially helpful given that many acute problems that breed terrorism (e.g., poverty, economic under development) are associated with a lack of access to energy.

The NPT is inherently discriminatory with respect to the possession of nuclear weapons. For the purposes of this Treaty, a nuclear-weapon state is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to January 1, 1967 (Article IX, paragraph 3). Also, there is a provision that nuclear weapons states would take steps to reduce their nuclear arsenals and assist other countries in reaping the benefits of peaceful nuclear energy. At the same time, nuclear technologies and related knowledge may be of the dual-use variety and can therefore be used for military purposes or as a disguise for undeclared nuclear activities. This is why numerous attempts have been made to constrain the development of especially sensitive nuclear technologies. In 1978, for example, U.S. President Jimmy Carter called on nuclear power countries to give up reprocessing activities to curb the proliferation of nuclear materials, most notably plutonium, that can be extracted from spent nuclear fuel produced by nuclear power plants.

However, restricting the transfer of peaceful nuclear technologies to non-nuclear member states in good standing with the NPT or prohibiting them from development of such sensitive technologies as uranium enrichment and spent nuclear fuels reprocessing would be yet another step in broadening the gap between the "haves" and the "have-nots."

It goes without saying that prohibitive measures will not stop technological progress. Moreover, such measures are in contravention of the guiding principles of the NPT. We need to seek a way out of this situation. One of the promising prospects is closely connected with President Vladimir V. Putin's initiative voiced at a UN Summit in 2000.[47] Russia proposed that new designs for nuclear reactors and proliferation-resistant fuel cycles be developed. Russia is already engaged in such research, and it should join efforts with other countries, first and foremost, with the United States. Recently, Russia has also put forth a proposal regarding the return of spent nuclear fuel to countries that have the appropriate infrastructure for, and experience with, safe management of spent nuclear fuel.

Several countries have already championed the idea of consolidating uranium enrichment, spent nuclear fuel reprocessing, and fresh fuel fabrication at so-called international fuel service centers. In this vein, Russia has proposed the establishment of a uranium enrichment center at the Rosatom chemical electrolysis facility in Angarsk.

Pursuant to directives of the two presidents after the U.S.-Russian summit in 2002 (see Appendix D), issues pertaining to the development of advanced reactors and innovative nuclear fuel cycles have been addressed. Recommendations have been reviewed and approved at the ministerial level but remain unrealized because of the disagreements on the Iran issue. Signing of the 123 Agreement on the peaceful use of nuclear energy has been deferred.[48]

Over the last several years, quite a few initiatives to expand the use of nuclear energy (in addition to the Russian Angarsk proposal) have been made public. They are: the U.S. Global Nuclear Energy Partnership,[49] the IAEA International Project on Innovative Nuclear Reactors and Fuel Cycles,[50] and Generation IV International Forum.[51] After the U.S.-Russian summit in the summer of 2007, the two presidents stated their intention to initiate, in conjunction with other

---

[47] Statement by Russian Federation President Vladimir V. Putin during a press conference at the United Nations Headquarters, September 8, 2000. Available at www.newsru.com/world/08sep2000/spich.html.

[48] The 123 Agreement refers to Section 123 of the U.S. Atomic Energy Act of 1954, which requires a bilateral agreement between the United States and any country wishing to receive U.S. exports of technology and equipment related to civilian nuclear energy. The U.S. Atomic Energy Act of 1954, can be found at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf; accessed April 8, 2008. The 123 Agreement was signed May 6, 2008, in Moscow and submitted for ratification. For further information, see *Vestnik Atomproma*, N. 5, May 2008. See also the papers by Orde F. Kittrie and Alexander Pikaev in this volume and Appendix E for the text of the U.S.-Russian 123 Agreement.

[49] For further information regarding the U.S. Global Nuclear Energy Partnership, see http://nuclear.inl.gov/gnep/index.shtml; accessed April 6, 2008.

[50] For further information regarding International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), see http://www.iaea.org/OurWork/ST/NE/NENP/NPTDS/Projects/INPRO/index.html; accessed May 1, 2008.

[51] For further information regarding Generation IV International Forum (GIF), see http://gif.inel.gov/; accessed May 1, 2008.

countries, a new kind of in-depth cooperation on peaceful use of nuclear energy (see Appendix D).

In order to expedite the implementation of these initiatives, it is necessary that countries see the economic benefits of nuclear cooperation. They must also feel that they really are equal participants in this process. To prevent discrimination, the prohibition on enrichment of uranium or on reprocessing of spent nuclear fuel must be in effect for all countries. Control over these technologies must be handed over to international institutions.

If we were to embark upon this path, however, another issue that will have to be resolved is the development of nuclear energy using fast reactors. These reactors work on mixed uranium-plutonium fuels. One cannot simply outlaw their construction as a matter of policy. A better way to proceed would be through the development of comprehensive methods for the detection of undeclared nuclear activities. For example, we could develop techniques for remote monitoring of nuclear fuel cycle facilities and nuclear reactors to prevent any unauthorized modifications or other proscribed activities. We could also introduce the practice of assessing various technologies and facilities with respect to their proliferation potential.

In summary, these proposals merit in-depth study and the development of corresponding rules and norms. Possibly, a set of requirements will have to be established so that all countries interested in developing peaceful nuclear energy will adhere to them.

## CONCLUDING REMARKS

The United States and Russia must lead the process of perfecting the NPT and the entire non-proliferation regime as a whole. We must pay greater attention to progress in nuclear disarmament and peaceful use of nuclear energy for the benefit of the international community. We should gradually move away from programs that deliver economic and science and technology assistance to Russia, and embrace joint programs based on partnership and collaboration. We must be responsive in identifying and analyzing existing impediments, difficulties, and differences of opinion, as well as work to find ways to resolve them.

This global partnership must include not only such activities as dismantlement of nuclear-powered submarines, disposition of nuclear materials and elimination of chemical weapons, but must also seek to create a new non-proliferation regime and make major scientific and technological breakthroughs that would enable this regime.

We must find a mechanism and establish a process for resolving the most salient non-proliferation issues and overcoming existing disagreements. Differences of opinion between the United States and Russia on a number of issues must not undermine the foundations of our cooperation because we agree on the most important issue. We agree that U.S.-Russian cooperation in the field of nuclear disarmament and non-proliferation has fundamental importance for strengthening strategic stability and is in the interest of our two countries and the international community as a whole.

Finally, it is also critical that U.S. and Russian working groups, both ones comprised of government officials and those staffed by non-governmental organization leaders, continue to talk about issues of security and non-proliferation and provide sensible recommendations.

# ACCUMULATED EXPERIENCE THROUGH LONG-TERM COOPERATION: APPLYING LESSONS LEARNED FROM U.S.-RUSSIAN MPC&A PROGRAMS

# THE EXPERIENCE OF RUSSIA AND THE UNITED STATES IN COOPERATION ON PROTECTION, CONTROL, AND ACCOUNTING OF NUCLEAR MATERIALS

Sergei V. Antipov, Nikolai N. Ponomarev-Stepnoi, Vladimir K. Sukhoruchkin,
*Kurchatov Institute*

Cooperation between Russia and the United States in material protection, control, and accounting (MPC&A) has often been called a successful example of cooperation between the two countries in the area of international nuclear security and in resolving specific tasks aimed at strengthening the nuclear weapons and nuclear materials non-proliferation regime. This success can be explained by the fact that, right from the outset, this cooperation was in both countries' urgent interests.

One of the consequences of the collapse of the Soviet Union and the transition to a new economic and political system in the early 1990s was that the existing MPC&A system stopped functioning effectively. This was partly a result of changes to the state borders of the Russian Federation and partly a result of the emergence of a market price for nuclear materials. Furthermore, the Soviet MPC&A system was primarily based on human resources and made little use of technical means and methods, and this inevitably weakened the system during the transition period that brought with it the disorganization of management and falling standards of workplace discipline.

By the mid-1990s, a complex situation had emerged in the control over the use and storage of nuclear materials in Russia. Stories appeared in the Russian and foreign media about illegal sales of nuclear materials or transfers of these materials abroad. Not all of these stories appeared realistic and most of them concerned nuclear materials of little use for developing nuclear weapons, but they were nonetheless evidence that problems did exist. It was necessary to develop a new system that complied with the conditions of a new stage of Russia's economic and political development as well as with international requirements.

There was a clear need for a new system that was adapted to the new economic and political developments in the country and conformed to international standards. Russia did not have sufficient experience of its own in developing and operating such systems, nor did the state budget, which at that time was burdened with a deficit, have the funds to pay for the development of these costly systems.

The United States also wanted to see this problem addressed as swiftly as possible in order to prevent the possibility of the uncontrolled and illicit spread of nuclear materials from Russia, which would have had very negative consequences for the international nuclear weapons non-proliferation regime. Both countries and the international community in general sought to strengthen and maintain the non-proliferation regime. Acting in these interests, the United States offered financial and technical assistance to Russia to upgrade its protection, control and accounting systems for nuclear materials and installations. At that time, the need to introduce new MPC&A principles was not one of the biggest state priorities in Russia and the search for mutually acceptable forms of cooperation with the United States in this sensitive area took some time.

The urgency of this problem and the need to find a solution as rapidly as possible were, however, particularly evident at the Kurchatov Institute. The issue was so urgent for the Institute because of its location. The Kurchatov Institute, one of the world's biggest nuclear centers, is located in a densely populated district of the Russian capital only a dozen kilometers away from the Kremlin. The scale and seriousness of the problem was compounded by the fact that the Kurchatov Institute houses numerous nuclear installations and a considerable amount of nuclear materials are stored there, including 'direct use' materials such as non-irradiated 96-percent enriched uranium.[52] There are also laboratory quantities of plutonium at the Institute.

These circumstances and the awareness that a number of the existing MPC&A systems no longer answered the demands of the changing situation at the Kurchatov Institute meant that the problem received timely recognition and became the top priority. Staff at the Kurchatov Institute, with the aim of identifying the main problems involved in the transition to new protection, control and accounting procedures for nuclear materials, took the initiative of drawing up and testing new methods and procedures and new formats of accounting and reporting documents. The resulting project, A Model Automated System for the Protection, Control and Accounting of Nuclear Materials for Complex Nuclear Devices, began in September 1993, in cooperation with a private American research institute.[53]

MPC&A cooperation between the Kurchatov Institute and the U.S. national laboratories began in May 1994, when a group of specialists from the U.S. Department of Energy (DOE) and the American national laboratories first visited the Institute. During this visit, a protocol of intent was drawn up and areas for joint work were outlined. The protocol was signed in Moscow on June 24, 1994.

In August 1994, following a U.S. proposal, the Kurchatov Institute joined the lab-to-lab MPC&A cooperative program. This marked the start of intensive work to install modern MPC&A systems at the Kurchatov Institute's installations. The first general cooperation agreements with the Los Alamos and Sandia National Laboratories in the United States were signed in August-September 1994. A specific contract for the development of a modern physical protection system for one of the Institute's main buildings, Building 116, was signed with Sandia National Laboratory in October that same year. Building 116 houses the Narciss and Astra experimental installations, and a sizeable amount of direct use nuclear material – 96-percent enriched uranium-235 in manufactured and bulk form – is housed here. The project's aim was

[52] The IAEA defines direct use materials as "nuclear material that can be used for the manufacture of nuclear explosive devices without transmutation or further enrichment. It includes plutonium containing less than 80 percent 238Pu, high enriched uranium and U233. Chemical compounds, mixtures of direct use materials (e.g. mixed oxide [MOX]), and plutonium in spent reactor fuel fall into this category. Unirradiated direct use material is direct use material which does not contain substantial amounts of fission products; it would require less time and effort to be converted to components of nuclear explosive devices than irradiated direct use material (e.g. plutonium in spent reactor fuel) that contains substantial amounts of fission products." *The IAEA Safeguards Glossary* is available at http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/Start.pdf; accessed May 1, 2008.

[53] In 1993, there were not really any existing and effective automatic systems for material protection, control, and accounting in Russia. It was impossible to use existing American systems due to security issues. Therefore, with U.S. financial support, the decision was taken to develop such systems for Minatom and Kurchatov Institute, and later for the Ministry of Defense (MOD).

not only to equip this building with modern physical protection systems but also to develop and test in practice a physical protection concept and vulnerability assessment method. Most important was to test the principles and methods for joint work with the U.S. national laboratories in this sensitive area and produce an example of effective cooperation that would provide the impetus for developing this kind of cooperation at other nuclear research and industrial centers in Russia. The contract was signed in October 1994, and intensive efforts by the staff of the Kurchatov Institute and Sandia National Laboratory meant that all work on upgrading Building 116's physical protection system was completed in December that same year. A special seminar and ceremony marking the beginning of operations of the new physical protection, control and accounting system in Building 116 took place at the start of February 1995. Officials from numerous Russian nuclear enterprises and from the Russian Navy were invited to attend these events.

Simultaneously, through a contract with the Los Alamos National Laboratory, a pilot computerized system for the control and accounting of nuclear materials was developed and its trial operation began. This system went on to serve as the foundation for developing the Kurchatov Institute Materials Accounting and Control System (KIMACS) universal control and accounting system (see below for further information).

After the new MPC&A system in Building 116 began operation, the scope of work broadened. Other U.S. national laboratories also joined in work with the Kurchatov Institute. The Kurchatov Institute worked intensively with six U.S. national laboratories on upgrading MPC&A systems:

- Sandia National Laboratory – physical protection
- Los Alamos National Laboratory – computerized nuclear material control systems and systems for measuring and monitoring nuclear materials
- Lawrence Livermore National Laboratory – vulnerability assessment
- Oak Ridge National Laboratory – nuclear material identification, optical seals and operation support systems
- Pacific Northwest National Laboratory – communications, measuring systems, seals
- Brookhaven National Laboratory – physical inventory of nuclear materials

A series of work on secondary lines of protection was also carried out in cooperation with Argonne National Laboratory.

## WORK ON PHYSICAL PROTECTION OF NUCLEAR MATERIALS AT THE KURCHATOV INSTITUTE

A number of projects in the area of nuclear materials non-proliferation over recent years have seen substantial investment with the support of DOE and the Kurchatov Institute. These projects include upgrading nuclear material physical protection systems and increasing the security of nuclear materials, which has reduced to a minimum the risk of unauthorized access to nuclear materials and external threats.

A second important aspect of raising the level of nuclear materials' security is the increased workplace discipline of security forces at the Kurchatov Institute and its individual facilities containing nuclear materials. These forces are responsible for operating the physical protection systems.

Work to improve physical protection began with a vulnerability assessment to identify the weak spots and lay the foundation for a project to upgrade physical protection for specific buildings and territories. In accordance with the concept of multi-barrier physical protection, the project may include passive and active barriers, reinforced doors and windows, detention systems, access control systems, nuclear material monitoring systems, metal detectors, communications systems, and guaranteed energy supply and lighting systems. A great deal of attention was paid to consolidating nuclear materials in order to reduce the number of places where direct-use nuclear materials were kept.

Based on this concept, aside from Building 116, physical protection upgrades were carried out at the following buildings and facilities:

- two central storage buildings
- the building housing physical test beds simulating reactors used by the Navy
- the building where the department for high-temperature nuclear energy is located and where a large amount of highly enriched uranium (HEU) is kept
- the main perimeter of the Kurchatov Institute (passive protection)
- two vehicle access gates and one railway access gate to the Institute's territory
- four pedestrian access gates to the Institute's territory
- the building housing the central security and reaction forces command post
- some facilities at the Gas Plant, a separate area on the Institute's territory
- a number of other buildings

American financial assistance was also used to install special means of transport for transporting nuclear materials and security personnel at the Kurchatov Institute. Given the Kurchatov Institute's location in a city of millions of people, work to strengthen and upgrade the external perimeter and the pedestrian and vehicle access gates is especially important. All signals from the physical protection systems are transmitted to the buildings' security command posts and to the Institute's central security command post where the reaction forces are located.

Realizing the importance of work in this area, the Kurchatov Institute not only participated in implementation of these projects, and not only brought in specialists to help carry them out, but it also took part in their financing. Practically all of the construction work was financed by the Kurchatov Institute, while installation of physical protection systems was carried out on the basis of contracts with the U.S. national laboratories.

## MATERIAL PROTECTION, CONTROL, AND ACCOUNTING WORK AT THE KURCHATOV INSTITUTE

Much work has been carried out to upgrade the nuclear material protection, control, and accounting systems at the Kurchatov Institute. The work to upgrade the nuclear materials control and accounting systems initiated at the Kurchatov Institute in 1993-1994, revealed an absence of corresponding Russian laws and standards that could be used as a guideline in carrying out large-scale and important work to upgrade nuclear materials control and accounting.

The Russian Federal Law on Atomic Energy Use was only adopted at the end of 1995. Federal regulations and standards conforming to the law finally appeared only at the end of 2001, that is, almost six years later. Two basic federal regulations came into force as of January 1, 2002:

- "Main Guidelines for the Control and Accounting of Nuclear Materials" (Russian Federation Regulation NP-030-01)
- Atomic Energy Ministry Order No. 464 of August 21, 2001, on Approval and Entry into Force of Reporting Procedures in the Area of State Control and Accounting of Nuclear Materials and the Procedures and Frequency for Providing Reports

Between 1994 and 2002, that is, until the Russian regulations came into force, upgrading of nuclear materials control and accounting systems at the Kurchatov Institute was carried out using DOE regulations in the area as a basis, and in close cooperation with the DOE national laboratories.

## NUCLEAR MATERIALS BALANCE ZONES

In 1995-1996, analysis of the main characteristics of all the nuclear materials at the Kurchatov Institute was carried out, as was an analysis of the main design characteristics of the nuclear installations at the Institute. The structure and composition of the material balance zones and key measurement points were determined and internal regulations were drawn up.

In 1996, the Kurchatov Institute had in its possession thirty active nuclear installations and nuclear materials storage centers. A total of 28 material balance zones were determined for them, of which 13 zones, in accordance with DOE criteria, were put in the 1C category (the highest category of attractiveness for nuclear materials that are not considered to be components of nuclear weapons and their component parts). The Institute also had significant quantities of more than 1,500 different types of nuclear materials in the form of individual articles and in bulk form.

All of the Kurchatov Institute's internal regulations on nuclear materials control and accounting were later brought into line with the provisions of Regulation NP-030-01. The new regulations provide a detailed description and list of the organizational structure for control and accounting procedures at the Institute as a whole and for each of the 33 material balance zones; they are subject to annual adjustment and revision.

## PHYSICAL INVENTORY

It is difficult to overestimate the scale of efforts required for initial physical inventory at the Kurchatov Institute. With the help of the U.S. national laboratories, a number of nuclear installations at the Kurchatov Institute have been equipped with modern measuring systems that include electronic weights, gamma spectrometers (such as InSpector and PC-FRAM) and active-well neutron coincidence counters integrated with the KIMACS nuclear materials computerized control and accounting system developed by the Kurchatov Institute.

The use of modern measuring systems made it possible to carry out initial and subsequent physical inventories of a large quantity of nuclear materials. In 2003, an inventory of the most attractive forms of nuclear materials (plutonium and uranium with U235 isotope enrichment of more than 50 percent) was completed.

Significant upgrading of the containers and storage facilities used for storing nuclear materials was also carried out during the inventory process. Modern bar-code based methods for identifying accounting units and the corresponding bar-code equipment have been widely used, as have modern anti-tampering devices in the form of improved seals of various types.

## COMPUTERIZED CONTROL AND ACCOUNTING SYSTEM

Specialists from the Kurchatov Institute, in cooperation with Los Alamos National Laboratory, have developed and installed a universal computerized nuclear materials control and accounting system, KIMACS. This system is the most advanced of its kind in Russia and can be adapted to the needs of nuclear enterprises of any complexity. As well as being used at the Kurchatov Institute, this system is used in the Russian Navy and will also be used, for example, at Rosatom's Krasnoyarsk-26 Mining and Chemicals Plant. A specialized computer class to train Kurchatov Institute staff to use the KIMACS system was set up during work to improve nuclear material control and accounting systems at the Institute.

The particularity of KIMACS is that it is the only system of its kind in the Russian Federation to have gone through state certification procedures for information protection and it has the capacity to process information with various levels of secrecy.[54] The Kurchatov Institute paid for the very costly certification procedure with its own funds.

## EXPORT CONTROL WORK

One of the first joint projects between the Kurchatov Institute and Los Alamos National Laboratory in 1994-1997, was work on nuclear export controls. After the collapse of the Soviet Union, Russia and the other Commonwealth of Independent States (CIS) countries had to analyze new export control demands and draw up new documents to guarantee control of nuclear exports in new conditions. Under a contract between the Kurchatov Institute and Los Alamos National Laboratory, an analysis of the situation and new demands regarding export controls in Russia and the other CIS countries was conducted. The criteria and methodology for technical analysis of requests to issue nuclear export licenses and permissions were also drawn up.

Further, an analysis of export control lists was carried out. Items on the lists were grouped according to the level of danger they represented in terms of nuclear weapons proliferation risks. Analysis was also made of the technical procedures for export controls in Russia and the other CIS countries with the aim of drafting scientific and technical recommendations for improving export controls. A nuclear export analysis and control system

[54] The MPC&A system shall go through the correspondent certification process as per procedure specified by the MOD (both soft-and hardware) to be used at MOD facilities. This procedure has been completed in strict compliance with the existing requirements and procedures set up by the MOD.

was developed by the Kurchatov Institute in cooperation with Los Alamos National Laboratory and subsequently presented to the Russian Atomic Energy Ministry for use.

## REMOTE MONITORING WORK

In accordance with a lab-to-lab cooperation program between Sandia National Laboratory and the Kurchatov Institute, a remote monitoring system project began in 1994. Based on the principle of mutuality, two sites were chosen for the project: one HEU storage facility at Argonne National Laboratory and one HEU storage facility at the Gas Plant at the Kurchatov Institute.

The Sandia/Argonne/Kurchatov Institute remote monitoring system was also the first experience in Russia with the practical use of this kind of technology in the control of nuclear materials use. The system's trial operation period at the Kurchatov Institute made it possible to identify and resolve a number of organizational and technical problems and also gave rise to diverse ideas on developing the applications for this technology in the practice of nuclear materials protection, control and accounting, both for domestic needs and for international use. Demonstrations of the functioning remote monitoring system made a positive impression in both countries. Some commentators even called the system's development a historic event as it marked the first time that the two principle nuclear powers had placed their direct-use nuclear materials under mutual control.

## REMOTE VIDEO MONITORING USING MOM TECHNOLOGY AT THE KURCHATOV INSTITUTE

The first pilot Material Operation Monitoring System (MOM) was installed in Building 135 at the Kurchatov Institute in 2003. The network technology used in the MOM system's structure and design makes it possible to expand the network by connecting it with MOM systems to be installed in other buildings at the Institute. One of the main aims of monitoring is to raise the level of workplace discipline of staff and ensure that they follow the rules for handling nuclear materials, and to raise control over the aspects of the work and functioning of physical protection systems, especially control systems for access to buildings, that could affect access.

## WORK WITH THE RUSSIAN NAVY

In March 1995, the Commander-in-Chief of the Russian Navy asked the Kurchatov Institute to help the Navy install modern MPC&A systems at its sites. It was not a coincidence that the Navy turned to the Kurchatov Institute for help. The Institute has worked together with the Navy for many years. Practically all of the naval nuclear reactors and the fuel for them were developed under the scientific direction of the Kurchatov Institute. Hundreds of naval officers have received training at the Institute and now serve on board nuclear submarines, surface vessels or at land bases in all of the naval fleets. The Institute has test beds that simulate naval nuclear reactors.

That same year, the Kurchatov Institute proposed to DOE an expansion of the lab-to-lab cooperation program in the area of MPC&A systems for Russian naval installations. After several meetings and talks, the U.S. energy secretary, a Russian naval official and the president of the Kurchatov Institute issued a joint statement in July 1996, declaring in particular that the Russian Defense Ministry and DOE had decided to cooperate in order to "guarantee the highest possible standards of MPC&A for all Russian naval storage sites containing fresh highly enriched nuclear fuel for the Russian Navy's nuclear reactors."[55] The Kurchatov Institute was responsible for coordinating this work.

The Kurchatov Institute became the link between the Russian Navy and DOE and also took on the role of general subcontractor. What was important was that by this time the Kurchatov Institute and DOE had built up a lot of experience cooperating during the work to upgrade the MPC&A systems at the Institute itself.

Practical work began at several Navy sites in 1998. Upgrading was completed rapidly for fresh nuclear fuel storage facilities belonging to the Northern Fleet (Site 49) and the Pacific Fleet (Site 34). The upgrading of these storage facilities means that all of the highly enriched fresh nuclear fuel is now stored in facilities well equipped with modern MPC&A systems. These storage facilities could be said to be the best of their kind in Russia. Work was then carried out at three floating workshops used for reloading submarine reactors, and work was also conducted to improve physical protection at spent fuel storage facility No. 32 near Vladivostok.

In 2000, the Russian Defense Ministry and DOE concluded an agreement on MPC&A cooperation, and this was followed by the signing of a number of protocols setting out procedures for information handling, access to sites, and so on. In 2001, work began at special Russian naval sites and all of the work planned for the sites selected for cooperation has now been completed.

The MPC&A upgrading program in the Russian Navy is a successful example of using a cooperative program with the United States involving scientific centers in both countries to achieve fruitful cooperation between such complex organizations as the Russian Defense Ministry and DOE in the areas of protection of nuclear materials, non-proliferation of nuclear weapons, and nuclear terrorism prevention.

The participation of scientific colleagues from large scientific centers in both countries, their creation of joint working groups, even while working at facilities of third parties, brings an atmosphere of cooperation, greater trust and creativity, and allows participants to 'speak the same language' to better understand one another, to find new, non-traditional paths toward the resolution of difficulties that may arise, and to achieve better results.

This experience should be taken into consideration and used when preparing new joint Russian-U.S. projects aimed at raising levels of nuclear security, improving the safety culture, consolidating nuclear materials and developing partnership relations in the nuclear sector over the coming years.

---

[55] *The Joint Statement on Cooperation between the Russian MOD and the United States Department of Energy on Control, Accounting, and Physical Protection of Nuclear Materials*, signed at the seventh meeting of the U.S.-Russian Joint Commission on Economic and Technological Cooperation on July 15-16, 1996, in Moscow.

# MATERIAL PROTECTION, CONTROL, AND ACCOUNTING: LESSONS LEARNED APPLIED TO UNITED STATES AND RUSSIAN NUCLEAR SECURITY COOPERATION IN 2015

Dori Ellis, Byron Gardner, M. Teresa Olascoaga,
*Sandia National Laboratories*[56]

## INTRODUCTION

In the early 1990's the United States began working with the Russian Federation and Newly Independent States to increase security and accounting of nuclear materials. This cooperation was initially part of the U.S. Department of Defense (DOD) Cooperative Threat Reduction Program and was funded by the Nuclear Threat Reduction Act of 1991, sponsored by Senators Sam Nunn and Richard Lugar.[57] This legislation is now commonly known as the Nunn-Lugar Act. The goals of this program were to secure and eliminate nuclear materials and nuclear weapons and prevent proliferation of other potential weapons of mass destruction from the former Soviet Union. This effort was implemented in 1992 as the Government-to-Government Program, administered by the Defense Threat Reduction Agency. In 1994, the U.S. Department of Energy (DOE) initiated a separate cooperative effort between the U.S. national laboratories and corresponding Russian institutes; this program was called Laboratory-to-Laboratory (Lab-to-Lab). In 1996, DOE took over funding responsibilities for these programs. Finally, in February 1997, DOE combined the two programs into the Material Protection, Control & Accounting (MPC&A) Program.[58]

The MPC&A program is now administered by the DOE National Nuclear Security Agency (NNSA). The goal of the MPC&A program is to provide defense against nuclear

[56] Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. Department of Energy's (DOE) National Nuclear Security Administration (NNSA) under contract DE-A-AC04-AL85000.

[57] For further information regarding the Cooperative Threat Reduction programs, see http://www.nti.org/db/nisprofs/russia/forasst/nunn_lug/overview.htm; accessed April 8, 2008.

[58] For further information regarding this program, see Nuclear Threat Initiative (NTI), "Russia: Lab-to-Lab Program," April 13, 2001, available at http://www.nti.org/db/nisprofs/russia/forasst/doe/labtolab.htm; NTI, "Russia: Government-to-Government Program," April 13 2001, available at http://www.nti.org/db/nisprofs/russia/forasst/doe/govtogov.htm; and, NTI, "Russia: DOE MPC&A Program," February 1, 2005, available at http://www.nti.org/db/nisprofs/russia/forasst/doe/mpca.htm. All cites accessed May 1, 2008.

proliferation and nuclear terrorism. To comprehensively address the scope of the problem, the program established three primary focus areas: Secure, Reduce, and Sustain.

- **Secure:** Install physical security and accountancy upgrades appropriate for the level of material attractiveness and the threat of theft
- **Reduce:** Consolidate material into fewer buildings at fewer sites, and convert excess highly enriched uranium to low-enriched uranium to reduce the number of theft targets and costs
- **Sustain:** Encourage the development of Russian capabilities and commitments to operate and maintain these security improvements

The MPC&A program has teamed with two primary entities in Russia to achieve significant risk reduction for special nuclear materials and nuclear weapons in Russia. These two entities are the Federal Atomic Energy Agency (Rosatom), which was formerly the Russian Ministry of Atomic Energy (Minatom), and the Ministry of Defense (MOD). The national security of both the United States and Russia has been enhanced by this cooperation.

The majority of security upgrades under the MPC&A program are to be completed by the end of calendar year 2008. Maintenance and sustainability assistance for these upgrades will be phased out gradually until 2013.[59] As U.S. monetary assistance for the MPC&A program gradually phases out, the relationship between the U.S. and Russia in the nuclear security arena should move from one of assistance to equal partnership and joint leadership on the nuclear safety and security global stage. The objective for this new partnership should be to enable expansion of nuclear energy while enhancing nuclear safety and security worldwide. The lessons learned in the MPC&A program can be of significant value in shaping this future partnership.

## SCOPE

This paper covers the relevant lessons learned from the MPC&A program that can be used in the formation of a new globally strategic nuclear safety and security partnership between the U.S. and Russia. The paper also covers the nature and goals of this partnership, and a process for facilitating the transition from assistance to a full partnership.

## RELATIONSHIP CHANGES FROM ASSISTANCE TO PARTNERSHIP

The Bratislava accords and the NNSA/Rosatom Joint Action Plan call for virtually all MPC&A upgrades to be finished by the end of calendar year 2008.[60] Additionally, the Bob

---

[59] For further information, see DOE, "FY2007 Congressional Budget Request," February 2006, available at http://www.cfo.doe.gov/budget/07budget/Content/Volumes/Vol_1_NSSA.pdf.

[60] For further information regarding the "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation," of February 24, 2005, see http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html; accessed February 23, 2008. See also Appendix D for full text of this Joint Statement.

Stump National Defense Authorization Act of 2003 mandates that the Secretary of Energy develop a sustainable MPC&A program that will be supported solely by Russia no later than January 1, 2013.[61] At this date, all NNSA funds for these activities will stop and Russia will assume full financial responsibility. Projects that are already finished are currently in an evolving maintenance and sustainability phase that includes seven key fundamentals:

1. Site MPC&A Organization
2. Site Operating Procedures (Instructions)
3. Human Resource Management and Site Training
4. Operational Cost Analysis
5. Equipment Maintenance, Repair, and Calibration
6. Performance Testing and Operational Monitoring
7. MPC&A System Configuration Management

This end date for U.S. financial assistance is being treated very seriously by both sides. Both also recognize the benefit of some form of continuing cooperation that builds on the joint technical and project management expertise, team work, and relationships that have grown during the program. This joint experience could be of significant value to the national security of both nations and the promulgation of better nuclear safety and security worldwide. The United States and Russia have stated that although the number of contacts in the MPC&A arena will inevitably shrink, there needs to be a sanctioned mechanism for continued cooperation.

## IMPLEMENTATION OF LESSONS LEARNED: KOLA TRAINING AND TECHNICAL CENTER AS A HISTORICAL EXAMPLE

In November 2000, the Russian MOD requested U.S. assistance to establish regional support centers. The Kola Training and Technical Center (KTTC) was designed and constructed to institutionalize a technical support infrastructure that includes training, maintenance and testing, lifecycle support, and spare parts inventory. This facility is unique in that it was designed and constructed based entirely upon the needs of the upgraded sites in the Kola region, located in the far north of Russia.[62]

The KTTC supports the overall MPC&A strategic goal of assisting Russia in enhancing capabilities and commitments to operating and maintaining improved nuclear security. More specifically it supports the strategic objectives of fostering the development of regulatory institutions, regulations, procedures, and training centers, and determining the level of sustainability assistance required to transition full operations and maintenance of MPC&A

[61] The Bob Stump National Defense Authorization Act of 2003 mandates that a sustainable materials protection, control, and accounting system be transferred to sole Russian Federation support no later than January 1, 2013. For further information regarding the Bob Stump Act, see http://www.army.mil/armybtkc/docs/PL%20107-314.pdf; accessed May 1, 2008.

[62] For further information, see L.D. Lambert, W.J. Toth, S. Hendrickson, "Russian Federation Regional Technical Centers for MPC&A Sustainability Operations," Forty-fourth Annual Meeting of the Institute of Nuclear Materials Management, Phoenix, AZ, July 13-17, 2003.

equipment. To meet these objectives, the KTTC provides training for key personnel at Russian sites.[63]

Physically establishing a location for the KTTC began by developing a conceptual design that documented Russian MOD-identified needs to support MPC&A system upgrades at their sites. Based on the conceptual design and documentation identifying Russian contributions to the project, a preliminary design for the facility was jointly developed to meet documented needs of the Russian MOD in the Kola region. The initial design activity involved describing and analyzing current or past practices to determine the areas in which they were adequate and areas in which additional processes were necessary. Proposed assets were evaluated against specific criteria (i.e., number of people to be trained) to determine their cost-effectiveness. Actual construction activities and equipment provisions were based on the final design of the facility. Construction of the KTTC facility commenced in March 2003 and was completed June 2005. The KTTC facility includes a training/administration building, emergency generator housing, a maintenance workshop building, and a power substation.

The KTTC training program includes the development and implementation of courses for maintenance, operations, and management that are directly related to MPC&A systems installed within the Kola region. Course design and development follows the Instructional System Design for training development. The KTTC training team has adopted a "train the trainer" approach; such an approach provides for the long-term sustainability of a training system by developing a standardized course curriculum and a cadre of qualified instructors.

A Russian MOD-led Training Advisory Committee was established with the responsibility of conducting quality training evaluations, reviewing the Quality Evaluation Guidelines, defining additional training needs, developing training standards, prioritizing training activities, coordinating work with other MPC&A training programs, and assisting in the development of training plans for specific sites.

Equipment maintenance and testing is another primary activity associated with the KTTC conduct of operations. Maintenance tasks for items on the master equipment list focus on the areas of preventative maintenance, routine and corrective maintenance, a spare parts stock and maintenance plan, and maintenance tool acquisition and calibration. Performance testing methodology and planning is vital to the long-term sustainability of all MPC&A systems, such as physical protection, material control and accounting, and response forces. A centralized approach will also be used for testing, including integrated system acceptance testing, functionality testing, operability testing, and limited and broad scope performance testing.[64] Computerized maintenance management tools for analyzing data acquired during routine operation or testing of MPC&A systems will be integrated into the KTTC internal infrastructure to provide continuous improvement and feedback.

The KTTC has been equipped with the technical and maintenance equipment used at the sites the center supports and on which training will be conducted. This training will involve both the appropriate use and care of the equipment as well as how to maintain the equipment. Mobile maintenance vehicles were purchased for use by the KTTC and a garage is simultaneously being

---

[63] For further information, see N.N. Nelson, P. O'Shell, S. Hendrickson, V. Sukhoruchkin, S. Antipov, E. Melkhov, N. Ponomarev-Steponi, N. Yurasov, "Cooperative MPC&A Enhancements at Russian Navy Sites," Forty-second Annual Meeting of the Institute of Nuclear Materials Management, Indian Wells, CA, July 15–19, 2001.

[64] For further information, see C. Harmon, L. D. Lambert, A. Khoudykin, and S. Matonin, "Fundamental Activities in Sustainability Development and Operations," Forty-sixth Annual Meeting of the Institute of Nuclear Materials Management, Phoenix, AZ, July 2005.

constructed to accommodate these vehicles. Equipment needed for replacement and continued functionality of MPC&A systems will be distributed to the sites through the KTTC.

The Russian MOD and NNSA developed a strategy for transition and U.S. exit. Implementation of the KTTC training curricula and equipment testing and maintenance functions are being phased to ensure availability of core functions at the time of expansion to full functionality during the transition period. The KTTC will eventually assume full responsibility for sustainability of those sites within the Kola Region.[65] A detailed transition plan was jointly developed.

## APPLYING LESSONS LEARNED

In reviewing the success of the KTTC project, one can identify several lessons learned that could be applied to similar projects.[66]

**Training is best institutionalized by involving qualified training developers from the beginning.** Developing indigenous training capabilities enables the long-term goal of sustainability. In the U.S.-Russian MPC&A program, involving qualified Russian developers from the beginning ensured that both the technical requirements were met and the end product was a lesson plan that could be certified by the Russian authorities.

**Train the operational staff to increase the level of on-site field maintenance, especially for remote sites.** Almost all technical knowledge about the more sophisticated systems installed through technical assistance programs is held by Russian vendors. Site electricians and other craft personnel are not generally prepared to perform many routine maintenance functions, and are especially not capable of performing any technical equipment repairs. That technical knowledge can be shared with the proper facility personnel through training development efforts, but those activities take some time to accomplish.

**Match the technology used to indigenous capability to maintain it.** During the design process, it is important to consider the indigenous technology capabilities in order to avoid inadvertently introducing technology that cannot be maintained or sustained.

**Match the project to the needs.** The design process for the KTTC building began with function and training needs assessments to identify an appropriate scope and size of the facility. Data points on the curriculum to be taught, the throughput of trainees, and the number of instructors required to conduct the training were analyzed using standard DOE methodologies to calculate space and training equipment requirements, thus defining the size of the building actually needed.

**Efficiencies of scale related to training and spare equipment provision can be realized through the use of regional centers with a "depot" level focus.** Having a smaller number of instructors at a regional center rather than duplicating instructors at individual sites allows for better utilization of Russian human resources. Less spare equipment needs to be

---

[65] For further information, see C. Harmon, N. Peterson, L. D. Lambert, M. Elliott, W. J. Toth, S. Hendrickson, A. Khoudykin, "Challenges to Sustaining Material Protection, Control, and Accounting Systems in the Russian Federation Ministry of Defense," Forty-fifth Annual Meeting of the Institute of Nuclear Materials Management, Orlando, FL, July 2004.

[66] For further information, see M. O'Brien and D. Lambert, "Kola Technical Center Lessons Learned White Paper," October 15, 2007.

purchased when management of the maintenance and replacement effort is concentrated at a regional level where a "bigger picture" perspective is possible.

**Russian institutes are interested in western methodologies for gathering and analyzing data on the installed technical systems.** Their interest is high, primarily because they need to know how to determine failure rates, replacement life-cycles, and other attributes for themselves without relying totally on vendors.

### Organizational Lessons Learned from the MPC&A Program

In addition to the specific lessons learned in MPC&A, there are more general lessons that can be applied to facilitate the cooperative efforts on a broader scale.

**Commitment at the highest levels within each of the partner organizations and governments has a significant benefit.** One of the most important lessons learned has been the positive benefit of having extremely high-level commitment for the program. The program has made the most progress when high-level commitment has been codified into joint action plans. For example, the program significantly accelerated with the Bratislava Initiatives (see Appendix D). These initiatives defined the entire scope of remaining MPC&A assistance and established the goal of 100 percent completion by the end of calendar year 2008. Presidential direction (Presidents Vladimir V. Putin and George W. Bush) strongly contributed to rallying action; this direction substantially accelerated the placement of remaining contracts, the pace of upgrades implementation, and the amount of training underway to operate the soon-to-be-completed security upgrades. Engagement between the laboratories also needs to start at the Laboratory Directors' level to assure that resources and processes meet the needs of the cooperative efforts.

**Strong relationships contribute to success, so it is important to minimize changeover in personnel.** The MPC&A program has achieved the most success when key individuals are in positions long enough to develop productive working relationships based on joint goals and trust. This joint trust allows for cooperation to proceed at a progressively faster and bureaucratically easier pace. Where there is trust, there has been action, creative problem solving, and results. Outside-of-the-box thinking allowed by trusting and open relationships yielded some of the most creative solutions to bureaucratic obstacles, which produced tangible results. For example, the U.S.-Russian disagreements over on-site inspections delayed the upgrades to a number of weapons storage sites. The impasse was resolved when two long-time participants in the program worked with their respective governments to establish a system of "assurances" rather than intrusive monitoring. Relationship stability also led to the development of agreements and procedures that allowed for the continuation of the program in spite of necessary personnel changes, and minimized the impact of those changes. Occasionally, the MPC&A program experienced slowdowns as key individuals changed at the governmental, institute, and national laboratory levels.

**Focus on the most important projects/problems for the maturity level of the collaboration.** MPC&A cooperation was most efficient when the cooperation focused on the highest priority problems, such as highly attractive nuclear materials. In part, projects addressing the highest risk materials received more funds sooner. However, the faster pace was also a result of the clarity of the mission. When both sides were in perfect agreement on the goals and urgency for a particular objective, contracts were more easily placed, projects were completed in little time, access issues were resolved, and maintenance and sustainability and training issues were solved. Note, however, that the objectives of the program evolved over time. In the early stages of a partnership, building trust and relationships are important; as a result, it may be better to start with lower risk objectives.

**Establish a clear legal framework for the cooperation.** MPC&A cooperation was sanctioned under the "Agreement Between the United States and the Russian Federation Concerning the Safe and Secure Transportation, Storage, and Destruction of Weapons and the Prevention of Weapons Proliferation," of June 17, 1992. This is known as the "Umbrella Agreement." The Russian MOD and Rosatom and the DOD and DOE each negotiated implementing agreements under this umbrella agreement. Key provisions with respect to liability, access to sensitive facilities, access lists, and protection of sensitive information were not adequately defined in the umbrella agreement or in individual implementing agreements. This resulted in periods where the cooperation was significantly handicapped because neither side was getting the assurances needed to allow work to proceed. Although work proceeded under the authority of the chairman of the DOE/MOD Joint Coordinating Group (JCG) and the DOE/Rosatom Joint Coordinating Committee (JCC) both sides were at some risk because of the lack of formalized expectations and procedures. This period, which lasted several years, was heavily relationship-driven. The pace of cooperation and results significantly accelerated when the Administrative Arrangements and Access procedures were signed in early 2000.

**Insulate the program from political issues to the extent possible.** Since the start of U.S.-Russian cooperation in 1992, the projects have been relatively insulated from impacts of non-MPC&A U.S.-Russian political issues. This allowed the completion of important projects in spite of issues that occasionally caused great tension between the United States and Russia. It is believed this phenomenon existed because both sides realized the importance of the cooperation and took actions to reduce the impact of tensions. Without this insulation, the cooperation would not be at the evolved state that has been achieved with the end in sight.

**Establish efficient organizational structures and delegate programmatic decision-making authority as low as possible.** MPC&A achieved the most fruitful cooperation when the chairmen of the various implementing committees (JCG and JCC) had full authority to set the direction of the program. With programmatic directional authority residing at the chairman level, decisions could be made rapidly to enable the required pace of cooperation. Prior to the creation of these committees under the implementing agreements, decisions on both sides took more time. This periodically resulted in program delays or slowdowns. Inevitably, some high-level decisions were required at the Minister, Secretary, and/or Interagency levels. However, the decentralized decision-making authority residing at the chairman level was extremely beneficial to MPC&A program implementation. Authority at this level allowed inclusion of necessary expertise from Russian contractors and institutes and from U.S. national laboratories and contractors, as needed.

## OBJECTIVES AND GOALS FOR A NEW MODEL

The joint experience gained in the MPC&A program could be leveraged to support a new model of joint partnership based on fundamental, mutually agreed-upon goals and objectives. The partnership should expand beyond a United States-Russian-centric approach and undertake a broader, global engagement with both sides contributing personnel, expertise, technology, and resources. Possible global goals and objectives to build from could include:

- global leadership in nuclear safety and security (Russia and the United States using their collective expertise to push for more effective nuclear safety and security standards)
- enhanced sustainable worldwide security of global nuclear material stockpiles, including material consolidation, inventory reduction to necessary levels, and robust material controls
- commitment to safe, secure, and proliferation-resistant growth of nuclear energy
- investment in science and technology development
- measures to combat terrorism, including security of radioactive sources

Furthermore, this new model should be based on a joint needs assessment that focuses on what each side really wants from the relationship and what each side is willing to commit to the relationship. This carefully constructed assessment should be based on active listening and understanding what each side needs, wants and can commit.

The new partnership could include governmental representatives, national laboratory/institute representatives, and selected non-governmental organizations from both countries, such as representatives from Rosatom, DOE, Russian MOD, DOD, Eleron, U.S. national laboratories, etc. However, it is extremely important that the new relationship be sanctioned by an appropriate agreement. Potential areas of cooperation for the new partnership include the following:

- joint implementation of projects based on high-security experience and technical expertise (such as expedited denuclearization of a clandestine nuclear program)
- joint technology development projects (sensors, assessment, access delay, simulation and modeling, measurement methods, safety systems, etc.)
- joint technology performance testing projects (tests of systems against capabilities of evolving threats, including cyber and other highly technical attack methods)
- observation and evaluation of large-scale safety and security exercises
- joint training and technical exchanges, both bilateral (Russia-U.S.) and trilateral (Russia-U.S.-International Atomic Energy Agency)
- hyper awareness of threat changes (sharing of information on adversary capabilities, tactics, and targets)

## METHODS TO IMPLEMENT NEW RELATIONSHIPS, STRUCTURES, AND PROCESSES

This new Global Nuclear Partnership between the U.S. and Russia needs to be established while the relationships developed under the MPC&A still exist. The relationships that form the foundation for such a partnership can take years to develop. Work should begin now to establish this partnership because of its potential importance. As the amount of U.S.-funded cooperation begins to diminish, the amount of personal contact between the two sides will start to erode, making it imperative that concrete steps be taken now. The following recommendations layout the roadmap for this future partnership:

- **Establish a Framework Agreement for the Elements of the Partnership, as appropriate**—This agreement could be modeled on the umbrella agreement or one of the implementing agreements. There also may be another set of U.S.-Russian agreements this new partnership could leverage. Historically, new agreements can take up to two years to codify, even with high-level support from both sides. In any case, the pursuit of a framework agreement needs to begin now. Recommendations for this transition should be made at high levels within the respective U.S. and Russian government agencies. Additionally, requests for creation of the partnership should be made in the joint protocols of the JCC and JCG meetings in 2008. A key issue to be addressed in a framework agreement is sharing of sensitive information.
- **Create Charter, Organizational Structure, and Project Implementation Plan for activities under the New Partnership**—This work should be based on results of a joint needs assessment that attempts to clearly define what each side wants from the partnership and what each is willing to invest in it. The documents should clearly state which organizations are involved and which organization on each side is the lead agency responsible for direction of the partnership. Schedules and milestones must be clearly stated to provide a method to measure success.
- **Address Visa Issues**—There has been an inequity in processing visas for entry into the United States for Russian citizens. U.S. visas for Russian citizens take much longer than Russian visas for U.S. citizens, which has caused cancellations and delays that interfere with cooperation. The United States should consider expedited visa processing for Russian personnel involved in the new partnership to ensure this does not happen.
- **Identify Funding Sources and Scope**—The funding requirements for the partnership need to be identified early and budget requests made as soon as possible to ensure partnership activities can begin at the pilot project level. Because pilot projects have been the best sounding board for new modes of cooperation, this concept should be used as the catalyst to refine how the new partnership will operate. For example, follow-on MPC&A activities could be used as a pilot to begin to establish the relationship. Initially, funding needs to cover only a few projects to kick off the new partnership.
- **Jointly Develop and Select a Number of Pilot Projects**—The first steps in establishing this new way of cooperating will lay the foundation for the longer-term cooperation. Therefore, the scope of the first projects needs to be relatively small but should address critically important topics. The pilots should also be chosen to exercise the full range of logistical, bureaucratic, and security hurdles so future projects can proceed without obstacles. Pilots could be selected to address potentially sensitive and previously difficult topics, but probably should not require any access to sensitive facilities in either country. Teams working on the pilot projects need to be relatively small to ensure agile response and clear delegation of responsibilities. This will also reduce security concerns on both sides. Topics for the pilot projects could include the following:

    - **Joint technical exchanges with other weapons states hosted by the United States and Russia on nuclear weapons safety and security.** This technical exchange would discuss safety, non-sensitive protection methods, and means for analysis and performance testing of these systems. The goal of this exchange is to encourage all states with nuclear weapons to ensure adequate safety and protection, and to increase awareness of the risks facing their materials. The United States and Russia have extensive experience that could be beneficial to other weapons states. This pilot fits the goals of the United States and Russia providing worldwide leadership and stewardship of nuclear stockpiles.

- **Small joint implementation project to secure nuclear material in a third country.** This pilot would use the expertise gained during the MPC&A program in a team effort to secure material at risk in a third country. Russia and the United States would work together to secure the materials at an ultra-rapid pace. This pilot could serve as the model for many such projects and would further the U.S.-Russian leadership role in global nuclear security.
- **Joint program to support global implementation of United Nations Security Council Resolution 1540 and the Convention on the Physical Protection on Nuclear Material (CPPNM).**[67] In this pilot, the United States and Russia could collaborate in the development of assistance programs to support other States' in the implementation of domestic controls, export control regimes, and international cooperation in support of Resolution 1540 (that "all States shall act to prevent proliferation of mass destruction weapons") and the amendment to the CPPNM. This pilot would further U.S. and Russian leadership in preventing the proliferation of weapons of mass destruction and appropriately securing materials and assets. Because the amended CPPNM has expanded jurisdiction from international transport of nuclear materials to include nuclear materials in domestic use, storage, and transport, an example activity would be to assist other IAEA Member States in implementing a physical protection regime based on the fundamental principles contained in the amended CPPNM.
- **Civilian nuclear energy cooperation.** Signature of the U.S.-Russian 123 Agreement[68] would establish a framework agreement to enable cooperation on civilian nuclear energy. Collaborative pilot projects in civilian nuclear energy cooperation could include advanced safeguards; nuclear waste storage and disposition; nuclear energy safety; and analysis and development of proliferation resistant processes, technology, and fuel cycles. Such pilots would further U.S. and Russian leadership in the safe and secure expansion of nuclear energy.

[67] To read the text of United Nations Security Council Resolution 1540, see http://daccessdds.un.org/doc/UNDOC/GEN/N04/328/43/PDF/N0432843.pdf?OpenElement; accessed April 6, 2008. See also Convention on the Physical Protection of Nuclear Material, which entered into force on February 8, 1987. The text and amendments are available at http://www.iaea.org/Publications/Documents/Conventions/cppnm.html; accessed May 1, 2008.

[68] The 123 Agreement refers to Section 123 of the U.S. Atomic Energy Act of 1954, which requires a bilateral agreement between the United States and any country wishing to receive U.S. exports of technology and equipment related to civilian nuclear energy. The U.S. Atomic Energy Act of 1954, can be found at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf; accessed April 8, 2008. The 123 Agreement was signed May 6, 2008, in Moscow and submitted for ratification. For further information, see *Vestnik Atomproma*, N. 5, May 2008. See also the papers by Orde F. Kittrie and Alexander Pikaev in this volume and Appendix E for the text of the U.S.-Russian 123 Agreement.

Similar projects could easily fall within the scope of the new partnership. The important element is that they address issues that are both U.S.-Russian-centric as well as those more global. Success in these pilots can solidify the new partnership—financially and politically. The pilot phase for the new partnership should end no later than 2013. The partnership should be fully functioning by 2014 to ensure meaningful progress through 2015 and beyond.

## CONCLUSION

The time is right for the formation of a new U.S.-Russian partnership focused on global nuclear safety and security. U.S. assistance programs are winding down and projects are transitioning into the maintenance and sustainability phase. All U.S. financial assistance is expected to end by 2013. In order to capitalize on the joint cooperative experience and expertise gained in the MPC&A program, a plan for a new partnership needs to be undertaken soon. The goals for this new partnership should include the following:

- worldwide nuclear safety and security leadership
- commitment to the safe, secure, and proliferation-resistant growth of nuclear energy
- measures to combat terrorism, including the security of radioactive sources
- science and technology collaboration to enable joint goals

Specific programs under this new partnership need a solid legal framework, high-level commitment, identification of funding and personnel resources, solid project management, and initial pilot projects to be successful. Starting the process today will ensure a strong, fully implemented global nuclear security partnership between Russia and the United States in 2015 and beyond.

# THE KOLA TRAINING AND TECHNICAL CENTER OF THE RUSSIAN NAVY

Sergei V. Antipov, Nikolai N. Ponomarev-Stepnoi, Vladimir K. Sukhoruchkin,
*Kurchatov Institute*

The development of new, modern systems for the physical protection, control and accounting of nuclear materials and the modernization of existing systems at naval nuclear and radioactive-hazard sites and a number of other Russian Defense Ministry sites is one of the real results of successful cooperation between the Russian Navy, the Kurchatov Institute, the U.S. Department of Energy (DOE) and U.S. national laboratories working together through the program for the protection, control, and accounting of nuclear materials (MPC&A program). These systems were designed, built and installed from 1998 to 2007, and have begun operation at 14 sites belonging to Russia's Northern Fleet, eight sites belonging to the Pacific Fleet, and at a number of sites belonging to other subdivisions of the Defense Ministry. The largest number of sites equipped with the new systems (13 in total) is on the Kola Peninsula.

The introduction of new systems is not sufficient in itself to guarantee protection of nuclear materials. Systematic technical servicing by qualified and trained operating personnel is also required to keep the systems operating reliably. Initially (for free during the guarantee period and on a contract basis thereafter) technical servicing was carried out by the organizations that installed the systems and took part in their construction. The training issue was resolved using the following method: at the same time the systems were developed and installed, training was organized for the personnel who would be operating the new systems during the initial phase. This training took place at the Kurchatov Institute and was organized by the Institute's specialists and specialists from the L.G. Osipenko Naval Training Center in Obninsk. Representatives of the organizations that developed and manufactured the technical systems were also brought in. Financial support for training came from the U.S. national laboratories.

The following training courses took place as part of the training program for Defense Ministry officers at the Kurchatov Institute between 1998 and 2005:

1) A two-week basic training course on MPC&A at Russian naval nuclear sites for eight groups of Defense Ministry personnel. A total of 180 people went through this training course.
2) A two-week inspectors training course for six groups of Defense Ministry personnel. A total of 80 people went through this training course.
3) A one-week training course for the commanders of Russian naval nuclear sites. Three training courses were organized for a total of 40 people.
4) Two two-week training courses for the heads of nuclear materials physical protection services at Russian naval nuclear sites. A total of 30 people attended these courses.

5) Two training courses for one group of Russian strategic nuclear forces personnel. A total of 16 people attended these courses.
6) One training course for senior command officers, attended by approximately 30 people.

Overall, approximately 370 Russian Defense Ministry personnel received training in different aspects of MPC&A. This made it possible to launch the new systems and ensure their reliable operation during the initial phase.

But guarantee periods always come to an end sooner or later and the staff working at sites gradually changes. Protection of nuclear materials, meanwhile, requires the reliable and guaranteed long-term work of the systems in place, from both a technical and personnel point of view (personnel are needed for technical servicing and repairs and for the systems' operation).

Practice in developing and operating the MPC&A systems at the Northern Fleet sites highlighted the need to establish specialized regional training and technical centers as the most effective solution to providing systematic training for personnel and technical service to maintain these complex systems in operational state.

Work began on establishing just such a center, the Kola Training and Technical Center (KTTC), in Severomorsk in 2001, in close cooperation with the Russian Navy, the Kurchatov Institute and the U.S. national laboratories. This center will train personnel and provide technical servicing for MPC&A systems not only at Russian naval sites but also at other Defense Ministry sites and civilian sites. All equipment used for physical protection systems at special facilities is of Russian origin. And all personnel working at these facilities are trained with the purpose of operating this very equipment, not American equipment.

## KOLA TRAINING AND TECHNICAL CENTER

### Construction Stages and Technical Characteristics of the KTTC

Design of the KTTC began at the end of 2001 and construction began in mid-2002. The KTTC consists of a group of functionally interrelated buildings and facilities that blend harmoniously into the urban design of the city of Severomorsk and are located on a territory measuring 0.66 hectares in area. The complex includes:

- a training center
- a test ground for Technical Protection Systems
- workshops
- a training checkpoint
- a training zone for technical inspections
- a distribution sub-station
- a module-based diesel electricity station
- engineering and communications infrastructure for the complex's operations

Functional ergonomics and optimization of the interrelations between the different parts of the complex are at the basis of all the design and planning solutions for the buildings and facilities.

The engineering and communications infrastructure enables the site to function in ordinary and autonomous regimes. A comprehensive quality control system was used during the center's construction, as were modern technology methods and the most advanced, certified materials, designs, and equipment.

The KTTC complex offers:

- classrooms for theoretical training in MPC&A and communications systems
- facilities and a test ground for practical work
- technical service workshops for MPC&A and communications systems for Russian naval sites
- administration and auxiliary premises

The center's training and administrative building is a three-storey building with a workspace of approximately 2,600 square meters. It includes classrooms, rooms for practical work, a library, one large and two small conference halls, MPC&A system technical service workshops, teachers' rooms, and rooms for the center's administrative personnel. Workshops are located in a one-storey building with an area of approximately 250 square meters. These workshops will carry out repairs and tests of MPC&A systems installed at Northern Fleet naval sites.

The KTTC also has a training checkpoint that includes a training zone for vehicle inspections. This facility is designed to enable people to learn and practice correct access procedures to and from Russian naval sites and for practical work on technical maintenance of the equipment installed at the facility. Installed at the test ground are technical protection systems that are linked to the information collection and processing control posts and the access control system located in the main building. A particular feature of the test ground's location is that students can observe work in the test ground from the windows of the classrooms where the control posts are located.

The KTTC makes it possible to fully meet the demand for MPC&A technical maintenance, tests, technical support, and staff training for Northern Fleet and other Defense Ministry nuclear-hazard sites.

## Development of Training and Methodological Documents and Training for the KTTC Teaching Staff

The following work was required for organizing MPC&A training for Russian Defense Ministry personnel:

1) training teachers in the area of MPC&A for the KTTC
2) drawing up a training program and training and methodology documents for the KTTC

Toward these goals, specialists from the Kurchatov Institute, Eleron Federal Unitary Special Scientific Production Enterprise, and Eskort Center Closed Joint-Stock Company worked closely with Defense Ministry personnel on the following tasks:

1) drafting planning documents for the naval training programs

2) drafting guidelines for MPC&A training programs for naval specialists
3) drawing up an MPC&A training program for the KTTC
4) drawing up standards for the teaching management process and carrying out analysis of existing commercial systems
5) drawing up quality evaluation guidelines for the training courses provided at the KTTC
6) drawing up a catalogue of the training courses offered at the KTTC
7) drawing up training and methodological material for 18 courses on MPC&A at naval sites and two courses on communications systems

Eleron and Eskort Center, the two companies developing physical protection systems, are carrying out training for the teachers at the KTTC. Teacher training in the area of communications systems is being carried out by the Kurchatov Institute. The first training course for KTTC teaching staff took place from August 16 to September 10, 2004. Training for the KTTC teaching staff was fully completed in 2006.

## The KTTC Training Program

The KTTC offers unique technical training resources and an operational training and resource base for training all types of nuclear materials specialists in MPC&A at nuclear-hazard sites. The Center has unique specialized classrooms for training people to operate the physical protection system control posts and for training specialists in the use of site and perimeter detection systems, security television systems and access control systems. Classes take place in classrooms, laboratories, computer classes and at the physical protection engineering and technical systems test ground. All of the necessary technical resources, installations and equipment are in place to carry out practical exercises and laboratory work. In order to make training more effective, classrooms have been equipped with computers, multimedia projectors and other technical teaching equipment.

More than 40 percent of the teaching time when training engineering and technical personnel is spent on practical work, during which time students study regulation and adjustment procedures for technical physical protection systems.

The Center's staff have extensive experience in operating engineering and technical systems and hold senior positions in the Russian navy. The Center's teachers attended a special training course at the Kurchatov Institute and at Eleron and the Eskort Center, the main organizations developing physical protection systems for nuclear materials. They also received methodological training and had internships at the Naval Training Center in Obninsk.

The KTTC will also organize the following MPC&A training courses for naval personnel:

- one training course on the basics of MPC&A
- 12 training courses on physical protection systems
- two training courses on communications systems
- six training courses on control and accounting of nuclear materials

All personnel at nuclear-hazard sites working in security and safety of nuclear materials will undergo training at the KTTC. This includes the sites' commanders and their deputies, the heads of physical protection services, the operators of central and local physical protection system control posts, physical protection system engineers and technicians, access checkpoint operators, communications engineers and technicians, and other personnel, including guards. The length of training will differ depending on the course. Access checkpoint operators, for example, will receive one week of training, while training for physical protection system operators will last five weeks.

Practical activities will form part of the training process for some categories of students. For this purpose, the KTTC is equipped with training equipment of the same kind as that operated at naval sites on the Kola Peninsula. During practical classes and individual study, students will have the opportunity to develop practical skills in working with all of the different types of equipment used during the training process. The training programs are designed so that the personnel receiving training at the Center will be able to independently operate and service physical protection systems installed at naval sites in the Kola region.

## The KTTC Program for Technical Support for MPC&A Systems Operation at Russian Naval Sites

The KTTC's program of technical support for MPC&A systems operation at naval sites includes the following:

- coordination and planning of technical operation of physical protection systems, communications systems, and accounting and control systems at the sites
- organization of technical service and repairs of MPC&A and communications systems' engineering and technical systems at the sites in accordance with the guidelines for technical service
- delivery upon request of equipment, spare parts, and materials needed for technical service of the systems, spare parts storage, and additions
- collection, processing, and statistical analysis of information on failures of physical protection system engineering and technical systems, preparation of proposals for their repair and upgrade
- organization of reclamation work

The Center's technical support functions are carried out by its technical departments.

The Center's cooperation with the sites to which it provides services is carried out in accordance with the technical service guidelines that have been drawn up and approved for a five-year period and the annual technical service plans. These documents are used as the basis for calculating costs and resources (the necessary human resources, amount of equipment, spare parts, and materials to be delivered).

The operators of the systems at the sites carry out the initial collection of statistical information on any failures in the physical protection system engineering and technical systems, and this information is then sent to the Center for further review and analysis. This processed statistical material is the information source used for organizing work to improve the systems' robustness and operational reliability, forecast critical situations, plan and distribute spare parts needs, and carry out reclamation work.

Division of responsibility between the KTTC and the sites is determined by the types of technical service in question. The sites are responsible for carrying out technical service on a daily, weekly and monthly basis, and carrying out rapid repair of any failures in accordance with a list approved by the KTTC. The sites are also responsible for routine technical repairs of security systems. The KTTC carries out all other regulation work, rapid repair of failures, medium-scale repairs of technical equipment and replacement of broken down equipment, and also delivers to the sites, upon request, the equipment, components and materials needed for technical service of the systems.

The Center's control and revision function consists of developing programs for regulation checks (tests), organizing tests of the systems, and evaluating the overall effectiveness of the systems and their individual components. The aim of carrying out regulation tests is to determine the systems' effectiveness and establish how ready they are to ensure protection of nuclear materials from any illegal action. Tests check how the systems function with the aim of determining their effectiveness. The tests include:

- equipment tests
- tests to determine how correctly the staff carry out procedures
- tests to determine how well prepared the operations, security, and other departments are to react to routine and emergency situations

Systems tests can be planned or unplanned. Planned tests are carried out in accordance with the annual work plan. The sites concerned are informed in advance of the planned tests. Unplanned tests (without prior warning) are carried out:

- if there have been violations of a system's condition and organization
- if decided by the Fleet command or other state services of the Russian Federation with the relevant powers

## CONCLUSION

The start of operations at the KTTC does not mean that work in this area has ended. The next stage has now begun: that of maintaining the systems in operational state and ensuring the reliability and effectiveness of MPC&A systems at naval and other Defense Ministry sites in order to guarantee protection of nuclear and radioactive materials and nuclear installations. All of this work is part of the effort to strengthen the nuclear non-proliferation regime and prevent nuclear materials from falling into the hands of terrorists.

The effectiveness of the MPC&A systems will be determined by a complex of measures that include maintaining their technical state and selecting and training personnel for their operation, drawing up normative instructions and documents, ensuring material and technical supplies, and ensuring financing for all of these different areas of work.

The positive international experience of establishing and operating the KTTC gives us reason to believe that it could be used in other regions as well. An agreement has already been reached between the Russian Defense Ministry and DOE to establish a similar center in Russia's Far East region.

The ambitious plans to develop the nuclear energy sector not only in Russia but in other countries make the issue of material protection, control, and accounting more relevant than ever.

Not only will it be necessary to develop new technical systems for the physical protection of new sites over the coming years, but it will also be necessary to ensure the guaranteed operation of both the earlier and the new systems. There will also be a need to train qualified personnel to operate these systems and provide them with ongoing training. The establishment of regional training and technical centers along the lines of the KTTC can help to resolve these complex tasks over the coming years.

As experience gained from the cooperation between Russia and the U.S. has proven to be effective for Russian facilities and regions and as it continues to develop, it could be reasonably applied to third countries. Strong, mutually collaborative, experienced teams of Russian and American specialists could arrange initial training, including in safety culture issues, develop criteria and requirements for the MPC&A systems, design and modify or create such systems, and further establish on-site technical training centers on the model of the Kola Training and Technical Center to organize regular training of local personnel.

# PARTNERSHIP IN THE GLOBAL CONTEXT OF THE 21ST CENTURY: A PERSPECTIVE FROM THE INTERNATIONAL ATOMIC ENERGY AGENCY

# ASSURANCES OF SUPPLY VS. PROLIFERATION: A NEW FRAMEWORK FOR NUCLEAR ENERGY

Tariq Rauf,[69]
*International Atomic Energy Agency*

The past few years have been a time of significant challenges and achievements for the International Atomic Energy Agency (IAEA). In the area of nuclear non-proliferation, the Agency has been at the center of attention and has demonstrated its ability to perform objective and credible verification—but we continue to face a number of difficult and unresolved situations. In the area of nuclear safety and security, we see overall improvement and our work is making a difference, but much remains to be done. In the area of nuclear technology, the Agency is contributing to sustainable development through its technical co-operation program—with the benefits of nuclear applications increasingly recognized—but more partnerships are needed to optimize the use of these valuable technologies.

For the past five decades, the role of nuclear power has been shaped by many factors such as growing energy needs, economic performance, the availability of other energy sources, the quest for energy independence, environmental factors, nuclear safety and proliferation concerns, and advances in nuclear technology. And while nuclear power continues to hold great potential as an environmentally clean source of energy, it remains in a holding position due to a number of associated concerns.

## NUCLEAR POWER

The urgent need for sustained human development will clearly necessitate increases in the supply of energy in the coming decades. In recent years, nuclear power has supplied about 16 percent of world electricity production, and it remains the only energy source that can provide electricity on a large scale with comparatively minimal impact on the environment.[70]

There are currently 439 nuclear power reactors operating in 30 countries, and they supply about 15 percent of the world's electricity.[71] To date, the use of nuclear power has been concentrated mostly in industrialized countries. But of the 30 new reactors currently under

[69] These remarks are based on a presentation made on November 10, 2007, in Houston, Texas, at the *Nuclear Non-Proliferation Workshop on the Policy Implications of Managing or Preventing Proliferation.*

[70] International Atomic Energy Agency (IAEA), "Reference Data Series, No. 1, Energy, Electricity and Nuclear Power Estimates for the Period up to 2030. 2007 Edition," p. 21. Available at http://www-pub.iaea.org/MTCD/publications/PDF/RDS1-27_web.pdf; accessed April 6, 2008.

[71] Ibid, pp. 12-13.

construction, 16 are in developing countries.[72] And while the highest percentage of existing reactors is in North America and western Europe, recent expansion has been primarily in Asia and eastern Europe. In other regions, the more immediate focus is on power upgrades, restarts of previously shutdown reactors, and license extensions. For example, in the United States of America, 16 reactors have had their operating licenses extended to 60 years, and many more applications are under review.[73]

The long term prospects for nuclear power, however, will depend on the industry's success in addressing concerns associated with waste disposal, safety and security, and proliferation, while also improving economic competitiveness of future reactors. Nearly 20 IAEA Member States are currently involved in projects to develop reactor and fuel cycle designs that would address some of these concerns, and a number of countries are also exploring the nuclear co-generation of hydrogen, to address demands for cleaner energy in the transportation sector.

The current spectrum of proliferation and security issues should provide the impetus for greater innovation in *policy* as well as *technology*. One example relates to the operation of sensitive parts of the nuclear fuel cycle. It is time to re-consider the merits of limiting the *reprocessing* of weapon-usable material (separated plutonium and highly enriched uranium) in civilian nuclear programs—as well as the *production* of new material through reprocessing and enrichment—by agreeing to restrict these operations exclusively to facilities under multinational control and verification. These limitations would need to be accompanied by appropriate rules of transparency and—above all—assurance of supply for would-be users.

Furthermore, it is also important to consider multinational approaches to the management and disposal of spent fuel and radioactive waste. Over 50 countries currently have spent fuel stored in temporary locations awaiting reprocessing or disposal.[74] Not all countries have the appropriate geological conditions for such disposal—and, for many countries with small nuclear programs for electricity generation or for research, the financial and human resource investments required for the construction and operation of a geological disposal facility are daunting.

## ENERGY FOR DEVELOPMENT AND GLOBAL ENERGY SECURITY

Recently, the IAEA has begun emphasizing the role of "energy for development" since it is becoming more and more clear that without energy there can be no development, and without development there is misery that can often lead to violence. The energy shortage in developing countries is a staggering impediment to development. To give some perspective, it is enough to mention that the countries of the Organisation for Economic Co-operation and Development, on average, consume electricity at a rate roughly 100 times that of the world's least developed countries.[75]

---

[72] Ibid.

[73] Ibid.

[74] Mohamed ElBaradei, IAEA Director General, Statement to the Forty-ninth Regular Session of the IAEA General Conference 2005. Available at www.iaea.org/NewsCenter/Statements/2005/ebsp2005n010.html; accessed May 26, 2008.

[75] IAEA, "Reference Data Series, No. 1." See also, "Nuclear Energy: The Need For A New Framework," statements by Director General Mohamed ElBaradei, April 17, 2008, Berlin, Germany, International Conference on

The IAEA offers energy assessment services that build a State's capability for energy analysis and energy planning, taking into account the country's economic, environmental, and social development needs. These services treat all energy supply options equally. They are in increasingly high demand and we have been expanding our capacity to offer them.

The G8 Summit in St. Petersburg in 2006 emphasized the importance of "global energy security."[76] At the expanded summit, the IAEA Director General emphasized that global energy security means fulfilling the energy needs of all countries and peoples, including the 1.6 billion people who have no access to electricity and the 2.4 billion who continue to rely on traditional biomass fuels. He also emphasized at that meeting that the current global organization of energy resource management and distribution is quite fragmented in terms of both geographical coverage and the types of energy resources managed. Global structures for setting norms, oversight, and management exist in most other key areas of human activity such as trade, civil aviation, labor relations, and health. However, no similar structure currently exists for energy.[77]

It is important to note that, as a sophisticated technology, nuclear power requires a correspondingly sophisticated infrastructure. For new countries considering nuclear power, it is essential to ensure that such necessary infrastructure will be available. This infrastructure includes many components from industrial infrastructure such as manufacturing facilities, to the legal and regulatory framework, to the institutional measures to ensure safety and security, to the necessary human and financial resources. The IAEA recently published guidance on the infrastructure needed for countries to introduce nuclear power, and we are working to define a set of milestones for the development of this infrastructure to assist us in prioritizing our support for those Member States.[78]

Nuclear energy might not be the choice of all countries and some, such as Germany and Sweden, have decided to phase out their nuclear power programs. Other countries have also adopted a policy against the use of nuclear power. However, for those Member States that choose to use nuclear power as part of their energy mix, there is much the Agency can do to make this option accessible, affordable, safe and secure.

## NEW FRAMEWORK FOR THE NUCLEAR FUEL CYCLE

The increase in global energy demand is driving a potential expansion in the use of nuclear energy. And concern is mounting regarding the proliferation risks created by the further spread of sensitive nuclear technology, such as uranium enrichment and spent fuel reprocessing. The convergence of these realities points to the need for the development of a new framework for the nuclear fuel cycle.

---

Nuclear Fuel Supply: Challenges and Opportunities. Available at www.iaea.org/NewsCenter/Statements/2008/ebsp2008n004.html; accessed May 26, 2008.

[76] See Appendix D for the texts of 2006 G8 St. Petersburg Summit Statements.

[77] "IAEA Chief Calls for Global Framework on Energy Security. New International Pact and Body Needed, He Says," Staff Report, July 21, 2006. Available at www.iaea.org/NewsCenter/News/2006/G8_2006.html; accessed May 26, 2008.

[78] IAEA, "Milestones in the Development of a National Nuclear Infrastructure for Nuclear Power," *Nuclear Energy Series*, N. NG-G-3.1, Vienna, 2007. Available at www-pub.iaea.org/MTCD/publications/PDF/Pub1305_web.pdf; accessed May 26, 2008. See also, IAEA, "Considerations to Launch a Nuclear Power Programme," Vienna, 2007; available at www.iaea.org/Nuclear Power/Downloads/Launch_NPP/07-11471_Launch_NPP.pdf.

For the last two years, the IAEA Director General has been calling for the development of a new, multilateral approach to the nuclear fuel cycle, as a key measure to strengthen non-proliferation and cope with the expected expansion of nuclear power use. The establishment of a framework that is equitable and accessible to all users of nuclear energy acting in accordance with agreed nuclear non-proliferation norms will be a complex endeavor that needs to be addressed through progressive steps.

The first step is to establish mechanisms for assurances of fuel supply for nuclear power reactors and, as needed, assurance of supply for the acquisition of such reactors. The second step is to limit future enrichment and reprocessing to multilateral operations and to convert existing enrichment and reprocessing facilities from national to multilateral operations.

A broad range of ideas, studies, and proposals have been put forward on this topic. At the IAEA General Conference in September 2006, we organized a Special Event, in which experts from all relevant fields discussed ways and means to move forward. A report on this Special Event was submitted to the General Conference and the IAEA Secretariat, in consultation with Member States. We will continue to work on identifying options and alternatives to move this concept forward.[79]

It has been more than fifty years since the Atoms for Peace initiative; the time has come to think of a new framework for the use of nuclear energy – a framework that accounts for both the lessons we have learned and the current reality. This new framework should in our view include:

- innovative nuclear technology that is inherently safe, proliferation resistant, and more economical
- universal application of comprehensive safeguards and the Additional Protocol
- concrete and rapid progress towards nuclear disarmament
- a robust international security regime
- an effective and universal nuclear safety regime

The first notion of fuel assurances came in the 1946 Baruch plan.[80] Some thirty years later, the 1976 international nuclear fuel cycle evaluation looked at multilaterally owned-and-operated nuclear frameworks.[81] Sixty years after the Baruch Plan, the 2006 Special Event focused on several new proposals for multilateral approaches such as commitments to supply enrichment services, international nuclear fuel centers, and even multilateral control over all fuel cycle facilities.

So, what has changed in the intervening half-century? It is obvious that many changes have taken place with significant implications. There is a spread of dual-use material and technologies with attendant risks of proliferation and nuclear terrorism. Such nuclear threats have impact on the future of both peaceful uses of nuclear energy and the prospects for nuclear disarmament.

---

[79] This report can be found at http://www.iaea.org/About/Policy/GC/GC50/SideEvent/report220906.pdf; accessed April 6, 2008.

[80] The text of the Baruch plan can be found at http://www.atomicarchive.com/Docs/Deterrence/BaruchPlan.shtml; accessed April 6, 2008.

[81] IAEA, Expert Group Report to the Director General of the IAEA, "Multilateral Approaches to the Nuclear Fuel Cycle," Vienna, 2005; available at www-pub.iaea.org/MTCD/publications/PDF/mna-2005_web.pdf; accessed July 13, 2008. See also, pp. 30-31 and Annex IV, pp. 156-169.

The spread of nuclear fuel cycle facilities and technologies is motivated in part by States' interest in ensuring reliable fuel cycle services through indigenous capability. This then is the challenge: What needs to be added to the existing market fuel-cycle services to provide enough assurance of supply in order to obviate the need for indigenous fuel cycle facilities?

Nuclear fuel assurance is an issue that the IAEA Director General has been dealing with for the past four years. Starting at the IAEA General Conference in September 2003, the Director General once again pointed to the need for balancing access to nuclear energy for generating power and balancing non-proliferation considerations. In that context, he proposed the possibility of revisiting previous approaches to multilateral solutions to the nuclear fuel cycle and to find a new framework for the utilization of nuclear energy.[82]

At that time, his comments were partly driven by one special verification case that is still continuing on the books of the IAEA, but since then, given the multiplicity of proposals, the debate has been considerably enlarged. We are now looking at the fuel cycle in its broadest aspects, looking not only at the front end of the fuel cycle (uranium enrichment), but eventually also at the back end, (spent fuel and reprocessing).[83]

The Director General has also focused specifically on providing assurances, not only of fuel but also of reactor technology. This is an area where, again, at the IAEA we need to do some more work. In the first instance, we focused on the front end, and that is uranium enrichment. In our view, we need to balance the interests of all Member States. The IAEA needs to make sure that the needs of developing countries, countries that are already relying on nuclear power or those countries that have plans to develop nuclear power are adequately represented while at the same time ensuring that we minimize the possibility of the misuse of sensitive aspects of the nuclear fuel cycle, in particular, uranium enrichment and plutonium reprocessing.

In the discussion on energy, there is now increasing talk about a potential nuclear renaissance. For the past 20 years, nearly 16 percent of the world's energy has come from nuclear sources, and this percentage has remained relatively stable. But over the next couple of decades, the projections are that this percentage will increase and as the world's energy requirements increase and as the pressures of reducing carbon emissions become more pressing on governments, there is expected to be an increasing reliance on nuclear energy. If there is to be this nuclear renaissance, there will be a major new demand for nuclear energy, both in terms of reactors, as well as in terms of fuel supply. The question then is where the new fuel supply will come from? Will it remain in the hands of the existing suppliers who would then perhaps expand capacity? Would new countries develop their own national indigenous enrichment capabilities? The vision of the IAEA's Director General is that all enrichment and reprocessing over time should be exclusively under multinational control.

In that context, the task that has been given to the policy staff at the Agency is to look at the existing proposals that have already been formulated to try and find a framework that draws upon the common elements of those proposals and to suggest a possible framework for the

---

[82] The IAEA Director General's Statement to the General Conference of September 2003 can be found at http://www.iaea.org/NewsCenter/Statements/2003/ebsp2003n020.html; accessed April 6, 2008.

[83] The Nuclear Energy Agency defines the stages of the fuel cycle as follows: "a) the so-called front-end which extends from the mining of uranium ore until the delivery of fabricated fuel elements to the reactor site; b) fuel use in the reactor, where fission energy is employed to produce electricity, and temporary storage at the reactor site; c) the so-called back-end, which starts with the shipping of spent fuel to away-from-reactor storage or to a reprocessing plant and ends with the final disposal of reprocessing Vitrified High-Level Waste or the encapsulated spent fuel itself." For further information, see http://www.nea.fr/html/ndd/reports/efc/efc02.pdf; accessed April 6, 2008.

consideration of the IAEA's policymaking organs that will focus on assurances of supply. The second task for the medium term would be to convert existing enrichment and reprocessing facilities to multilateral auspices; and, third, over the longer term to have all enrichment and reprocessing under multilateral control.

In this context, one will also need to have a global, internationally verifiable treaty on the prohibition of fissile material production for nuclear weapons. As long as the loophole is there, any new framework for multilateral approaches to the nuclear fuel cycle will still have a backdoor. So in that context, the challenge is to find a way of balancing both non-proliferation and economic considerations with the choices that are facing States.

## ASSURANCE OF SUPPLY

We need to find a way to promote the expanded use of nuclear energy to those countries that have made a sovereign choice to do so. The IAEA is not in the business of pushing countries to go into the nuclear field, but we can assist them in making energy choices; at the end of the day, it's the decision of the State to decide whether or not it chooses nuclear power. And if it does so, then the IAEA is there to assist it in the safety, security, and non-proliferation, regulatory, legal, and other aspects of that decision.

In our discussions both with supplier States, but more importantly also with consumer States, it has become abundantly clear that different States will choose different policies and solutions. And this will depend on their historic situations; it will depend on their geography, their technical abilities, and their individual choices. Thus, in this context, it is of utmost importance that we retain flexibility in this area and not try to suggest solutions that are perceived to be imposed, particularly on consumer States. This was something that became abundantly clear at the 2006 Special Event on the nuclear fuel cycle.

During the summary of the Special Event, the chairman mentioned in part that the recent proposals for assuring supplies of uranium-based nuclear fuel can be seen as one stage in a broader, longer-term development of a multilateral framework that could encompass assurance-of-supply mechanisms for both natural and low-enriched uranium, as well as nuclear fuel and spent fuel management.[84] In this context, establishing a fully developed multilateral framework that is equitable and accessible to all users of nuclear energy is a key element for the IAEA and its Director General.

The chairman's summary also pointed to why we need an assurance of supply mechanism. An assurance of supply mechanism could potentially address two particular challenges. The first is to deal with the possible consequences of interruptions of nuclear fuel supply due to political considerations that are not associated with non-proliferation, commercial, or other considerations related to contractual obligations. Such interruptions might dissuade countries from initiating or expanding nuclear power programs and, at the same time, might create incentives for countries to build new national enrichment and reprocessing capabilities.

Hence, an assurance of supply mechanism would be envisaged solely as a backup mechanism to the operation of the current, normally functioning market in nuclear materials, fuels and technologies. This would not be a substitute for the existing market, nor would it deal

[84] For further information, see Report of the Chairman at http://www.iaea.org/About/Policy/GC/GC50/SideEvent/report220906.pdf; accessed April 6, 2008.

with disruption of supply due to commercial, technical, or other failures. In this regard, an assurance of supply mechanism would be designed to give supply assurances to States that potentially voluntarily choose to rely on the international market for their nuclear fuel requirements, and therefore, no country would be asked or expected to give up or abridge any of their rights under the Treaty on the Non-Proliferation of Nuclear Weapons.[85]

A summary of various existing proposals is available on IAEA's website. There are, at the moment, 13 proposals that are mutually complimentary.[86] These proposals range from providing backup assurance of supply to establishing an IAEA-controlled fuel reserve to setting up international uranium enrichment centers where the IAEA would have some role in the decision-making process; all of these proposals are currently under consideration in the secretariat of the IAEA.

## A POSSIBLE FRAMEWORK: A THREE-LEVEL APPROACH

Drawing in part upon the World Nuclear Association study and the various other proposals, we in the IAEA Secretariat are proposing to our Board of Governors and Member States a possible framework that is based on three levels. The first is the existing market, based on existing commercial and other arrangements. The second would be backup commitments provided by suppliers of enrichment and fuel fabrication services and their respective governments that would be utilized when predetermined conditions and criteria had been met following a political supply disruption. This can be viewed as a combined virtual enrichment and fuel fabrication reserve mechanism. There may be some States that still might not be fully assured by the first two levels, and therefore it is essential to also have a third level. The third level could be a real reserve of low-enriched uranium stored in one or several separate locations, and a set of arrangements and agreements between suppliers of fuel fabrication services as well as owners of fuel intellectual property rights, creating additional fabrication possibilities. So, we need assurances not only of natural and low-enriched uranium, but also of fuel fabrication if necessary for the consumer State.

In his Statement to the IAEA Board of Governors in June this year, the IAEA Director General presented his report on a possible new framework for the utilization of nuclear energy assurances of supply.[87] In this statement he said that we are looking at these proposals and their associated legal, technical, financial and institutional aspects: the trends clearly point to the need to develop a new multilateral framework for the nuclear fuel cycle, and it is clear that an incremental approach with multiple assurances is the way to move forward. And he said that such a multilateral framework would best be achieved through establishing mechanisms that would, in the first instance, assure the supply of fuel for nuclear power plants, over time convert enrichment and reprocessing facilities from national to multilateral operations, and third, limit future enrichment and reprocessing to multilateral operations exclusively. Such a framework

---

[85] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

[86] For further information and to access these proposals, see http://www.iaea.org/NewsCenter/Focus/FuelCycle/index.shtml; accessed April 6, 2008.

[87] For information regarding this statement, see http://www.iaea.org/NewsCenter/Statements/2007/ebsp2007n007.html; accessed April 6, 2008.

would be voluntary, States would be free to choose their fuel options, and no rights of States would be compromised.

This is something that is critical to understand in the debate outside of Vienna, because more often than not, a certain word is used: "forego" (foregoing of rights). In this day and age, no country is prepared to give up any rights, and one of the so-called perverse outcomes of these various proposals and this larger discussion is that at least seven countries have said that while they do not necessarily need enrichment technology today, they might need it in the future, and they are not prepared to compromise, dilute or give up any rights. These countries, for example, are Argentina, Australia, Brazil, Canada, Kazakhstan, Ukraine, and South Africa; Brazil and Iran are already continuing with enrichment at the research and development level. Japan has a small enrichment capability to serve its domestic markets. None of these countries is prepared to dilute its rights, and therefore we need to frame this debate in a way that enables countries to make sovereign choices in a context where they feel comfortable relying on a multilayered mechanism that is built upon the market, backup assurances, as well as a real physical reserve of nuclear material.

The IAEA report, which was released to the Board of Governors on the 13th of June 2007, was still restricted when this proceedings was published.[88] The Board of Governors decided not to make this report available for public distribution at this time. This report has 90 plus pages and outlines a possible framework based on the three levels that I just mentioned. It discusses all of the various existing proposals, and provides some description of the release criteria that would be needed: the IAEA's Board of Governors could agree in advance on certain non-proliferation criteria that would need to be met by consumer States when they invoke the supply assurance mechanism if a supply of fuel has been cut off for political reasons so that the Board would not need to decide on eligibility on a case by case basis.

Finally, as the Director General has mentioned, this is a complex approach. It will need more time to develop. We in the Secretariat are not in a hurry. Some of the proposals are very complex. They require a great deal of legal and technical discussion, and therefore, in order to make sure that we do not repeat the mistakes of the past, we do not bring under-developed proposals for consideration before the Board of Governors. We bring proposals for consideration only after a full, frank, and comprehensive discussion both with consumer States as well as with supplier States so that when States meeting in the framework of the IAEA's Board of Governors decide to meet to consider this issue they can do so with the full range of information available. Hopefully they will then take the right decisions to empower the IAEA to continue to work on this issue and to help create a framework for establishing a nuclear fuel bank and for developing a partnership with the international uranium enrichment centers that have been proposed by the Russian Federation and by Germany.

There also is a proposal from the Nuclear Threat Initiative under consideration offering the IAEA $50 million on the condition that the IAEA's Member States raise an additional $100 million in material or cash donations within two years to set up an IAEA-controlled reserve of nuclear materials for those States that would choose to rely on the market.[89] One year has already elapsed, but this is also an area where we need the support of Member States.

---

[88] At the time of this publication, it still was not clear when the IAEA Board of Governors would include multilateral approaches to the nuclear fuel cycle, assurances of supply on its agenda for discussion.

[89] For further information on this proposal, see http://www.nti.org/c_press/fuel_bank_122707.pdf; accessed on April 6, 2008.

## CONCLUSION

The Agency continues to play a key role in ensuring that the benefits of nuclear technology are shared globally for economic and social development, that nuclear activities are conducted safely, that nuclear and radioactive materials and facilities are adequately protected, and that a credible inspection regime exists to verify compliance with non-proliferation commitments.

In his 'Atoms for Peace' speech, U.S. President Dwight D. Eisenhower articulated a vision, shared by many world leaders, that would enable humanity to make full use of the benefit of nuclear energy while minimizing its risk.[90] This vision led to the establishment of the International Atomic Energy Agency. Much has changed since that time, and I believe it is appropriate for us to take stock of our successes and failures, and to resolve to take whatever actions are required, including new ways of thinking and unconventional approaches, to ensure that nuclear energy remains a source of hope and prosperity for humanity, and not a tool for self-destruction.

In the present context of Atoms for Peace, the IAEA Director General believes the time has come to think of a new framework for the use of nuclear energy – a framework that accounts both for the lessons we have learned and the current reality. This new framework should include swift and concrete action to achieve:

- robust technological development and innovation in nuclear power and nuclear applications
- a new multinational framework for the fuel cycle, both the front and the back end, to assure supply and curb proliferation risk
- universal application of comprehensive safeguards and the Additional Protocol as the standard for nuclear verification to enable the Agency to provide assurance about declared activities as well as the absence of undeclared activities
- recognition of the linkage between non-proliferation and disarmament and therefore the need for concrete and rapid progress toward nuclear disarmament through deep cuts in existing arsenals, downgrading of alert levels for deployed nuclear weapons, and the resuscitation of multilateral disarmament efforts starting with bringing into force the Comprehensive Nuclear Test Ban Treaty[91] and beginning negotiations on a Fissile Material Cut-off Treaty[92]
- a robust international nuclear security regime, in light of the diverse threats we face
- an effective and universal nuclear safety regime, a cornerstone for any expansion in the use of nuclear power
- sufficient funding for the Agency to meet its increasing responsibilities in an effective and efficient manner

[90] The text of this speech can be found at http://www.iaea.org/About/history_speech.html; accessed April 6, 2008.
[91] The text of the Comprehensive Test Ban Treaty can be found at: http://www.ctbto.org/; accessed April 6, 2008.
[92] For more information on the Fissile Material Cutoff Treaty, see http://www.fas.org/nuke/control/fmct/index.html; accessed April 6, 2008.

# FULL PARTNERSHIP: SHARING STRATEGIC, MANAGEMENT AND FINANCIAL RESPONSIBILITIES

# THE SALIENT NEED TO DEVELOP NEW APPROACHES TO ADDRESS NUCLEAR WEAPONS PROLIFERATION ISSUES

Academician Ashot A. Sarkisov,
*Russian Academy of Sciences*

Presently, mankind is facing a whole host of complex issues stemming from the revolution in science and technology that began in the second half of the 20th century. These issues have been brought to the fore even more by the gradual globalization of political, economic, and social processes in the world. To resolve these issues, the entire international community needs to make consolidated efforts.

Some of these issues revolve around the need to curb the proliferation of weapons of mass destruction, combat international terrorism, eliminate the legacy of the Cold War, and preserve the planet's environmental balance. Unfortunately, most of them are not being addressed effectively enough: resources and funding allocated for these purposes are misused, and desired results take decades to materialize.

The reasons for this low effectiveness lie in striking conflicts of political and economic interests among stakeholders. They are also manifested in the differences of culture, religion, and mindset among different peoples, in a great gap in levels of social development, and in many other factors. Additionally, one of the major obstacles standing in the way of a more dynamic movement toward resolution of these issues has to do with a lack of a single comprehensive approach. Quite naturally, such an approach is required simply because the scale and complexity of issues that arise require it.

While most of the obstacles identified above are indeed hard to remove in the foreseeable future, there are no specific hurdles to the implementation of a comprehensive, systemic approach to the planning of activities required to resolve the issues under discussion.

I would like to share my experience with respect to one such issue. In my opinion, the example is instructive in that we have been able to avoid inefficiencies while demonstrating new approaches to securing a more successful consolidation of participating countries' efforts. In this paper, I will discuss an international project: the development of a Strategic Master Plan (SMP) for decommissioning nuclear-powered ships and vessels, and the environmental rehabilitation for their support infrastructure facilities located in the northwest region of Russia.[93] I would like to emphasize that the methodology of SMP development, provided for this particular SMP case, can not be directly applied to the analysis of other problems and non-proliferation issues.

[93] For more information about the Strategic Master Plan (SMP), see www.ibrae.ac.ru/index.php?option=com_content&task=view&id=152&Itemid=198; accessed July 13, 2008.

However, general principles and approaches used during SMP development are of a universal nature and can be adopted to solve other similar problems.

## MAIN GOALS AND OBJECTIVES OF THE STRATEGIC MASTER PLAN: ROLES AND MECHANICS

The Cold War has left some nuclear facilities located in the Russian northwest in the grip of numerous environmental problems. The extent of the threat caused by these problems has created the necessity for international collaboration and multilateral financing. The European Bank for Reconstruction and Development (EBRD) responded by establishing a fund to support the Northern Dimension Environmental Partnership (NDEP). One of the priorities of the 'nuclear window' of NDEP is to develop a controllable set of measures to efficiently reduce nuclear and radiation hazards presented by decommissioned nuclear-powered submarines, surface ships with nuclear propulsion, and their support infrastructure facilities located in the Russian northwest.

In partnership with Rosatom, the EBRD and its donor nations decided to develop a Strategic Master Plan in order to implement a comprehensive strategy to resolving the following problems:

- complex decommissioning of nuclear submarines and other floating sources of nuclear and radiation hazards
- rehabilitation, in a manner safe for people and the environment, of on-shore hazardous nuclear and radiological facilities
- strengthening physical protection of nuclear materials

Unlike previously developed plans, the SMP viewed all facilities as a single interconnected entity or system. This ensured a coordinated approach to common problems and made it possible to avoid any unnecessary duplication. The SMP offers both a comprehensive strategy and individual, facility-specific strategies that will be conducive to achieving certain end-states in decommissioning and rehabilitation activities in the Russian northwest. The SMP, and the Complex Decommissioning Program (CDP) it contains, will serve as the basic guiding document for project implementation in order to reach these end states. The SMP should not, however, be viewed as a program for direct action. Rather, it is a framework program, doctrinal in nature and set up to facilitate and guide Rosatom in its development of short- and medium-term action plans. With this in mind, it is assumed that the SMP (CDP) will be a 'living and breathing' document that will evolve as additional research takes place and more detailed information becomes available. This will make future avenues of strategic development more informed.

Development of the SMP was split into two stages. The first stage (preparation) [SMP-1] was completed in December 2004. Three leading research organizations participated in the development effort: the Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE), the Russian Research Center Kurchatov Institute, and the N.A. Dollezhal Research and Development Institute for Power Engineering. This effort provided the necessary inputs and identified the procedural basis for future work. Funding for a number of priority projects was provided based on major recommendations formulated in SMP-1.

Development of stage two [SMP-2] was assigned to a Program Development Team (PDT) comprised of the most eminent experts from a number of relevant organizations. The PDT was set up under the auspices of the Foundation for Environmental Safety of Power Engineering co-located within IBRAE.

The PDT was reinforced and supplemented by an international consultant (IC) that included representatives from Fluor Ltd. and British Nuclear Group Project Services (BNG PS). In compliance with the Terms of Reference (ToR), the IC was integrated into the PDT structure and tasked to perform IC functions for each individual goal spelled out in the ToR. To illustrate, the IC was responsible for review and consulting, as well as for sharing of the most recent western experience on a wide range of issues associated with SMP development.

According to the ToR, the SMP must:

- serve as a basis for strategic decision-making by the Russian Federation in such domains as management of spent nuclear fuel and radioactive and toxic waste produced during project implementation
- be conducive donor nations' technical and economic project evaluations based on such benchmarks as an increased level of safety and security in the region, better physical protection of nuclear materials, and an improved environmental status
- facilitate decision-making with due regard to relevant interests of the Russian Federation and donor nations

## PLANNING FROM THE TOP DOWN

First, in characterizing the entire scope of accomplished work, I would like to stress that a systemic approach was used at all stages of SMP development. One of the fundamental principles of such an approach is planning 'from the top down.' This methodology implies sequential development of increasingly detailed plans for achieving end objectives of the program. This is logically illustrated in Figure 1 below.

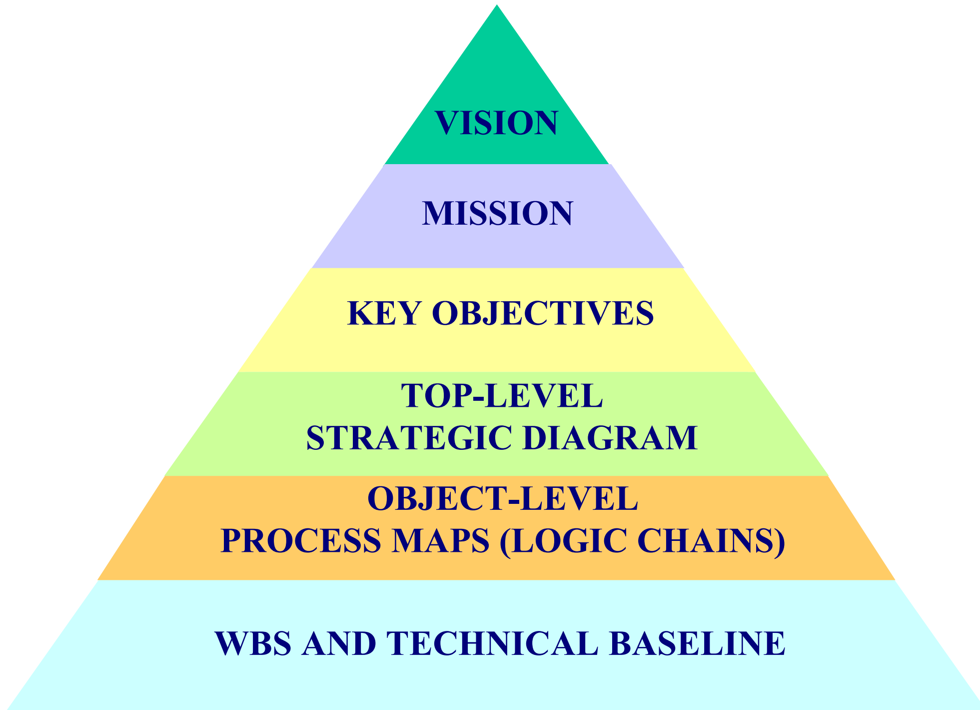



Figure 1 Strategic Planning "From the Top Down"
[WBS= Work Breakdown Structure]

The first step in the implementation of this logical progression is defining the expected end result (vision). Then, based on the expected end result, we must formulate the overall objective of the SMP development effort (mission).

The next step in the top-down planning process is the identification of strategic end objectives for all key elements/facilities in the program (i.e., nuclear submarines [NS], nuclear powered surface ships [NPSS], reactor units [RU], nuclear maintenance service [NMS] vessels, and former coastal maintenance bases). To achieve these specific end objectives across the entire spectrum of facilities subject to decommissioning and environmental remediation, an integrated 'roadmap' was developed. It is a big-picture diagram that depicts all movements and transformations of CDP elements leading to the achievement of the strategic end objective.

Then, every element in this top-level diagram was brought to a higher degree of granularity – as if looking at it through a 'magnifying glass.' As a result, functional diagrams (logical chains) were developed to describe the sequence of actions that have to transpire in order to achieve a certain pre-defined end state for a specific facility. On the basis of these logical chains and with an eye to interdependencies reflected in the top-level diagram, the work breakdown structure and CDP technical baseline were developed.

After the information was synthesized, a final diagram of CDP implementation was assembled *from the bottom up*. It reflects the most critical program milestones and this program's funding profile over the entire span of its lifecycle.

Later in this paper, we will touch on the contents of individual tiers of this logical progression in more detail.

## MAIN GOALS AND FINAL PRODUCT OF THE SMP DEVELOPMENT ACTIVITIES

Let us start at the top. The expected final result from implementation of all projects envisioned in the SMP Complex Decommissioning Program can be formulated as follows. First, the Russian northwest and neighboring countries will no longer be exposed to radioactive and toxic releases (from retired nuclear-powered ships and NMS vessels, as well as former maintenance bases) in excess of normative limits. Second, facilities, land, and water areas adjacent to the former maintenance bases will have to be rehabilitated to levels not harmful to human health or the environment if the land is to be used in the future.

Let us now move one level down in the planning hierarchy. The cornerstone objective of the Strategic Master Plan is to create an integrated program and control system that would ensure that the expected end results can be achieved in the Russian northwest. The program covers NS, NPSS, NMS vessels, former coastal maintenance bases (CMB), and the entire scope of associated hazardous materials: spent nuclear fuel, radioactive waste, and NMS vessel waste.

The third tier in the top-down planning hierarchy refers to identifying end objectives relative to specific facilities subject to decommissioning and environmental rehabilitation. In short, these objectives can be summarized as follows:

1) By 2015, all NS, RU, NPSS and NMS vessels must be decommissioned and their reactor compartments, NPSS reactor rooms (RR) and storage units on NMS vessels with solid radioactive waste inside must be placed in long-term storage (70 –100 years) at the Saida Bay temporary storage facility (TSF).
2) By 2025, former CMB at the Andreeva Bay and Gremikha must be rehabilitated to a level not harmful to human health or to the environment and be acceptable for future land use per Russian Government guidance.
3) By 2018, reprocessable conditioned and damaged spent nuclear fuel from VVR reactors must be safely extracted and moved to Mayak.
4) By 2015, non-reprocessable spent nuclear fuel must be placed in a safe configuration and held in long-term storage pending final decision.
5) By 2025, most radioactive waste must be appropriately packaged and placed in safe storage facilities for long-term storage. The waste must be prepared for final disposal at a later time.

If completed, the projects of the Complex Decommissioning Program will bring about these results.

These objectives are quite ambitious and they too had a formative effect on the SMP. In order to achieve these objectives, all Navy nuclear and radiation hazardous facilities (and their supporting infrastructure) that present any nuclear or radiation hazard – no matter military or civilian and regardless of which agency jurisdiction under which they fall – were examined during the SMP planning stage. In fact, this is the aspect that distinguishes the SMP from all previously developed or currently active plans and programs in the field.

The second important point is that all the facilities subject to decommissioning and environmental rehabilitation are viewed as a single integrated system linked by technological, manufacturing, and transportation ties.

The third unique feature of the SMP is that the CDP developed within its framework is geared toward end objectives of decommissioning and environmental rehabilitation. This also sets it apart from other currently active programs, including federal programs for decommissioning of armaments and military equipment with a time horizon of just five to 10 years.

Finally, another important difference has to do with the fact that specialized strategic studies were being conducted to secure an in-depth understanding of problems for which no conceptual solutions had been found previously. The end goals, strategic solutions, and specific implementation activities had to be identified in compliance with requirements and constraints of international and national laws. Therefore, one of the strategic studies was specifically dedicated to an analysis of the entire body of laws and regulations governing activities in this particular field. In the course of this strategic study, an updated list of decommissioning-related laws and regulations was compiled. It contains a total of 971 items. The study justified the need to develop four federal laws pertaining to the management of spent fuel, radioactive waste and radioactive materials. Here I would like to take note of just one specific proposal offered in the study. It calls for the creation of a special category of "very low level waste (VLLW)" and a justification for the underlying classification criteria (norms).

SMP development activities have progressed in compliance with the following guiding principles taken from cutting-edge Russian and western practices:

- use of a single common technical approach to all facilities
- use of tested and verified solutions wherever feasible
- maximized use of existing production capabilities and infrastructure
- minimized construction of redundant waste/material management and storage facilities
- placement of new waste/material management facilities at points of greatest concentration of these materials
- consolidation of storage facilities (for spent nuclear fuel and radioactive waste) to achieve economies of scale and simplify security measures
- storage of VLLW at facilities of their origin

This approach approximates a concept of safety used by the UK Nuclear Decommissioning Authority. The concept is based on the recognition that the main objective is hazard minimization and environmental protection. Such an approach ensures quicker minimization of risks associated with facilities subject to decommissioning and leads to a better use of funding provided to complete these activities. General consensus is that it results in reductions of life cycle expenditures.

The advantages of these principles and their positive contribution to strategy are obvious. For instance, the second principle, 'use tried-and-true solutions wherever feasible,' creates a high degree of assurance that required cost and programming benchmarks will be met. Practical impact of this principle on strategy comes in the form of using standard technologies for radioactive waste management and applying standard approaches to spent fuel management wherever possible. There have been, of course, necessary exceptions, for example, the technology for handling Spent Removable Core and liquid-metal coolant (LMC) reactors. They turned out to be new problems requiring unique solutions.

The following types of inputs were used to develop the SMP and CDP (see Figure 2):

- a data base covering all facilities subject to decommissioning and rehabilitation and listing all support infrastructure required for project implementation
- results of strategic studies (SS)
- laws and regulations

The process of strategic planning involves modern approaches that make use of such tools and methods as data collection, prioritization, programmatic risk assessment, quality assurance, strategic planning procedures, and others listed in the middle column in Figure 2. The right-hand column lists the main outputs of the CDP.

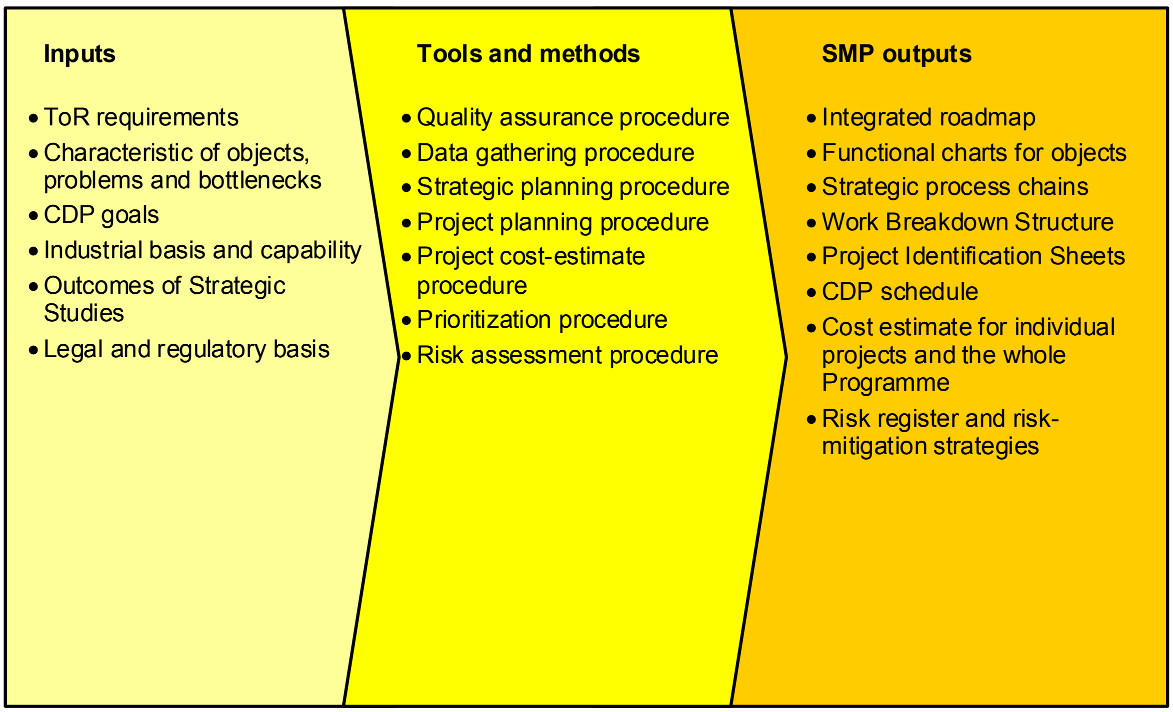



Figure 2 SMP Inputs, Methods, and Outputs

## Strategic Approaches to Basic Tasks of Decommissioning and Rehabilitation of Facilities Presenting Nuclear and Radiation Hazards

Before we move on to discuss the remaining levels of planning, which have to do directly with specific facilities subject to decommissioning and environmental rehabilitation, it would be worthwhile to put in perspective the scale of tasks that were tackled in the process of SMP development. Figure 3 below pinpoints the exact locations of all major facilities that were included in the SMP studies and review.

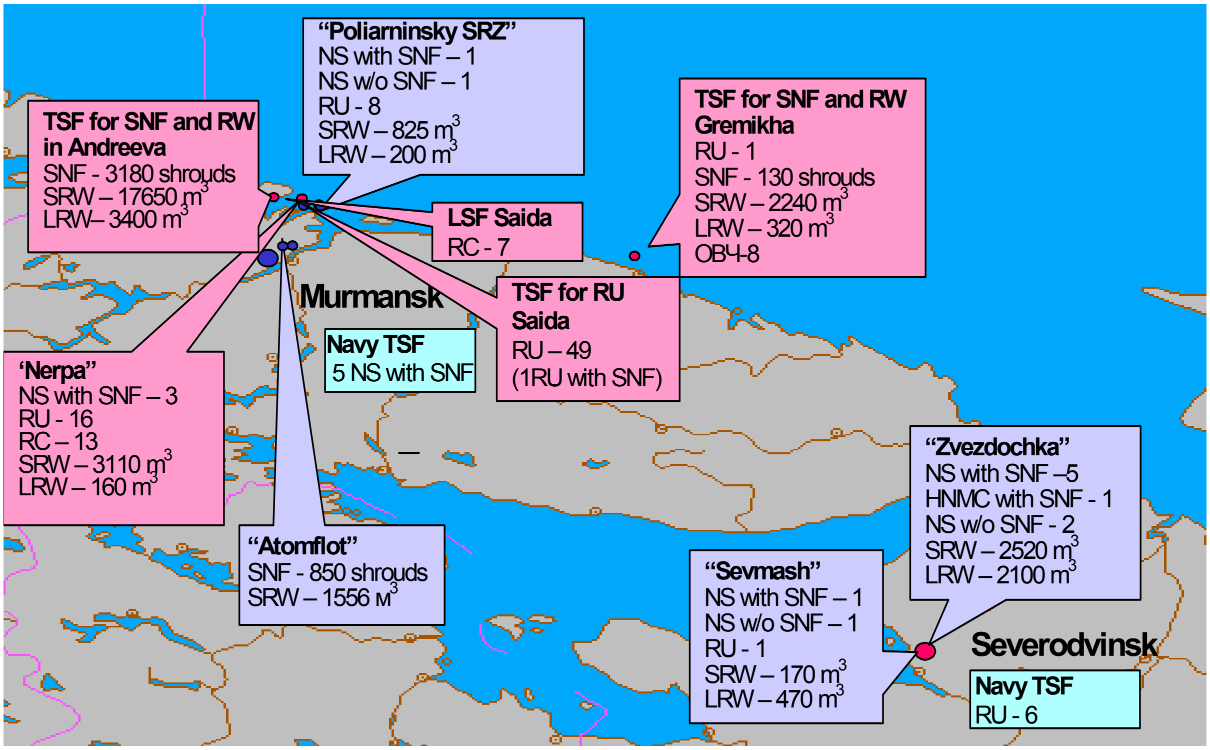


Figure 3 Locations of Facilities Subject to Decommissioning and Rehabilitation in the northwest region of Russia

As one can see from Figure 3, radiation-hazardous facilities intended for decommissioning and environmental rehabilitation in the northwest region of Russia are located at temporary storage facilities at Andreeva Bay and Gremikha, as well as on the grounds of the naval enterprises Federal State Unitary Enterprise (FSUE) Nerpa, FSUE Shipyard #10 [Poliarninksy SRZ] (which reports to the Russian Ministry of Defense of the Russian Federation), FSUE Atomflot, FSUE Zvezdochka, FSUE Sevmash, and at the long-term radioactive waste storage facility (LSF) at Saida Bay.

An important point is that participating organizations belong to different chains of command, which make it challenging to effectively coordinate such activities as the spent nuclear fuel (SNF), radiological waste (RW) and TW management, transportation, and final disposal.

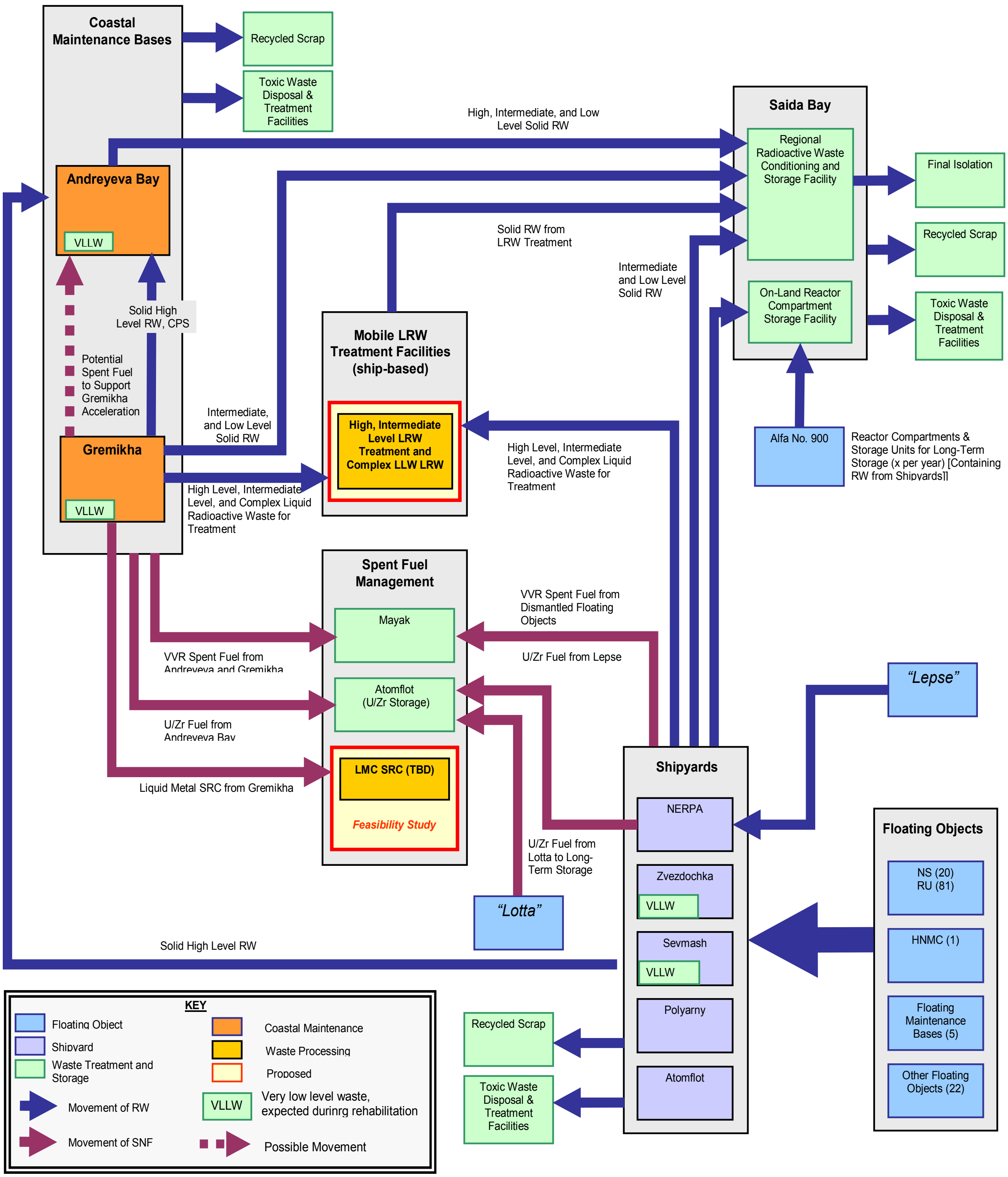



Figure 4 Integrated Top-Level Strategy

Based on input analysis and principles, and the results of strategic studies described earlier in this paper, an integrated top-level strategy was devised for the entire scope of activities (see Figure 4). The strategy takes into account all facilities intended for decommissioning and environmental rehabilitation and keeps track of SNF, RW, and TW flows throughout the northwest region of the Russian Federation. The integrated top-level strategy served as a basis on which SMP management strategies were developed for individual facilities. They included NS, NPSS, NMS vessels and CMB at Andreeva Bay and Gremikha.

The issue of spent nuclear fuel and radioactive and toxic waste management required a separate review. As an example, following is a brief description of the decommissioning strategy for nuclear submarines. On a practical level, it is comprised of the following constituent stages (see Figure 5 below):

- safe and controlled storage of submarines at bases prior to handing them over to shipyards for decommissioning
- cutting up and scrapping of submarines down to the level of producing a Reactor Units (RU) or Reactor Compartment (RC); the resulting solid radioactive waste shall be placed in the RC
- temporary storage of RU at Saida TSF prior to scrapping to the level of RC at Nerpa or Shipyard #10 [Poliarninksy SRZ]
- RC extraction and placement into LSF for at least 70 years

Decommissioning of nuclear and reactor units crippled by accidents is to be performed in compliance with special procedures described in the SMP. The procedures will take into account the initial condition of the submarine/block and adjust the decommissioning plan accordingly.

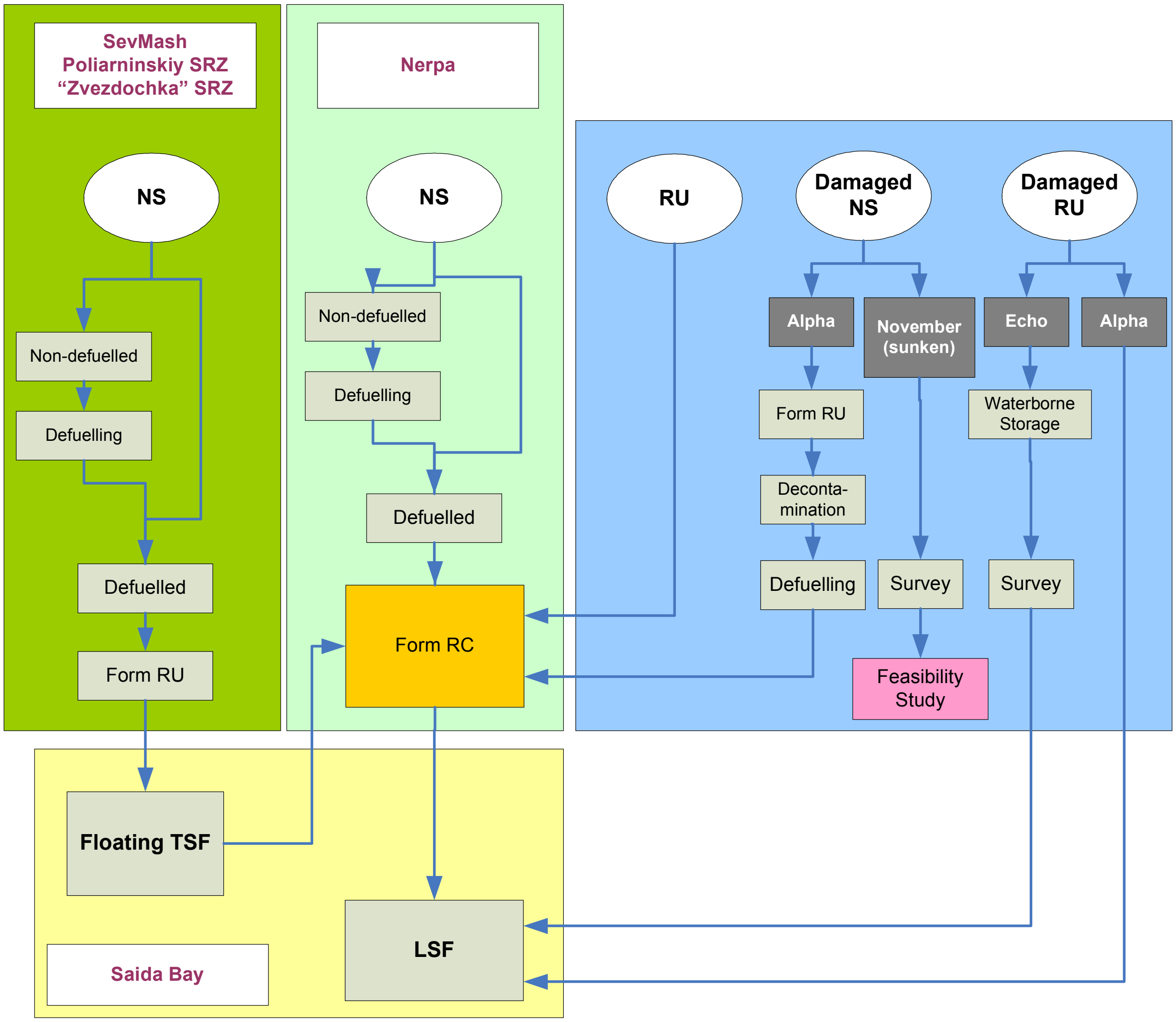



Figure 5 Strategy for Decommissioning of Nuclear Submarines and Reactor Units in the Russian Northwest

## COMPREHENSIVE DECOMMISSIONING PROGRAM

The next stage in strategic planning was the development of a WBS. The WBS for the CDP was developed in accordance with the Project Management Body of Knowledge (PMBoK). We found that having five structural levels was sufficient for the purposes of strategic planning. Substantively, the activities reside on Level Four (Projects) of the WBS (see Figure 6).

The first WBS level is represented by the CDP as a whole. This level has been assigned WBS Code 1. The second WBS level features 11 sub-programs. Their structure is shown in Figure 6. The third WBS level was introduced mostly for ease and convenience of classification. This level is populated by groups of projects unified by similarity of technologies, goals, resources, etc. (i.e., *multi-projects* such as decommissioning of different kinds of nuclear-powered submarines) or by commonality of the object of decommissioning activities (i.e., *mega-projects* such as decommissioning disposition of the Lepse Vessel).

From this point on, activities were mostly broken down according to a 'one project for one object' principle. Exceptions included sub-programs of environmental rehabilitation of a temporary storage facility at Andreeva Bay (TSFA) and a temporary storage facility at Gremikha (TSFG) where the number of sites is quite large and some of them are 'mismatched' (e.g., radioactive waste is being held at a spent nuclear fuel storage site or vice-versa). The WBS for these sub-programs was developed based on detailed flow charts depicting how the desired end states will be achieved. Graphically, steps in these flow charts represent individual projects.

Overall, 233 Level 4 elements (projects) were identified. Level Five elements were introduced only when it was necessary to adjust inter-project linkages or update the activity cost structure.

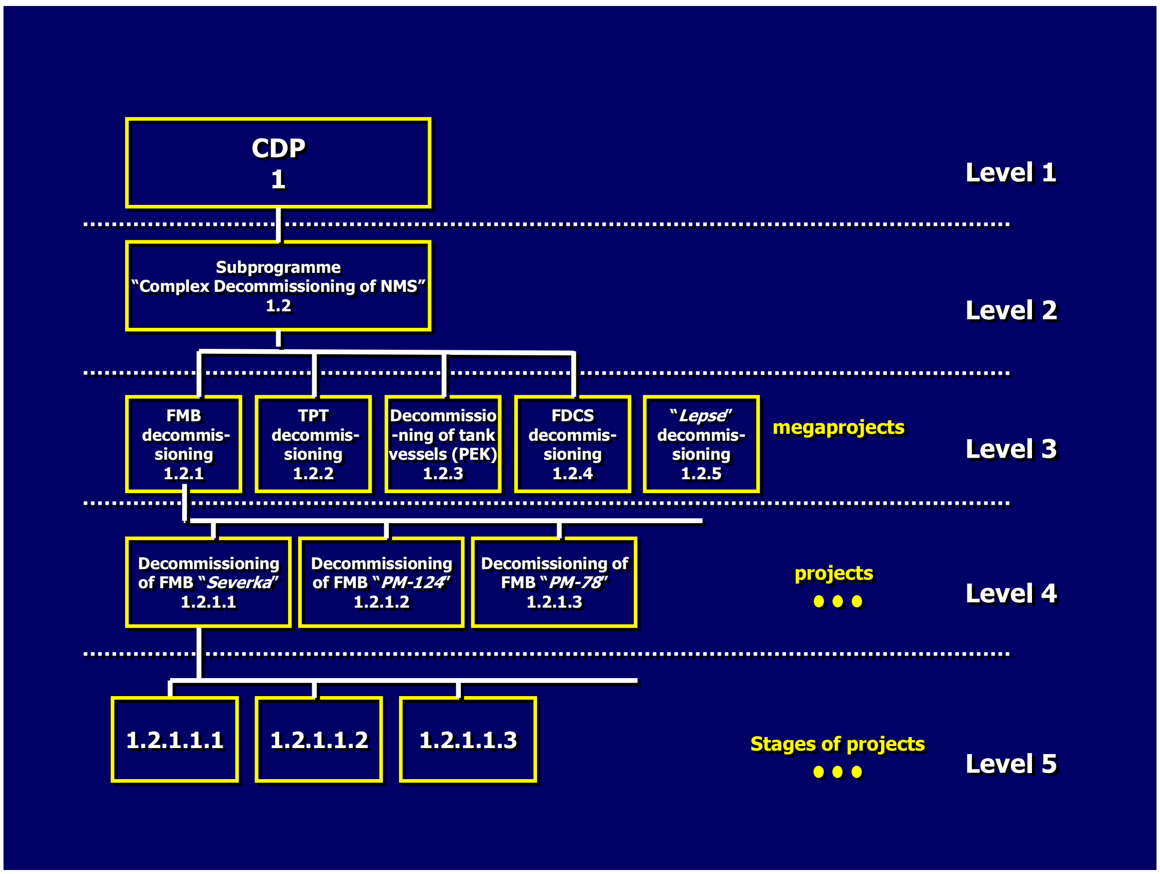



Figure 6 Generic View of the Work Breakdown Structure

Selection of high-priority projects from the pool of identified potential projects is a critically important stage of planning. For the SMP, we adopted a prioritization procedure that is based on the method used by the UK Nuclear Decommissioning Authority and adjusted it for local specifics and conditions of implementation (see Figure 7).

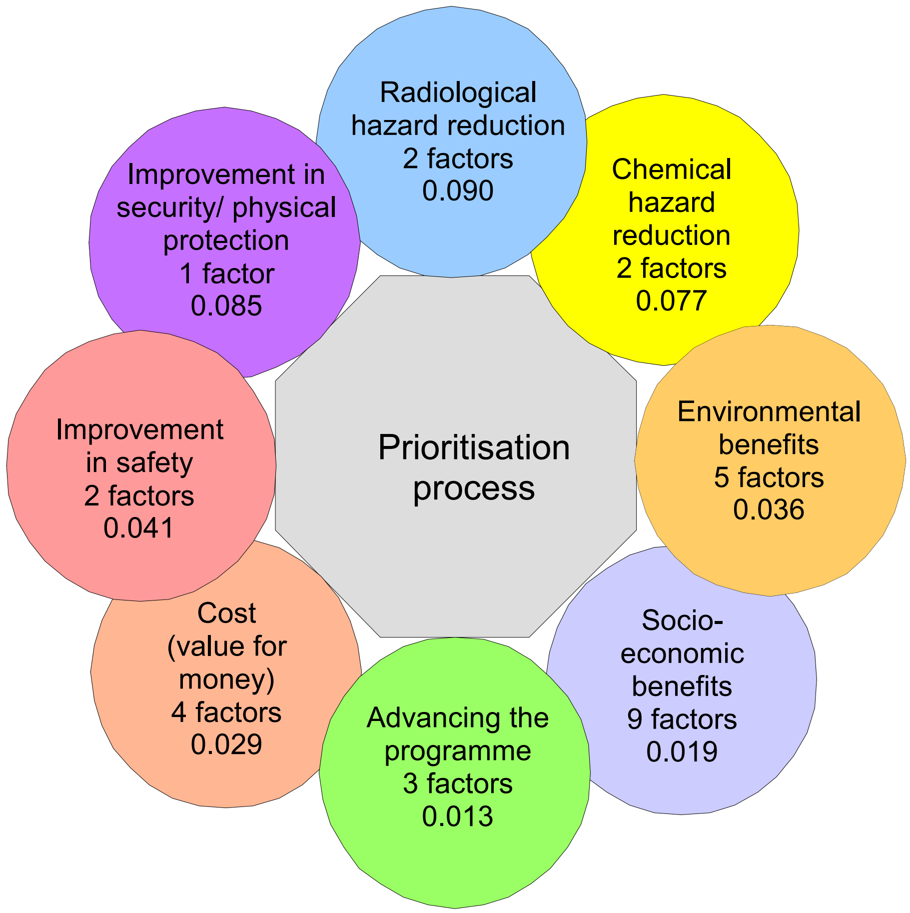



Figure 7 Factors That Were Taken into Account When Implementing the Prioritization Procedure

Eight basic criteria were selected as a skeleton of an expert evaluation. For each, several factors important in the context of a specific criterion were identified. Overall, the model is built on 28 factors (from one to nine). Numbers in the outer circles indicate the number of factors and their average weighted coefficient of applicability to every criterion. In calculations, every factor was used in conjunction with an individual weighted coefficient determined and assigned by experts.[94] There were 14 experts representing various Russian agencies and organizations.

To determine a priority ranking order, 123 projects (both mega-projects and multi-projects) were selected from across five thematic categories. The selection was made based on the following requirements:

- The project must be ongoing at the present time or must be prepared for implementation by 2011, provided there is funding for it.

[94] Values represented in Figure 7 are obtained by means of averaging of weighted coefficients as per particular more detailed factors each of which refer to the correspondent group. Values represented in Figure 7 are not used in calculations directly. They provide averaged experts' vision of the importance of the correspondent factor groups.

- The project must be substantively mature, in terms of scope of activities and envisioned end objectives. This will make it possible for experts to provide objective evaluations.
- All predecessors of the project must be ongoing at the present time or satisfy both of the above requirements.

To bring expert evaluations closer together, priority-ranking was done using the Delphi Technique. In the end, 50 top-priority projects (ten from each thematic category) were chosen. They, together with their predecessor projects and projects currently nearing completion, constitute the initial stage of the CDP.

CDP scheduling was being done per PMBoK principles. We also kept in mind that the SMP is unique in that it is not a recipient of any direct funding. The CDP Schedule was developed on the basis of detailed flow charts (logically constructed sequences) developed for all facilities, information provided by implementing organizations regarding progress in execution of current projects, as well as in keeping with the WBS and prioritization results.

Total CDP costs include two constituent components:

- investments required for project work
- life cycle expenses required to maintain the facilities and support the CDP infrastructure

Investment numbers included in Project Identification Sheets contain cost estimates obtained using different methodologies, including Justification of Investment, historical data, and expert estimates.

The expenditures over the 2008 – 2025 time frame amount to ~ €2 billion (see Figure 8). This number covers four line items:

- accountable life cycle expenses
- existing and committed funding
- new required funding
- possible optional funding that may be required if
    - the decision is made to lift and remove for decommissioning of the sunken nuclear-powered submarine November (Noyabr) (2010–2012)
    - any future operations with SRC from LMC reactors are sought by the Scientific Research Institute for Atomic Reactors (post-2010)

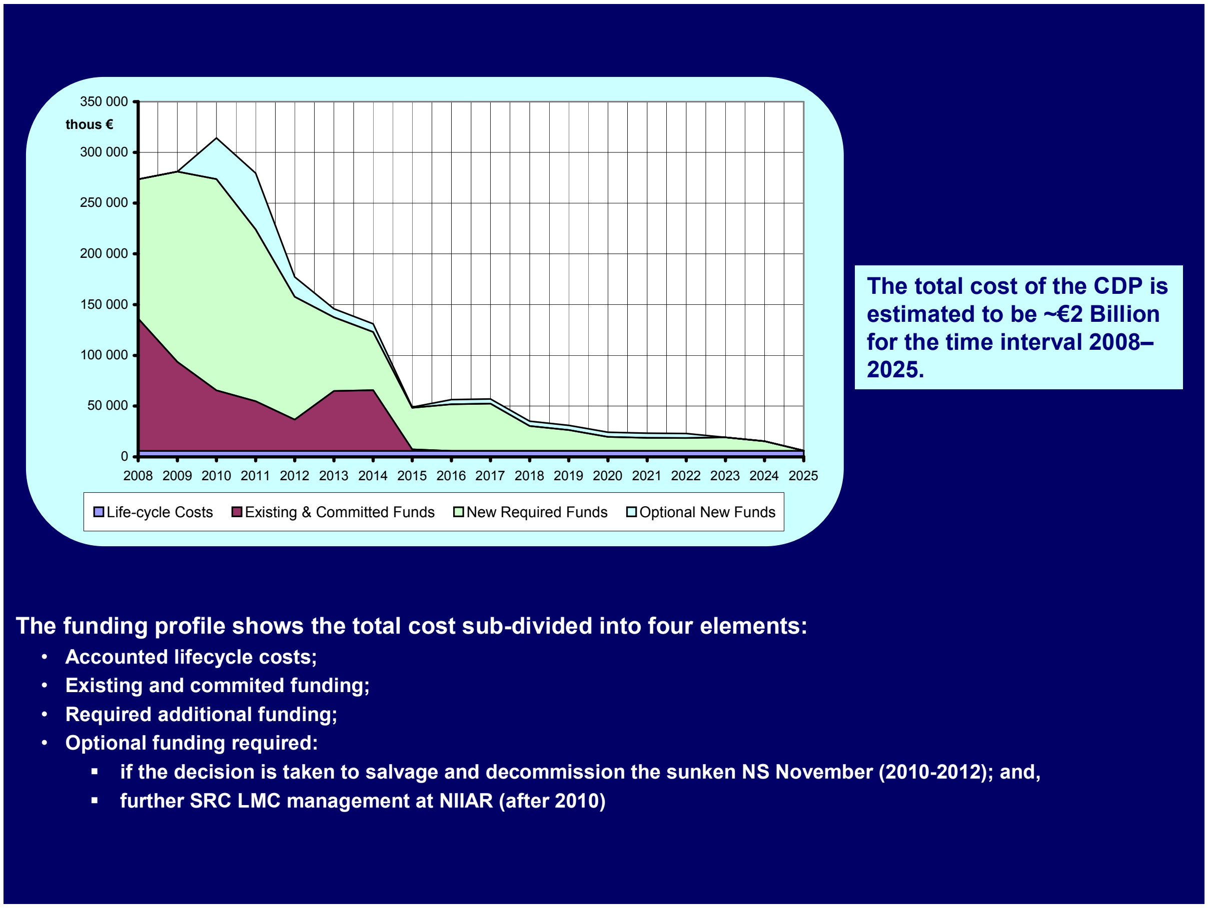



Figure 8 CDP Baseline

In Figure 9 below, we have summarized some main parameters in the integrated planning process. The schedule and associated costs will bring about the end result of all decommissioning and environmental rehabilitation activities in Russia's northwest region for the uppermost tier. To achieve this end result, the CDP looks to complete 233 projects. Numbers of projects specific to individual facilities and thematic categories are shown in Figure 9.

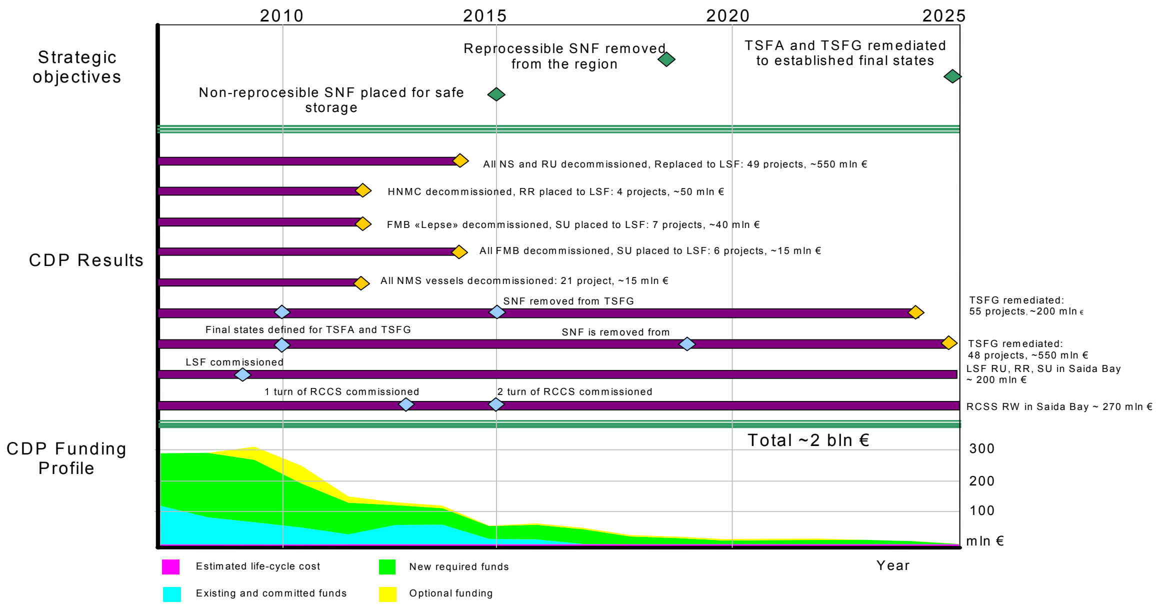



Figure 9  Main Achievements of the CDP Development Effort

The budget curve is characteristic of typical decommissioning and rehabilitation projects in which emphasis is placed on a rapid reduction of radiation hazards and speedy completion of complex high-priority activities.  These requirements call for large investment expenses at an early stage of program implementation.

The SMP strategy is to expedite the removal of spent nuclear fuel from the region and preparation of radioactive waste in scattered locations for long-lasting isolation from the surrounding environment.  For this to happen, several large-scale projects and mega-projects will have to be completed in the next several years.  Specifically, this includes:

- projects contributing to the establishment of a complex for SNF management at TSFA at a cost of ~€75 million
- projects to build SNF management infrastructure in the region at a cost of ~€85 million; the goal is to provide for uninterrupted removal of spent nuclear fuel from the area
- projects to build a Regional Center for Conditioning and Long-term Storage at a cumulative cost of ~€170 million; these projects will allow for safe RW management during the expedited preparations to remove SNF from TSFA and TSFG

The possibility of suspending or delaying the decommissioning activities associated with buoyant facilities (e.g., NS, heavy nuclear missile cruisers [HNMC], NMS vessels, including Lepse) was ruled out from the start.  Any slowdown in the rate of the ship/vessel decommissioning activities in Russia's northwest region was assumed to result in a greater risk of sinking due to physical degradation, underutilization of industrial capabilities, and social strife in the industry.

As direct funding is not envisaged under SMP project, and taking into account the large scope of decommissioning facilities and timeframes needed for decommissioning-related work, the SMP is to be considered a program at the doctrinal level. At the same time the SMP provides an effective tool, which allows one to observe the problem as a whole, plan and control on-going steps for their compliance with the defined strategic directions, and set final objectives. In this regard, the SMP serves as a/an:

- reference point for the development of federal targets and other programs
- justification for making strategic decisions and setting priorities during project funding
- justification for the selection of directions and particular locations for international cooperation both for the Russian Federation and foreign partners
- encouragement for donor countries in carrying out feasibility studies related to the implementation of decommissioning projects, including the improvement of nuclear, radiation and environmental safety, and physical protection

The SMP shall be regularly updated to take into account the real, on-the-ground situation regarding implementation and the possibilities for funding new programs. Only if this condition is met can the SMP prove its effectiveness as a forceful strategic planning tool.

The Program Management Information System shall maintain SMP adaptation to the CDP practical implementation. The experience of other countries worldwide shows that large-scale programs can not be implemented effectively without using modern automatic management information systems. Main PMIS tasks include:

1) obtaining reliable information on the implementation status of all projects within the program in the optimal mode
2) identifying problems, deviations, and trends in project funding, supply, and implementation schedules in a timely manner
3) determining critical points and their possible influence on other projects in the implementation of particular projects
4) selecting optimal variants of management actions in compliance with established conditions
5) updating the implementation plan in a timely and optimal manner to achieve the most effective results

The initial simplified PMIS version developed under the SMP project provides the first step in this direction. Over the course of trial operation, it will be improved and adapted to the existing management system.

The SMP has been highly appreciated by the Head of the State Corporation on Atomic Energy (Rosatom), Sergei V. Kirienko; the President of the EBRD, Jean Lemierre; the Chairman of the EBRD Expert Advisory Group, Laurence Williams; the Chairman of the NDEP Nuclear Operating Committee, Sophie Galley Leruste; the Chairman of International Atomic Energy Agency Contact Expert Group, Alan Mathiot; and a number of other officials and specialists.

By the Order of the Head of the State Corporation on Atomic Energy (Rosatom), Sergei V. Kirienko, No. 686 dated December 26, 2007, the SMP was put in force as a guiding document.

## KEY FINDINGS

1. The approaches used in the course of the SMP development are reflective of the scale, complexity, and scope of the problems that have to be resolved.

2. A virtually all-encompassing approach to decommissioning and environmental rehabilitation – regardless of the origin of facilities and the agency responsible for their custody – coupled with due regard for diverse process chains and transportation links, and informed by a systemic multi-variable analysis, has produced a solid justification for the strategic decisions that have been made.

3. Decommissioning of a nuclear fleet is the first experience in the context of large-scale decommissioning of nuclear facilities. This experience and, more specifically, the methodology that was put in practice can be used in the future to support decommissioning of nuclear power plants or nuclear fuel cycle facilities.

4. A comprehensive, systemic approach used to develop the SMP may also be useful in helping the international community resolve a whole host of other complex global problems. Without question, non-proliferation of nuclear weapons is one such problem. To be fair, the non-proliferation problem is admittedly more complex, and the approaches described earlier in this paper will hardly be applicable to resolve this problem in its entirety. Having said this, individual elements of this problem will not only welcome this experience but will, in fact, benefit from it. Advanced nuclear technologies highly resistant to proliferation of sensitive and potentially hazardous nuclear materials is a good example of the utilization of this experience.

# MINIMIZING CIVIL HIGHLY ENRICHED URANIUM STOCKS BY 2015: A FORWARD-LOOKING ASSESSMENT OF U.S.-RUSSIAN COOPERATION

Philipp C. Bleek, *Center for a New American Security* and
Laura S. H. Holgate, *Nuclear Threat Initiative*[95]

## INTRODUCTION

At a June 2015 summit, the U.S. and Russian presidents announce that by the end of the year, almost all highly enriched uranium (HEU) will have been removed from civil sites, the culmination of an effort launched by the two countries almost a decade earlier. Proliferation risks remain, but one key danger has been effectively eliminated.

Is this scenario a pipe dream? If the task is feasible, does it merit the effort required to realize it? And what steps need to be taken now to make this goal a reality? This paper argues that the goal of having HEU removed from civil sites, is both plausible and desirable and lays out specific actions the United States and Russia should take to realize it.

Minimizing civil HEU by 2015 is desirable.[96] As concern about nuclear proliferation to both states and terrorists has grown in recent years, policymakers and non-governmental analysts have increasingly seized on the importance of preventing access to nuclear-explosive material.[97]

---

[95] Philipp C. Bleek is a Nonresident Fellow at the Center for a New American Security and a doctoral candidate in international relations in the Department of Government at Georgetown University. This paper was written while he was a Visiting Fellow at the Center for Strategic and International Studies (CSIS). Laura S.H. Holgate is Vice President for Russia/New Independent States Programs at the Nuclear Threat Initiative. This paper draws substantially on Bleek's "Global Cleanout of Civil Nuclear Material: Toward a Comprehensive, Threat-Driven Response," *CSIS Strengthening the Global Partnership Issue Brief #4* (September 2005). The authors thank CSIS for permission to reproduce portions of that paper here. Finally, the authors thank the participants at the November 2007, Vienna workshop at which this paper was presented as well as informal reviewers including Pablo Adelfang, Wilhelm Bleek, Jim Fuller, and Ira Goldman, and several U.S. government officials who shared information on a not-for-attribution basis, for helpful comments and critiques.

[96] The authors chose to focus this paper on the goal of HEU minimization, rather than elimination, on the assumption that a compelling case could potentially be made for keeping a small number of civil facilities fueled with HEU, perhaps shared through multinational research consortia, and held to the highest security standards.

[97] This paper uses the term *nuclear-explosive* to refer to material that could be used in a fission-based explosive device, rather than the conventionally but often incorrectly used terms *fissile* or *fissionable*. Fissionable, the broadest category, includes materials that are not nuclear-explosive. More narrowly, all fissile materials are nuclear-explosive, but not all nuclear-explosive materials are fissile; for example, the even-numbered isotopes of plutonium are not fissile but are, under the correct conditions, nuclear-explosive. HEU is both fissile and nuclear-explosive. Uranium is defined as "highly enriched" or "weapons-useable" when it contains 20 percent or more of the U235 or

Acquiring nuclear-explosive material remains the most challenging step in the weapons acquisition process. Given such material, a sophisticated terrorist organization or a state could plausibly construct a rudimentary nuclear bomb.

As the now-defunct U.S. Congressional Office of Technology Assessment concluded: "A small group of people, none of whom have ever had access to the classified literature, could possibly design and build a crude nuclear explosive device… Only modest machine-shop facilities that could be contracted for without arousing suspicion would be required… The group would have to include, at a minimum, a person capable of searching and understanding the technical literature in several fields and a jack-of-all-trades technician."[98] This assessment is particularly relevant for HEU, because its usefulness in the most rudimentary gun-type design makes it the material of choice for terrorists as well as states seeking a more rapid or less challenging route to a crude nuclear bomb. A few tens of kilograms are sufficient for such a primitive design, similar to that used in 1945 to destroy Hiroshima. As enrichment levels decline, more material is required, yielding both a larger and less powerful device, but the former might not be problematic for terrorists contemplating delivery via truck or ship and even a relatively weak device could have a yield equivalent to thousands of tons of conventional explosive.

Luckily, HEU is extremely difficult to manufacture. Unfortunately, thousands of tons were manufactured over the past half-century for diverse uses, from nuclear weapons to targets used in civil production of medical isotopes. State weapons establishments are more likely to provide high degrees of security for their nuclear-explosive materials, although even here there is room for concern. Conversely, non-military or civil stockpiles of HEU are often less well secured, although their usefulness for constructing nuclear explosives is not necessarily commensurately lower.

Although comprehensive, detailed data on civil sites possessing nuclear explosive materials has not been compiled, estimates suggest that there are approximately 100 metric tons of civil HEU worldwide.[99] Located in civil research and test reactors, critical and subcritical assemblies, and medical isotope production facilities worldwide, some of this material is in facilities with high levels of security, some in facilities secured with little more than a padlock and a guard.[100] Today there are more than 140 research reactors in more than 40 countries fueled

---

U233 isotope. Constructing an explosive device with uranium at the lower end of the highly enriched spectrum poses additional technical challenges and also yields a larger and less powerful device. Material enriched to 90 percent is preferred by weapons designers and is often referred to as "weapons-grade."

[98] U.S. Congress, Office of Technology Assessment, *Nuclear Proliferation and Safeguards* (Washington, D.C.: OTA, 1977) p. 140. Available at http://www.princeton.edu/~ota/disk3/1977/7705/7705.PDF, accessed October 24, 2007.

[99] The International Panel on Fissile Materials (IPFM) estimates that there are "very roughly, 100 tons of…HEU in the fuel cycles of civilian research reactors worldwide and in Russia's nuclear powered civilian vessels." According to IPFM, the United States has about 45 tons of civilian HEU, 10 tons of civilian HEU are in non-nuclear weapons states, and 8 tons in the UK and France combined. Good estimates for China and Russia do not exist, but Russia can be assumed to have at least as much as the United States. International Panel on Fissile Materials, *Global Fissile Material Report 2007,* Princeton University (2007), p. 11 and fn.23. Matthew Bunn estimates that "60 metric tons of HEU is in civilian use or storage throughout the world," *Securing the Bomb 2007*, Harvard University (September 2007), p. 32.

[100] In addition, HEU is also used, to a lesser extent, for naval and space propulsion and as fuel for commercial fast-neutron reactors. For further information on the various civil uses of HEU, see "Civilian Uses of HEU" in "Civilian HEU Reduction and Elimination," Nuclear Threat Initiative Research Library, available at http://www.nti.org/db/heu/civilian.html; accessed October 21, 2007.

with HEU, and more than 120 civil research reactors and associated facilities around the world with 20 kg or more of HEU.[101]

The threat of HEU leakage is not hypothetical, even if, to the best of our knowledge, acquisition by those with proliferation aspirations thankfully remains so for now. For example, as recently as 2006, 100 grams of stolen HEU of approximately 90 percent enrichment was recovered in the Republic of Georgia. The material was suspected to have originated in Russia, but efforts to identify its provenance were unsuccessful, and Georgian authorities were reportedly dissatisfied with the degree of cooperation they received from Russia.[102] This seizure is not an isolated incident; an International Atomic Energy Agency (IAEA) database includes 17 separate incidents between 1993 and 2001 involving illicit trade in HEU or plutonium, with quantities as large as several kilograms, although the sum of the material intercepted during this period was inadequate for a nuclear bomb.[103] To underscore the point further, in 2006 the U.S. National Intelligence Council assessed that "Undetected smuggling of weapons-usable nuclear material has likely occurred, and we are concerned about the total amount of material that could have been diverted or stolen in the last 15 years. We find it highly unlikely that Russian or other authorities would have been able to recover all the material likely stolen."[104]

Eliminating civil HEU by 2015 is also feasible. Efforts to address elements of the civil HEU threat date back almost as far as the spread of this material beginning mid-century. For example, both the United States and Russia have long had in place programs to accept the return of HEU they supplied to other states. But until recently these efforts were *ad hoc* and addressed only a small fraction of potentially vulnerable materials.

New opportunities following the end of the Cold War led to additional activity, including some high-profile U.S.-initiated efforts to remove material stockpiles of particular concern. In recent years this activity has coalesced into a more systematic effort, involving the United States, Russia, and the IAEA, to identify, secure, and remove potentially vulnerable HEU stockpiles. The United States has taken the initiative on this issue and plays a key ongoing role in carrying out operations. Russia has played an important cooperative role, providing logistical and technical capabilities and taking back Soviet-origin material for disposition. Finally, the IAEA has increasingly played an essential role as a coordinator, knowledge base, and contracting mechanism that also brings with it a degree of international legitimacy absent from purely bilateral or trilateral efforts.

Although the goal is both desirable and feasible, it is also ambitious, and a variety of specific steps must be taken now and in the coming years if it is to be realized. Important progress has already been made, ensuring that at least some of these materials will never fall into the wrong hands. At the same time, much more remains to be done. There is substantial room to

---

[101] The General Accounting Office (GAO) estimated in 2004 that there were 128 civil research reactors and associated facilities with at least 20 kg of HEU onsite; operations to clean out some of these have reduced that number slightly since then. GAO, "Department of Energy (DOE)Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors," GAO-04-807, July 2004.

[102] Elena Sokova, William C. Potter, and Cristina Hansell, "Recent Weapons Grade Uranium Smuggling Case: Nuclear Materials are Still on the Loose," *Center for Nonproliferation Studies Research Story*, January 26, 2007, available at http://cns.miis.edu/pubs/week/070126.htm; accessed October 21, 2007.

[103] "List of confirmed incidents involving HEU or Pu" International Atomic Energy Agency, undated, available at http://www.iaea.org/NewsCenter/Features/RadSources/table1.html; accessed October 21, 2007.

[104] U.S. National Intelligence Council, "Annual Report to Congress on the Safety and Security of Russian Nuclear Facilities and Military Forces" (April 2006). Available at http://www.fas.org/irp/nic/russia0406.html; accessed October 24, 2007.

build on the successes that U.S.-Russian partnership has achieved to date. The United States could do much more to prioritize its efforts according to the threats particular stockpiles pose and to make those efforts more comprehensive. For its part, Russia should do more to make the efforts genuinely cooperative, stepping up as a partner rather than playing the subcontractor role as at present. Additionally, Russia could adopt a policy of HEU minimization for its domestic civilian research reactors, which make up half of HEU-fueled research reactors globally. The bottom line is that while much has already been accomplished and efforts to date deserve praise, much more remains to be done, especially if the goal of HEU minimization by 2015 is to be achieved.

## HOW DID WE GET HERE?

Spurred by widespread enthusiasm for the peaceful potential of nuclear technologies, in the 1950s and 1960s the United States, the Soviet Union, and a few other states exported nuclear research reactors around the globe, many fueled with HEU, which was then thought to offer substantial scientific advantages. These efforts became part of the compact eventually formalized in the 1970 Treaty on the Non-Proliferation on Nuclear Weapons (NPT), under which states that agreed to forswear nuclear weapons were promised assistance in developing civil nuclear programs.[105]

Concern about the proliferation risks such practices entailed dates back almost as far. Early attempts to control nuclear weapons and related materials and technologies through multilateral fora achieved little headway. By the 1970s, enthusiasm for civil nuclear applications had been significantly tempered by proliferation concerns. Efforts to reduce the availability of weapons-usable civil nuclear material date back at least to 1978, when the United States initiated its Reduced Enrichment for Research and Test Reactors program to develop low-enriched uranium (LEU) fuels for HEU-fueled research and test reactors and targets for medical isotope production facilities.[106] Since the 1970s, both the United States and Russia have made sporadic efforts to take back civil HEU they had previously provided to other countries, motivated at least in part by proliferation concerns.

The Cold War's end raised the specter of proliferation from the Soviet Union's substantial and widely dispersed nuclear as well as biological and chemical weapons and weapons infrastructure, but also opened up new opportunities to ameliorate proliferation threats. Cooperative threat reduction programs spearheaded by Senators Richard Lugar and Sam Nunn, initially intended as a short-term effort to help Russia consolidate and dismantle its nuclear weapons and materials, expanded into a broad and durable agenda to address global threats posed by nuclear, biological, chemical, and radiological weapons, materials, and expertise.

In the civil HEU area, the United States took advantage of several opportunities to conduct *ad hoc* operations addressing specific stockpiles of Soviet-origin material. Russia remained uninvolved in these early operations, tacitly or explicitly agreeing not to oppose them

[105] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

[106] Office of Defense Nuclear Nonproliferation, National Nuclear Security Administration (NNSA), DOE, "Reduced Enrichment for Research and Test Reactors," available at http://www.nnsa.doe.gov/na-20/rertr.shtml; accessed July 25, 2005.

but also declining to accept Soviet-origin material. As a result, in 1994 and 1998 the United States transported Soviet-origin material to its soil and to Britain, finally securing Russian agreement to accept material for a 2002 operation.

The first U.S.-initiated "cleanout" operation of Soviet-origin material was conducted in 1994, when Project Sapphire led to the removal of a remarkably large stockpile of 600 kg of unirradiated HEU, sufficient for tens of nuclear weapons, from Kazakhstan to the United States. Initiated through a backchannel communication from the Kazakhstani government, the high-profile effort required the efforts of officials representing multiple U.S. agencies and at all levels of the U.S. government, even involving then-Vice President Al Gore to overcome diplomatic hurdles. The operation was characterized by substantial and time-consuming interagency friction in Washington.[107] The senior officials involved in Project Sapphire viewed that initiative as a one-time effort and despite some efforts to build on the precedent lower in the bureaucracy, the initiative did not lead to similar projects being pursued elsewhere.

The next such operation did not take place until 1998, when Operation Auburn Endeavor removed from Georgia about 4 kg of unirradiated HEU along with additional LEU and spent fuel. Interagency friction again significantly impeded efforts. Given domestic political challenges to Project Sapphire, Energy Department officials were leery of once again bringing material to the United States, particularly since the Georgian material included spent fuel "radioactive waste." After France was approached as a potential recipient and declined, Britain agreed. As was the case with the previous operation, once the secret transport was publicized, environmental and other public interest groups subjected the British government to public criticism, although much of it centered on the secrecy of the effort.[108] Once again, little effort was made in the aftermath of Operation Auburn Endeavor to build on the successful effort by pursuing other vulnerable material stockpiles. And some U.S. officials subsequently concluded that in the future neither the United States nor Britain were viable locations to bring nuclear material, and particularly more controversial spent fuel, absent a critical proliferation emergency.

Given political difficulties encountered in earlier operations that brought material to the United States and Britain, when U.S. officials sought to remove Soviet-origin HEU from Serbia in the 2002 Project Vinca, they made concerted efforts to secure Russian agreement to accept it, which was eventually forthcoming. The operation ultimately removed 48 kg of unirradiated HEU from a research reactor in Serbia to a Russian nuclear institute for disposition. A mid-level State Department official spearheaded the implementation, leveraging preexisting relationships with senior U.S. and Russian policymakers to overcome bureaucratic and diplomatic hurdles. In a unique twist, the non-governmental Nuclear Threat Initiative was asked to pledge financial assistance for spent fuel management as an additional inducement for securing Belgrade's approval.[109] Characteristic of its involvement in these issues even today, and reminiscent of the Richard Nixon-Henry Kissinger approach to U.S.-Soviet arms control during the Cold War, the State Department approached cleanout efforts more as a means to improve bilateral relations than as a non-proliferation end in itself.[110]

---

107 For further information on Project Sapphire, see Philipp C. Bleek, "Global Cleanout: An Emerging Approach to the Civil Nuclear Material Threat," Harvard University, September 2004, pp. 5-9.

108 For further information on Operation Auburn Endeavor, see ibid, pp. 9-13.

109 For further information on Project Vinca, see Bleek, "Global Cleanout," pp. 13-17 and Bleek, "Project Vinca: Lessons for Securing Civil Nuclear Material Stockpiles," *Nonproliferation Review* 10 (Fall-Winter 2003), pp. 1-23.

110 This remains a strong side-benefit of U.S.-Russian cooperation: as several U.S. and Russian participants observed at the Vienna meeting at which this paper was presented, U.S.-Russian threat reduction cooperation, including on civil HEU minimization, is valuable not only for its risk reducing effects, but also because it maintains

Project Vinca had been removed from a "slow-and-steady" Energy Department-led effort by State Department officials crafting a broader political package to engage a newly cooperative Serbia. The Energy Department effort subsequently cohered into a joint U.S.-Russia-IAEA initiative, then termed the "Tripartite Initiative," to return Soviet-origin fresh and spent HEU to Russia. As part of that effort, 15 NPT signatory countries known to have received Soviet HEU were invited to participate.[111] All but China and Libya responded positively; the latter subsequently cooperated. The IAEA subsequently dispatched technical teams to conduct on-site assessments to gauge fuel quantity, condition, and security at each site.[112]

The joint U.S.-Russian-IAEA efforts bore fruit in a 2003 operation to transport 14 kg of unirradiated HEU from Romania to Russia. Subsequent operations included the 2003 removal of 17 kg of HEU from Bulgaria; the 2004 removal of 13 kg from Libya, approximately 11 kg from Uzbekistan, and 6 kg from the Czech Republic; the 2005 removal of 3 kg from Latvia and 14 kg from the Czech Republic; the 2006 removal of almost 40 kg from Poland, and 286 kg from the former East Germany; and so far in 2007, the removal of almost 9 kg from Poland and 4.5 kg from Vietnam.[113] As well, in 2006 the first shipment of spent HEU fuel was undertaken when 63 kg were removed from Uzbekistan, with another shipment of 80 kg of HEU contained in spent fuel shipped from the Czech Republic in December 2007.[114]

The pace of recent progress is due in no small part to understandings reached at the presidential level during a 2005 meeting in Bratislava. In their joint statement, U.S. President George W. Bush and Russian President Vladimir V. Putin committed both governments to securing nuclear weapons and material to preventing the possibility that they could fall into the hands of terrorists.[115] This commitment included an acceleration of operations to remove HEU fuel from vulnerable reactors "in third countries" (i.e. not in Russia) and convert them to LEU fuel.

The Libya operation is a special case, since it represented the culmination of years of on-again, off-again diplomatic engagement with the United States and several western European countries over Libya's offer to surrender its weapons of mass destruction capabilities. The shipment of spent fuel from Uzbekistan also deserves special note, as it marked the first effort under Russia's new law on spent fuel imports.[116] The successful completion of the multiple phases of required document preparation, submission, and approval paves the way for future

---

a channel for productive interaction even during times when increased friction characterizes the broader political relationship.

[111] Interviews with IAEA official, July and August 2003. Invitation letters were sent in September 2000 to 15 countries: Belarus, Bulgaria, China, Czech Republic, Germany, Hungary, Kazakhstan, Latvia, Libya, Poland, Romania, Ukraine, Uzbekistan, Vietnam, and Yugoslavia.

[112] Interviews with IAEA official, July 2003.

[113] "Global Threat Reduction Initiative: More than three years of reducing nuclear threats," *National Nuclear Security Administration Fact Sheet*, undated. Available at http://www.nnsa.doe.gov/docs/factsheets/2007/NA-07-FS-03.pdf; accessed October 23, 2007. For more information on the Romania and Bulgaria operations, see Bleek, "Global Cleanout," pp. 18-20 and 20-21, respectively.

[114] NNSA, "NNSA Removes Highly Enriched Uranium from Czech Republic," Press Release, December 11, 2007. Available at http://www.nnsa.doe.gov/docs/newsreleases/2007/PR_2007-12-11_NA-07-57.pdf, accessed December 14, 2007.

[115] For further information regarding the "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation," of February 24, 2005, see http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html; accessed February 23, 2008. See also Appendix D for full text of this Joint Statement.

[116] Decree #418, "Government of the Russian Federation on the Procedure for Importation of Irradiated Nuclear Reactor Fuel Assemblies Into the Russian Federation," July 11, 2003.

spent fuel shipments. Since a pledge to remove a reactor's spent fuel is typically a key element of obtaining agreement to remove fresh HEU fuel, this accomplishment is critical to fulfilling those promises and opens the door to more rapid approval processes in the future. Based on the Uzbek spent fuel experience, the IAEA has compiled a set of guidelines for spent fuel shipments to Russia and hosted a workshop for other sites that will be sending their spent fuel to Russia for disposition.[117]

The other recent operations were all broadly similar; the target countries expressed interest to the IAEA, which served as a facilitator in negotiations with the United States. In each case, packaging and transportation were conducted by several Russian firms who have established efficient working relationships with the program.[118] Compensation varied only modestly across each operation, with the United States generally agreeing to provide either equivalent LEU fuel or funds for surrendered HEU to the target country and also compensating Russia for transportation and processing costs.

At the same time, as operations were taking place with increasing frequency and in a permissive political environment following the September 11, 2001 terrorist attacks on U.S. soil, persistent advocacy from non-governmental organizations helped channel White House rhetoric on weapons of mass destruction threats into concrete programmatic developments. In May 2004, the Energy Department announced the Global Threat Reduction Initiative (GTRI), intended to consolidate a range of programs working to reduce the chance that terrorists could acquire either HEU or materials for a radiological "dirty bomb." At present, GTRI, the institutional home of HEU cleanout efforts in the U.S. government, oversees six new or previously separate programs that deal with HEU. (In addition, GTRI manages both a domestic and an international radiological threat reduction effort; these programs are outside the purview of this paper.) This programmatic integration has already significantly resolved the bureaucratic friction that hampered earlier, more *ad hoc* efforts.[119]

Although the various U.S. programs that have recently been consolidated and strengthened currently form the core of the global response to civil nuclear materials, it bears highlighting that many are implemented in collaboration with the IAEA, Russia, and other partners on a more *ad hoc* basis. The IAEA in particular conducts a range of activities, such as assisting sites assess and upgrade security at civil nuclear installations, that help to make it less likely that civil nuclear materials will make their way into nuclear bombs. The agency cannot conduct cleanout operations in its own right; it has neither the mandate to do so nor the ability to take vulnerable nuclear material into its possession. But the agency can and does play a key role both as a facilitator in negotiations and as an implementer with needed technical expertise and capabilities.

Finally, it is worth noting that the threat posed by civil nuclear material stockpiles, particularly as it relates to nuclear terrorism, continues to be contested. Officials implementing current U.S. programs, in contrast to more senior political leadership, tend to downplay the threat, highlighting the challenges posed by stealing sufficient material, evading capture, processing the material, and manufacturing an improvised nuclear device. Non-proliferation advocates outside government often respond by highlighting recent terrorist operations such as

---

[117] Pablo Adelfang, Ira Goldman, Edward Bradley, et al., "IAEA Perspective and Lessons Learned in Shipping HEU Spent Fuel to Russia," presented at the Institute for Nuclear Materials Management Annual Meeting, July 8-12, 2007.
[118] Interviews with U.S. administration officials, July 2005.
[119] For discussion of bureaucratic friction in an early cleanout effort, see Bleek, "Project Vinca," pp. 1-2, 17.

the large-scale hostage takings repeatedly orchestrated by Chechen terrorists in Russia and arguing that neither processing material nor manufacturing a crude nuclear device poses insurmountable technical challenges. Although disagreements persist, those more and less skeptical about the threat appear to have found a measure of common ground in the argument that because terrorist acquisition of nuclear weapons would be so evidently catastrophic, any risk thereof merits a vigorous response.[120]

Important progress has already been made. Some material has been removed from vulnerable sites and processed into non-weapons-usable form, ensuring that it will never find its way into a nuclear weapon. Perhaps even more importantly, a broader policy and programmatic framework has now been put into place that has the potential to facilitate a genuinely comprehensive solution. But while much has been done, much more remains undone. Only time will tell whether the steps being taken now ultimately serve as the foundation for such an effort, but extrapolating current trends into the future yields a mixed verdict at best. The pace of operations remains slow, if steadily improving, and driven more by metrics than by threats.[121] Given substantial difficulties in dealing with some of the more threatening sites, program officials appear to be concentrating their efforts on the more easily completed sites, which does not bode well for the pace once easier sites have been completed and only more challenging ones remain.

While the completion of current programs would be a significant step toward securing civil nuclear materials, much material still remains outside their purview. What is needed to realize HEU minimization by 2015 is a more comprehensive program, targeting more sites in possession of more materials with the help of more partners. This requires a genuinely cooperative international effort. The United States and Russia can do much on a bilateral basis with select partners, but a true global cleanout would require commensurately global participation.

The barriers to success are many and high. Facility operators pose some of the greatest hurdles, since policymakers tend to follow their lead in assessing cleanout proposals. Operators are likely to be skeptical about the feasibility and cost of maintaining functionality following facility conversion from HEU to LEU or of finding new work following the shutdown of a reactor. The higher security required to conduct research with weapons-usable material also often entails a higher level of prestige that facility operators may be loath to give up. And facility operators and targeted countries may feel singled out and hence resentful; the implication that some countries or facilities are less capable of adequately securing material or that their research does not merit the proliferation risk it poses is potentially offensive.

Just because the challenges are significant does not imply that the goals are not worth pursuing. If nuclear proliferation to terrorists is indeed a threat of the magnitude that both Russian President Vladimir Putin and U.S. President George W. Bush have assessed it to be—in a recent joint statement they called nuclear terrorism "one of the most dangerous international security challenges we face"—then it would be irresponsible not to think outside the narrow

---

[120] Both U.S. and Russian participants at the Vienna meeting at which this paper was presented suggested that joint discussions of the degree and character of the nuclear terrorism risk would be productive. Even if such discussion did not yield consensus, it would at least provide opportunities for better mutual understanding of threat perceptions, including areas of common ground and issues over which the two sides differ. That said, it is important not to overemphasize the degree to which threat perceptions differ between the two sides, in particular because there are also differences among policymakers and analysts on both sides.

[121] For discussion of both progress of nuclear threat reduction toward meeting metrics and the validity of various metrics, see Bunn, *Securing the Bomb 2007*, passim.

confines that characterize current efforts.[122] What is needed now are actions commensurate with those words.

## MOVING TOWARD CIVIL HEU MINIMIZATION BY 2015

### All Countries Should Take Concrete Steps to Minimize Civil HEU Possession and Use

Efforts to clean out vulnerable stockpiles of nuclear weapons-usable material will both promote and be enhanced by a strengthened global norm against civil HEU. A recent positive development in this regard is the inclusion of a commitment to minimize HEU use in civilian facilities and activities in the June 2007 Joint Statement on the third meeting of the Global Initiative to Combat Nuclear Terrorism.[123] Led by the United States and Russia in close and effective partnership, the Global Initiative has attracted the participation of over 60 states. Raising this principle to a global level through a formal IAEA policy, however, has proven difficult, as was demonstrated at a Norway-sponsored conference in June 2006. Despite the technical consensus that for most operating research reactors conversion to LEU would result in minimal loss of capacity, and that new reactors have been designed to run on LEU with performance equal to or better than existing HEU-fueled reactors, participants resisted any constraint on asserted rights to use any kind of nuclear material for peaceful purposes.[124]

Despite a plethora of IAEA-sponsored efforts to reduce global HEU risks, this rights-based perspective has prevented the IAEA from adopting a formal policy that would require that it reject any applications for technical assistance in establishing HEU-fueled research reactors or other HEU-based civilian facilities. An existing *de facto* understanding would cause any such applications to be frowned on and LEU-based (or non-nuclear) alternatives sought, but those member states who defend the broadest interpretation of their rights to peaceful nuclear technology have so far prevented the IAEA from a formal position opposing civilian HEU use. Given that little or no technical penalty is paid for staying within LEU boundaries for civilian applications, the member states to which the IAEA answers should seek a formal codification of this policy.[125]

---

[122] "Announcing the Global Initiative to Combat Nuclear Terrorism," Joint Statement by U.S. President George W. Bush and Russian Federation President Vladimir V. Putin, St. Petersburg, Russia, July 15, 2006, available at http://www.state.gov/p/eur/rls/or/69021.htm; accessed October 23, 2007. Note that U.S. policymakers tend to use stronger language, generally referring to nuclear terrorism as the greatest threat facing the United States, suggesting that Russian policymakers are more skeptical than their American counterparts and negotiated less strong compromise language for this statement. For the text of this Statement, see Appendix D.

[123] U.S. Department of State Media Note "Global Initiative to Combat Nuclear Terrorism: Joint Statement," June 12, 2007, available at http://www.state.gov/r/pa/prs/ps/2007/jun/86331.htm; accessed December 14, 2007.

[124] "Minimization of Highly Enriched Uranium in the Civilian Nuclear Sector," conference sponsored by the Government of Norway, June 17-20, 2006. The *Conference Proceedings* are available at http://www.nrpa.no/symposium; accessed October 19, 2007.

[125] As noted above, HEU is at present used in a variety of non-weapons applications, including providing compact power plants for ships, submarines, and space vehicles. The technical feasibility of converting all such power plants to lower-enriched uranium fuel remains a subject of debate. Russia has committed to an LEU core for their floating power plants, which will be based on the KLT-40 reactor, the same reactor used in Russian ice breakers; this implies that existing ice breakers could be converted to LEU. While there are uncertainties about conversion of existing

U.S. legitimacy in promoting global cleanout efforts would be strengthened by putting its own house in order. In this regard, a 2005 provision that lifts a legislative restriction on U.S. exports of HEU is shortsighted. A 1992 amendment to the Atomic Energy Act previously barred exports unless 1) no fuel or target of lesser enrichment were available, 2) the facility operator agreed to convert to LEU as soon as feasible, and 3) a U.S. program existed to develop an LEU alternative for the type of facility in question. According to the National Nuclear Security Administration (NNSA), "this law has been very helpful in persuading a number of research reactors to convert to LEU."[126]

The new law, which was passed following intense lobbying on behalf of a Canadian medical isotope production company eager to avoid the expense of converting its facilities from HEU to LEU, allows exceptions for Canadian and European companies.[127] It bears highlighting that the United States has no monopoly on such shortsighted policies: Germany recently completed construction on the first western HEU-fueled research reactor built since 1978. By contrast, Australia's OPAL reactor, opened this year as a state-of-the-art regional center of excellence, demonstrates that cutting-edge research and isotope production can be carried out with LEU-based technology.[128]

In the near term, to the degree that LEU conversion fuel is not available or that a small number of HEU-fueled research reactors are needed to develop new technologies in service of the anticipated "nuclear renaissance," adequate security systems designed to thwart demonstrated outsider and insider theft or diversion scenarios must be in place at such facilities.

### The United States and Russia Should Work with Others to Complete, Maintain, and Share a Comprehensive Database of Global Civil Nuclear Material Stockpiles

A comprehensive database would enable threat-based prioritization and facilitate efforts to approach, negotiate with, and implement cleanout efforts at specific sites. The current lack of comprehensive data is striking; the IAEA, national governments, and the non-governmental expert community all appear unable to answer a basic set of questions regarding how much material is in what types of facilities and in how vulnerable a form and how well it is secured.[129]

This characterization of the current situation merits some caveats. First, in April 2006, NNSA submitted a classified study to Congress that sought to document every facility with nuclear weapons or nuclear or radiological material, although it did not include site-specific vulnerability assessments. Second, energy intelligence officials have recently been tasked to

---

reactors in some cases, it is clear that new reactors could be designed to run off LEU; for example, French nuclear submarines employ LEU-fueled reactors.

126 NNSA Office of Defense Nuclear Nonproliferation Fact Sheet "Reduced Enrichment for Research and Test Reactors," available at http://www.nnsa.doe.gov/na-20/rertr.shtml; accessed July 25, 2005.

127 See Alan J. Kuperman, "The Energy Bill's Gift to Terrorists," *New York Times*, August 11, 2005; Matthew L. Wald, "Medical Company Sought an Eased Limit on Uranium," *New York Times*, August 9, 2005; and Michael Grunwald, "Uranium Provision to Alter U.S. Policy," *Washington Post*, July 29, 2005, p. A4.

128 For further information on the reactor, see http://www.ansto.gov.au/opal.html; accessed October 24, 2007.

129 Matthew Bunn makes much the same point in his September 2007 report: "Remarkably, it appears that neither the U.S. government nor the International Atomic Energy Agency (IAEA) has a comprehensive, prioritized list assessing which facilities around the world pose the most serious risks of nuclear theft." Bunn, *Securing the Bomb*, 2007, p. v. The IAEA Department of Safeguards maintains a comprehensive database whose information would be very useful for cleanout efforts. However, the information in that database is shared with the IAEA by countries under the explicit condition that it not be divulged, even to other departments within the IAEA. That database is also silent on the security status of nuclear sites and materials.

establish a database with more specific information, including vulnerability assessments. Finally, GTRI officials are in the process of establishing a program management database for the universe of sites over which their programs currently or potentially have a mandate, including sites within Russia that have not yet been formally included in that effort. This database includes factors such as nuclear and radioactive material attractiveness, internal site vulnerability, country level threat environment, and—more relevant for radiological threats—proximity to strategic assets.[130]

These efforts deserve praise. But they also have shortcomings; data access issues are particularly important and potentially problematic. An effective global cleanout will require sharing information across countries. At the same time, program officials are understandably wary of disseminating information about vulnerable nuclear material stockpiles too broadly, and sharing restricted information such as that contained in the databases currently in existence or under construction, even with allied countries, poses considerable hurdles. Compromises will be necessary, perhaps even involving parallel databases containing information of greater and lesser sensitivity, but some form of access for IAEA officials and partner countries is a nonnegotiable requirement. In fact, given the need for multilateral access, the IAEA could be an effective host for at least one iteration of such a database.

U.S.-Russian partnership can facilitate the database creation and refinement process; Washington and Moscow can work together on a basic set of questions that GTRI still cannot answer regarding how much material is in what types of facilities and in how vulnerable a form and how well secured. Some of this information may be difficult to obtain, but gaps themselves are likely to be instructive. This comprehensive database will almost certainly highlight materials or facilities outside the scope of current programs. Where these are found, the United States and Russia should work together on a prioritized approach to ensuring either the expeditious removal of vulnerable material or the adequacy of security at sites that will continue to use or hold this material.

## Russia Should Take on a Genuine Leadership Role

Russian cooperation has been important to many of the global cleanout successes achieved to date. The increased intensity of engagement on the GTRI mission following its mention in the Bratislava Summit Joint Statement and in the U.S.-Russian-led Global Initiative shows that high-level direction and accountability can quickly improve cooperation and achieve results. On fresh fuel, cooperation has been sufficiently institutionalized with Russian firms that operations are relatively straightforward. On spent fuel, the recent Uzbek shipments have shown the path forward, accelerating promised shipments of spent fuel from other reactors in the process of converting.

At the same time, there is a perception among many implementing officials that their Russian counterparts are more interested in profiting from operations than in genuine threat amelioration. Instead of funding repatriation activities itself, Russia insists on receiving complete compensation for packaging and transport expenses and takes possession of economically valuable fresh HEU. This suggests a lack of recognition that Russia is as much at risk from nuclear proliferation to states or terrorists as are the United States or other nations, and therefore that Russia has a powerful stake in the success of the global cleanout mission. Especially in the context of its recent economic achievements, Russia can and should

[130] Written communication, NNSA official, October 25, 2007.

demonstrate its international responsibility for the materials sent abroad in Soviet days by bearing at least some of the costs of repatriating fresh and spent HEU fuel.

This critique also highlights the fact that there is now a constituency within Russia for HEU-cleanout. As one participant in this workshop pointed out, the existence of this domestic constituency bears substantial responsibility for the success of efforts to deal with third-party materials that are repatriated to Russia. This suggests the need to think through how such a constituency might be created for efforts to address sites *within* Russia.

Perhaps owing to the lack of perceived threat, Russia has also done too little to get its own house in order.[131] Fully half of the remaining HEU-fueled reactors in the world are located within Russia. While important progress has been made to improve security and speed elimination of weapons-related stockpiles, Russia has explicitly closed off its own civilian research reactor fleet from the scope of GTRI cooperation. In part, this is explained by the lack of any policy decision to minimize HEU in civil use, such as the United States took in 1978. As a result, not a single HEU-fueled reactor within Russia has been converted to LEU fuel,[132] and HEU fuel continues to be transported around Russia and accumulate in spent fuel storage at dozens of reactors.

A Russian policy decision to minimize HEU use domestically would be an important way to demonstrate leadership on this critical issue. Such a decision would open doors to the development of LEU fuels for those reactors with ongoing missions, to develop processes for treating HEU-bearing spent fuel, and to initiate decommissioning of reactors which have outlived their purposes.

Current U.S.-Russian cooperation provides a valuable platform for these activities. While Russia's domestic fleet overlaps little with the reactor types exported during Soviet times, LEU fuel design principles developed in current U.S.-Russian efforts to convert those exported reactors should contribute to accelerated development of LEU fuels for Russia's domestic reactors. Furthermore, the United States has already developed two technologies for treating spent HEU fuel, which might be applicable to Russian needs. A "strategic master plan" for reducing risks of HEU use in Russian civilian research facilities, similar to those created for dismantling general purpose submarines and managing radiothermal generators, would be a useful starting point for defining the scope of effort required for Russia to take this challenge seriously.[133]

These recommendations mirror broader discussions at the Vienna workshop at which this paper was presented, in which multiple U.S. and Russian participants agreed that on nuclear threat reduction broadly, it is time for Washington and Moscow to move from a donor-assistance relationship to a full partnership, one with the two sides sharing responsibility for setting priorities, managing projects, and funding efforts.

### The United States and Russia Must Do More to Bring Targeted Sites on Board

Sites currently being or already addressed are the low-hanging fruit, and negotiations with many other sites appear to have bogged down. Bringing more sites on board is likely to require an expanded menu of potential inducements, ranging from environmental remediation to research contracts for scientists at the targeted site. One lesson of past operations is that most

131 On differing U.S. and Russian nuclear fission terrorism threat perceptions, see pervious footnotes in this paper.
132 William Potter, Monterey Institute, written communication, August 2005.
133 For further information on the Strategic Master Plan, see Academician Ashot A. Sarkisov in this volume.

cases have required genuinely unique sets of incentives. U.S. program officials consistently claim they have all the legislative authorities and senior official backing necessary, but current difficulties in bringing many sites on board suggest that more will be required. Additional flexibility and resources for designing incentive packages should be assigned to the global cleanout mission.

More high-level political engagement may also be required to deal with the most difficult bureaucratic and political impediments. If there is a relevant lesson from Cold War arms control negotiations, it is that without engagement and pressure from the top, negotiations almost invariably languish. In this regard, the joint U.S.-Russian approach to Belarus in the context of removing the HEU located at the Sosny reactor is an excellent and overdue example; there may be other instances where a joint high-level approach would be fruitful. Balance is vital: implementing officials need to feel both support and pressure from senior policymakers, but micromanagement should be avoided.

The United States and Russia and other partners can also make it harder for targeted sites to be intransigent. Interested nations exercise a range of potential levers ranging from trade access inducements to the ability to publicly name and shame.

Creative ways to meet national needs for the training, isotope production, and irradiation services provided by research reactors should be considered in designing approaches to remove vulnerable HEU stocks. The IAEA is leading an effort to develop research reactor "coalitions" that would help raise the quality of products and services provided by reactors while ensuring steady streams of supply and rationalizing client relationships. These coalitions may lead to arrangements whereby HEU-using reactors are able to manage the temporary shutdowns required to convert to LEU while still supplying customers through production at an allied reactor. It may also allow for efficiencies that can permit the decommissioning of certain reactors. If reactor operators choose to shut down their reactor as part of HEU removal from the site, they should be eligible for assistance in doing so.

There are likely to be several cases in which "repatriation" (literally, the return of HEU to the nation that exported it) is not politically or practically feasible. In these instances, the United States, Russia, and their partners should consider taking some vulnerable material of any origin to a venue where it can be safely and securely stored and disposed, perhaps in a third country. If such materials are to be brought to the United States, this would likely require expanding the coverage of the existing Environmental Impact Statement that defines the materials eligible for U.S. storage and disposition. Efforts to do so are underway, but are slow and politically charged. Certainly, post-September 11, 2001, post-Beslan security concerns call for a reexamination of the purely environmental basis for decades-old decisions to limit nuclear materials imports.

### The United States and Russia Should Do More to Spur Potential Partner Countries to Act and to Facilitate Cooperation When They Do

The United States and Russia can do much more to spur others to join in global cleanout activities. Continued advocacy is important; Washington and Moscow can credibly claim that it is in other countries' interest to engage. It is also important that efforts not be viewed as simply in the interests of or driven by the United States.

When other countries are prepared to engage, the United States can do more to facilitate cooperation. U.S. officials have so far kept their efforts firmly anchored in the United States, choosing to emphasize control over broader cooperation. Although it entails additional complications, the integration of other countries will almost certainly be necessary to achieve a truly global cleanout, and if done effectively could speed the pace of implementation. If and when other countries do take action, coordination will become key to ensure that efforts are jointly prioritized and neither redundant nor conflicting. The IAEA's extensive efforts in HEU minimization have created an excellent mechanism by which to coordinate contributions by multiple partners. The Agency's competitive procurement requirements also facilitate integrating a wider range of nations into global cleanout activities. For example, Argentina's INVAP company (Aplicadas Sociedad del Estado, "Applied Research, State Enterprise") has bid successfully on supplying modern integrated control systems—often required by safety regulations in the context of reactor conversions—to participating facilities through the IAEA's Technical Cooperation program.

Another such opportunity can be found in Kazakhstan. As part of a project to blend down 2,900 kg of HEU in the form of fresh fuel for its closing BN-350 reactor, Kazakhstan installed a small HEU blend down line at its large uranium processing plant in Ust-Kamenogorsk. This facility has operated under IAEA safeguards, and has been upgraded to security levels consistent with HEU storage and processing.[134] This blend-down line could be used to eliminate HEU stocks in nations for whom shipment either to Russia or to the United States is politically problematic, such as Ukraine. The resulting LEU is a commercial commodity, creating the chance to pursue this option as a mutually beneficial business proposition, which may be more acceptable to the HEU-holding state than the implication that it is not a responsible steward of such material. Similar potential exists in France at the CERCA facility and possibly elsewhere. These capabilities should be leveraged as part of creative solution sets to the challenges of global cleanout.

In-kind contributions can also be important components of a successful cleanout project. In the case of planning for spent fuel removal from the Vinca Institute in Serbia, transit nations have pledged to absorb the costs of regulatory review of such shipments, which would normally be charged to the shipping country. Slovenia's nuclear regulator has also supported, at no charge, the drafting and review of the multiple detailed plans and safety analyses associated with the spent fuel repackaging and shipping. These models can be replicated in future spent fuel shipments.

### The United States and Russia Should Engage the Private Sector More Fully to Assist in the Global Cleanout Mission

The current design of the U.S. GTRI program makes extensive use of private businesses to accomplish HEU removals, through contracts for packaging and shipping fresh and spent HEU to the United States and Russia for storage and disposition. The private sector could do more to facilitate decisions to convert research reactors and remove HEU fuel. In many cases, these shipping companies have been involved in providing and removing fuel from these reactors for decades, and relationships have been established that can facilitate decisions to convert facilities and remove HEU. The United States should maximize the use of such private firms to design and lead HEU removal campaigns for agreed lists of facilities, freeing federal program staff to focus on the more challenging cases that require more political involvement. Private

[134] A detailed account of this project is contained in *Kazakhstan's Nuclear Disarmament: A Global Model for a Safer World* (Washington, D.C.: Embassy of the Republic of Kazakhstan to the United States of America and the Nuclear Threat Initiative, 2006).

companies can also help design business plans for research reactors in the process of converting from HEU to LEU that would highlight the efficiencies and savings of operating with LEU fuel as well as ease the transition to the new fuel; such business plans should become a standard part of a reactor conversion package.

Non-government organizations (NGOs) have also played valuable roles in global cleanout efforts to date and may be able to expand their engagement. One of their most valuable roles has been in the analysis and public advocacy for the global cleanout mission. Several U.S. NGOs were instrumental in highlighting the risks of vulnerable fissile materials in civilian facilities in the early 2000s, and Harvard's Managing the Atom project along with the Monterey Institute for International Studies' Center for Non-proliferation Studies have continued to advise the U.S. GTRI effort. More directly, the NTI has worked side-by-side with U.S. government efforts as well as directly with the IAEA to design and fund aspects of global cleanout missions. Other NGOs, in the United States and elsewhere, may be well-positioned to add information and influence to the task of minimizing civilian use of HEU.

### The United States, Russia, and Their Partners Must Follow Through

In the rush to meet metrics and target high priority materials, the United States, Russia, and their partners must also follow through on sites where the highest priority materials have already been removed. Since the cleanout challenge is fundamentally political rather than technical—countries must voluntarily agree to cooperate—the "word on the street" regarding the treatment of cooperating sites has the potential to either facilitate or impede future efforts.

The 2002 operation to remove HEU from Serbia is, at least to date, an example of particularly effective follow-through. As part of the negotiations to remove unirradiated HEU, the United States pledged to assist with removing spent fuel—with contributions tied to the proportion of HEU in the spent fuel—as well as with securing radioactive sources. These projects are under way, and the IAEA has successfully launched activities related to spent fuel repackaging and radioactive waste storage based on NTI's $5 million contribution. At the same time, the IAEA has raised from European sources most of the additional funds required for shipping and reprocessing the spent fuel in Russia. The final cost of this contract is still under negotiation; willingness by Russia to absorb some of these costs would go far in demonstrating its leadership in global cleanout.

The civil research reactor community is small and other countries considering cooperation will certainly be aware of the track record on prior operations. Those active on cleanout efforts already have sufficient difficulty obtaining cooperation from targeted sites without additional recalcitrance due to a perceived failure to follow through and honor implicit if not always overt commitments.

## CONCLUSIONS

If civil HEU elimination by 2015 is to have even a chance of being realized, the United States and Russia will need to do a better job of matching deeds to words. Both sides have already taken important steps, laying the foundation for what could become a genuinely comprehensive effort. But that comprehensive effort has yet to be realized, and merely extrapolating the status quo will not achieve civil HEU elimination by 2015 or even on some lengthier timetable.

By acting boldly, the two sides can take responsibility for nuclear dangers for which they bear primary, though not sole, accountability. Further, they can serve as role models, enhancing their ability to engage third parties. Finally, the cooperation the two sides have realized to date in dealing with material in third-party states can provide the basis for cooperation on sites within Russia, as yet off the joint agenda. The United States and Russia are the indispensable partners in ameliorating the civil HEU threat.[135]

The foundation is in place; now the two sides need to build on it to ensure that civil HEU never ends up in a state, or worse, a terrorist nuclear bomb. It is often asked, the day after a nuclear terrorist attack, what will we wish we had done? The United States and Russia have a clear opportunity, today and in the coming years, to ensure that securing civil HEU is not the answer to that question.

[135] Additionally, as one participant at Vienna observed, U.S.-Russian threat reduction cooperation is important not only for its threat ameliorating effects, but also because successful cooperation helps the relationship weather political tensions that may undercut cooperation in other domains.

# COST-SHARING ARRANGEMENTS IN INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION: THE CRDF EXPERIENCE

Eric J. Novotny,
*U.S. Civilian Research & Development Foundation*

One major challenge in an international cooperative partnership is to ensure that the participants in the project have a sufficient stake in its successful outcome. A proven method for keeping cooperative projects on a successful track is to employ cost-sharing or co-financing arrangements among the partners. This method can be applied to bilateral programs or to joint projects in a third country. The U.S. Civilian Research & Development Foundation (CRDF) has used cost-sharing arrangements over the last decade in successful engagements for non-proliferation programs, for higher education reforms, for collaborative research grants, for seed-stage commercialization activities, and for centers of shared equipment usage.

## BACKGROUND

CRDF was created in 1992 through an Act of Congress and established operations in 1995 to engage former weapons scientists and institutions in the newly independent states of the former Soviet Union. CRDF provided an alternative to emigration for scientists in these countries and identified technologies that could be developed for the mutual advantage of the U.S. and the countries of Eurasia.[136]

CRDF remains actively engaged in Eurasian countries and has extended its activities to other regions, including the Middle East and North Africa. It has expanded its mission to include strengthening university research and education in science and engineering. Major programs with the Russian Federation and other Eurasian countries continue in all areas of science and higher education cooperation. In addition, CRDF maintains an active mechanism for ensuring project accounting, funds transfers, payments, customs clearances, and other award administration support services.

All CRDF programs engage other organizations, including the U.S. and host governments, private corporations, and the scientific communities in many countries. A number of these programs, such as the Freedom Support Act, are public-private partnerships, engaging governments, private institutions, and individual scientists. Increasingly, CRDF relies on cost-

---

[136] For further information regarding the Civilian Research and Development Foundation, see http://www.crdf.org/; accessed May 1, 2008.

sharing arrangements with its international partners to leverage U.S. funds more effectively. Other tangible benefits accrue from these arrangements.

## PROGRAM COST-SHARES

Funds for cost-sharing are either administered through CRDF or are given directly from the sponsor to the project. Typically, each partner will have project costs that are allocated either directly in the grant award to the recipient or that reflect internal administrative support costs. This practice allows the size and number of grants or other direct program costs to be projected accurately as the sum of contributions from each side. It also allows each partner to assume and control its own support costs without interference or disclosure. The partners generally do not verify the value of cost shares that they do not contribute directly, so the exact scale of support provided by partners is not measured precisely. Both the U.S. Office of Management and Budget and the U.S. National Science Foundation publish helpful, detailed guidelines on cost-sharing procedures and accounting.[137]

## TYPES OF COST-SHARES

Combining the value of the funds CRDF does administer with that reported by CRDF's partners, reveals a significant cumulative total of funds provided for cost-shares, as shown in Table 1. Almost half of the total distribution of cost-sharing arrangements is direct, host-country contributions. While a small percentage of these contributions are in-kind, most all are cash contributions that accrue to the project or grant award. The total amounts available for grantees are typically agreed in advance by CRDF and its funding partner as a matter of eligibility, not as a matter of an applicant's review. The applicant under a grant program can be required to verify matching funds from the host institution, along side the matches from CRDF and an overall international partner.

In-kind support can also be pledged by host institutions when they provide laboratory facilities, office space, or other similar contributions that factor into whether the prospective grantee has the ability to perform as proposed. Together, these levels of support embrace most of the cost-sharing funds. In a small number of cases, CRDF is asked to administer all grant or project funds where the partner or host institution requests such assistance.

137 National Science Foundation (NSF), "Initial Implementation Guidance Regarding Implementation of the Revised NSF Cost Sharing Policy," October 19, 2004; and U.S. Office of Management and Budget (OMB), "Revised Cost Principles for Educational Institutions," Circular No. A-21, revised August 8, 2000.

TABLE 1 Distribution of CRDF's International Cost Share Funds 1996-2006[138]

| | |
|---|---|
| Host country support, not administered by CRDF (cash & in-kind) | 45.8% |
| U.S. recipient organization in-kind support | 25.1% |
| Foreign recipient organization in-kind support | 21.2% |
| Recipient organization (U.S. and foreign) cash cost shares, administered by CRDF | 6.2% |
| Third party support, not administered by CRDF (cash & in-kind) | 1.4% |
| Third party cash cost share, administered by CRDF | 0.4% |
| **TOTAL:** | **100.0%** |

Cost sharing with partners is an important way for a program to achieve its goals while offering added value to the funding organizations. Although arranging cost shares can make project implementation more difficult, the resulting increase in resources available to meet project goals generally offsets the extra attention required.

Cost sharing demonstrates the value that others put on CRDF's activities. CRDF has a large collection of anecdotal evidence expressing appreciation, but cost shares are tangible evidence of how highly other organizations value CRDF's work.

No sponsoring organization can offer to fund specific programs in perpetuity. To assure that its work makes a lasting contribution beyond the terms of the program, CRDF assists its grantees in finding support for the future. Cost shares are a first step (and in some cases the only step needed) to secure permanent support from the host government or other indigenous sources.

Like CRDF, other organizations value cost shares as a way to increase the impact of their work. The ability to attract funding from other sources adds to the value we provide our current funders and makes a compelling case for other organizations to engage CRDF to leverage their funding.

[138] Data collected in the table are from original research conducted by the author, using CRDF's archival information.

## CRDF COST-SHARING EXAMPLES

Matching funds for the sample of CRDF's programs below have come from a wide variety of sources. Among the most significant examples of successful cost-shares are as follows.

In the **Basic Research and Higher Education** program in the Russian Federation, each Research Education Center project has included a combined fifty percent cost-sharing from the Russian Ministry of Education and Science (MES) and from local Russian sources. As a clear example of how cost sharing can lead to sustainability, MES has adopted this model and is now funding its own programs, independently of CRDF.

The **Russian Federal Agency for Scientific Innovation (FASI)** has shared costs on two large projects: 1) An HIV/AIDS Public Health Center of Excellence for which FASI committed fifty percent, fully matching CRDF's contribution to the project, and; 2) A Research Innovation Center in Pushchino where FASI and the Russian Academy of Sciences provided over twenty percent funding for CRDF's program under the Freedom Support Act.

The CRDF **"First and Next Steps to Market"** programs received over $2.5 million in cash cost shares from U.S. private corporations, approximately 25 percent of the total cost for 149 technology transfer projects.

The **Russian Foundation for Basic Research** has been a steady co-funding partner for the Cooperative Grants Programs research competitions. These programs fully match CRDF's contributions that go directly to grantees for basic research projects in a wide variety of scientific disciplines.

In Ukraine, CRDF has responded to an initiative from the Ukrainian Ministry of Education and Science (MESU), called **Cooperation in Research and Education in Science and Technology (CREST)**. MESU approached CRDF with the opportunity to share costs on a fifty-fifty basis for establishing resource centers in Ukrainian universities that better integrate graduate education and applied research. CRDF has solicited contributions from both U.S. government and private sector sources. Up to six CREST centers are planned under this program.

In the south Caucasus (Armenia, Azerbaijan, and Georgia) and in Moldova, the respective governments have provided fifty percent support for CRDF's institution building and **Science and Technology Entrepreneurship Program**. In Azerbaijan, a cost-sharing proposal has led to the single largest cooperative research grant program in the country's history, administered by CRDF. Funds are matched fully by a special appropriation to the Academy of Sciences. Successful involvement of both international and local sources has led directly to the establishment of an even larger national science fund, which will become operational in 2008.

## CONCLUSIONS

Cost-sharing arrangements establish each partner as a significant stakeholder in the project's outcomes. As each makes a significant investment in the program, sharing arrangements provide explicitly declared joint funding for direct activities—grants, awards, facilities, equipment, etc. At the same time, each partner is accountable only to itself for controlling its administrative and support costs, providing incentives to keep costs under control. Arrangements of this type make it more difficult for one partner to shift costs to another partner if the program encounters difficulties.

Second, cost-sharing can establish a sense of interdependence and equity among the partners, as each contributor must rely on the other to meet its obligations in pursuing a joint goal. In this way, projects are approached more in the spirit of cooperation among equals and less in a donor-client relationship. Each partner will bring its own capabilities, skills, and resources to accomplish the goals of the program. Cost sharing provides a way to measure these contributions and to align the tasks in the project with the organization most well suited to carry them out.

Cost sharing is also most effective in circumstances where the partners have had cooperative activities in the past. Where the partners have built up a level of trust and confidence from past activities, cost sharing proposals will be easier to justify. In cases where cost shares from various organizations are combined to produce a national share (for example a government ministry and a local university or institute) with a foreign partner, the experience of a lead national champion (e.g., a government ministry) can be crucial in obtaining the support of other organizations with less experience.

CRDF's experience also cautions that the process of securing cost shares be started early in the negotiations for the program. Clearly this is an obvious requirement to scale the project properly, but also experience shows that a valid commitment and the actual cash in the bank account do not always materialize simultaneously. The project must take into account potential delays due to approvals for contributions, especially through government agencies. Clear rules for such contingencies are crucial to avoid misunderstandings in the course of a program's implementation. These understandings need to be negotiated as early as possible in the process in an agreement that establishes the objectives of the joint program and the obligations of the parties. Particularly useful are agreements that establish these rules of the road for a broad cooperative effort, to be then amended by specific protocols for each successive program. In the case of one such agreement, CRDF and its international partner have amended the general agreement thirty-four times in adding successive program elements. As personnel change over time, this procedure has been invaluable in ensuring the continuity of basic principles among the partners.[139]

[139] The following sources were used in the background preparation of this paper: NSF, *Initial Implementation Guidance Regarding Implementation of the Revised NSF Cost Sharing Policy,* October 19 2004; NSF, *Proposal and Award Policies and Procedures Guide,* April, 2007, Effective June 1, 2007, NSF 07-140, OMB Control Number: 3145-0058; OMB, *Revised Cost Principles for Educational Institutions,* Circular No. A-21, Revised August 8, 2000; OMB, *Uniform Administrative Requirements* for *Grants and Agreements With Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations,* Circular No. A-110, Revised November 19, 1993, and further amended September 30, 1999; U.S. National Academies (NAS), Committee on Strengthening U.S. and Russian Cooperative Nuclear Non-proliferation, *Strengthening U.S-Russian Cooperation on Nuclear Non-proliferation: Recommendations for Action,* National Academies Press (NAP), 2005; NAS and Russian Academy of Sciences', Joint Committee on U.S.-Russian Cooperation on Nuclear Non-Proliferation, *Overcoming Impediments to U.S.-Russian Cooperation on Nuclear Non-Proliferation: Report of a Joint Workshop,* NAP, 2004.

# A NUCLEAR RENAISSANCE: EXPANDING NUCLEAR ENERGY AND ASSOCIATED SECURITY CHALLENGES

# INTERNATIONAL URANIUM ENRICHMENT CENTER IN ANGARSK: A WAY TO ENSURE THE SECURITY OF NUCLEAR FUEL SUPPLY AND NON-PROLIFERATION

Sergey V. Ruchkin,
*World Nuclear Association*[140]

## INTRODUCTION

On 11 June 2007, the International Atomic Energy Agency (IAEA) Director General (DG), Dr. Mohamed ElBaradei, in his Introductory Statement to the IAEA Board of Governors (BOG) pointed out that the increase in global energy demand is driving an expected expansion in the use of nuclear energy.[141] This means an increase in the demand for fuel cycle services. It also means an increase in the potential proliferation risks created by a consequential spread of sensitive nuclear technologies (uranium enrichment and spent nuclear fuel reprocessing), which demonstrates a clear need for the development of a new, multilateral framework for the international nuclear fuel cycle (NFC).

The IAEA DG believes that such a framework could be best achieved through establishing mechanisms that would assure the supply of fuel for nuclear power plants (NPP) and over time by converting enrichment and reprocessing facilities from national to multilateral operations, as well as by limiting future enrichment and reprocessing to multilateral operations. He called for an incremental approach, with multiple assurances as the way to move forward.

This paper gives a brief overview of recent proposals for fuel assurance mechanisms put forward by various governments and other stake holders in this regard, with a focus on the initiative of the President of the Russian Federation of January 25, 2006, to establish a network of international nuclear fuel cycle centers as a means to ensure the secure supply of NFC products and services and the non-proliferation of sensitive nuclear technologies.[142]

---

[140] Sergei Ruchkin is currently a Russian representative at the World Nuclear Association in London and is also affiliated with the Federal Agency on Atomic Energy of the Russian Federation (Rosatom), TENEX (Tekhsnabexport, Joint Stock Company), and the World Nuclear University in London.

[141] Introductory Statement to the Board of Governors by the International Atomic Energy Agency (IAEA) Director General, Dr. Mohamed ElBaradei, June 11, 2007, Vienna Austria, available at http://www.iaea.org/NewsCenter/Statements/2007/ebsp2007n007.html; accessed April 6, 2008.

[142] IAEA, "Creation of a System of International Centers Providing Nuclear Fuel Cycle Services, Including Enrichment," IAEA INFCIRC/667, February 8, 2006, available at http://www.iaea.org/Publications/Documents/Infcircs/2006/infcirc667.pdf; accessed July 13, 2008.

## SUMMARY OF PROPOSALS ON ASSURANCES OF NUCLEAR FUEL SUPPLY

Following publication of an IAEA report on multilateral nuclear approaches in February 2005, there have been more than a dozen (13) proposals made so far, which are largely complementary.[143]

### Existing Proposals and Initiatives on Assurances of Supply of Nuclear Fuel[144]

| | Title | Country/Organization | Date |
|---|---|---|---|
| 1. | Reserve of Nuclear Fuel (low-enriched uranium [LEU] downblended from 17.4t highly enriched uranium [HEU]) | US | September 2005 |
| 2. | Creation of a System of International Centers Providing Nuclear Fuel Cycle Services, Including Enrichment | Russian Federation | January 2006 |
| 3. | Global Nuclear Energy Partnership (GNEP) | US | February 2006 |
| 4. | Ensuring Security of Supply in the International Nuclear Fuel Cycle (Assurance-in-Depth Concept) | World Nuclear Association (WNA) | May 2006 |
| 5. | Concept for a Multilateral Mechanism for Reliable Access to Nuclear Fuel (RANF) – the Six Nation Proposal | France, Germany, Netherlands, Russian Federation, UK, U.S. | June 2006 |
| 6. | IAEA Nuclear Fuel Bank | Nuclear Threat Initiative (NTI) | September 2006 |
| 7. | IAEA Standby Arrangements System for the Assurance of Nuclear Fuel Supply | Japan | September 2006 |
| 8. | Multilateralizing the NFC - (Extraterritorial) International Uranium Enrichment Centre (Sanctuary) | Germany | May 2007 |
| 9. | Multilateralizing the NFC | Austria | May 2007 |
| 10. | International Uranium Enrichment Centre in Angarsk (IUEC) | Russian Federation | June 2007 |
| 11. | Governmental LEU Stock in Angarsk | Russian Federation | June 2007 |
| 12. | Enrichment Bonds (government commitments) | UK | June 2007 |
| 13. | European Union (EU) Non-paper on the NFC | EU | June 2007 |

143 "Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report submitted to the Director General of the IAEA," available at http://www.iaea.org/Publications/Documents/Infcircs/2005/infcirc640.pdf; accessed April 6, 2008.

144 For additional information, see IAEA, "12 Proposals on the Table," available at http://www.iaea.org/Publications/Magazines/Bulletin/Bull492/art13-subart1.pdf; accessed July 13, 2008.

Among these are two proposals on establishing physical low-enriched uranium (LEU) reserves as a last resort assurance of supply.[145] The United States announced in Vienna in September 2006, that it would commit up to 17 tons of highly enriched uranium to be down-blended to LEU to support assurance of reliable fuel supplies for states that forego enrichment and reprocessing.[146] A non-governmental organization, the Nuclear Threat Initiative, has offered the IAEA a $50 million 2-to-1 matching grant for a last-resort reserve of LEU, if the following conditions are met:

- the IAEA raises an additional $100 million
- the IAEA takes the necessary actions to approve the establishment of this reserve within two years from September 2006
- customer states do not engage in domestic enrichment[147]

The World Nuclear Association (WNA) set up an ad-hoc working group, which in May 2006, issued a report suggesting a tiered assurance-in-depth approach with three levels of assurance:

- Level I is the existing world LEU/SWU (separative work unit) market
- Level II provides for commitments among the enrichment supplier companies (supported by the supplier states) to collectively back each other if one is politically forbidden from honoring a commercial contract, and if the IAEA triggers the assurance mechanism
- Level III is a final last-resort backup LEU reserve(s)[148]

The 2006 WNA proposal also has a no-enrichment requirement.

In June 2006, the six enrichment supplier states (France, Germany, Netherlands, Russia, UK, and the United States) put forward a six-nation proposal (Reliable Access to Nuclear Fuel [RANF]), which was based on the WNA approach reinforced with governmental commitments, and had a no-enrichment requirement for consumer states as well.[149]

The UK Enrichment Bonds (a virtual fuel reserve) were first suggested later in 2006, to guarantee that national enrichment providers would not be prevented by the states from supplying LEU/SWUs, and to provide prior consent for export assurances (programmatic licenses).

There are two proposals that focus on augmenting the existing enrichment business by establishing new multilateral enrichment companies. The Russian initiative of January 25, 2006,

---

[145] For further information regarding these and all 13 proposals, see http://www.iaea.org/NewsCenter/Focus/FuelCycle/index.shtml; accessed April 6, 2008.

[146] For the U.S. statement presented at the IAEA Special Event on assurances of supply, see http://www.energy.gov/news/4173.htm; accessed April 6, 2008.

[147] For further information on this proposal, see http://www.nti.org/c_press/fuel_bank_122707.pdf; accessed on April 6, 2008.

[148] "Ensuring Security of Supply in the International Nuclear Fuel Cycle," World Nuclear Association, May 2006, available at http://www.world-nuclear.org/reference/pdf/security.pdf; accessed July 13, 2008.

[149] For further information on the "six-party" proposal, see http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2006/cn147_ConceptRA_NF.pdf; accessed April 6, 2008.

on International Nuclear Fuel Cycle Centers (INFCC)[150] aimed at establishing an INFCC network to ensure a reliable and non-discriminatory supply of NFC products and services without transferring sensitive technologies to the consumer countries. The second is a German proposal of 2006, which calls for a new IAEA-operated international enrichment facility on an extraterritorial site.[151]

A Japanese proposal of 2006 focuses on gathering and sharing information about capacities and production plans for all the front end stages of the fuel cycle[152] to prevent market disruptions.[153] It recognizes that countries are at different stages in their front end capabilities, and envisages countries with a small current enrichment capacity (like Japan) later expanding their capacity for an export market.

An Austrian proposal of 2007, in a way reinforces the Japanese proposal, calling for optimized international transparency going beyond current IAEA safeguards obligations.[154] It also suggests equal access to and control of the most sensitive technologies by placing all transactions regarding nuclear fuel under international control.

The U.S. proposal, the Global Nuclear Energy Partnership (GNEP) of February 2006,[155] is a long-term project intending, in particular, to jointly develop technologies for closing the fuel cycle. One of the key GNEP elements is a fuel services program to enable consumer nations to acquire nuclear energy economically while limiting proliferation risks. Under GNEP, a consortium of nations with advanced nuclear technologies would ensure that countries which agree to forgo their own investment in enrichment and reprocessing technologies, would have reliable access to nuclear fuel products and services.

The European Union non-paper on the NFC of 2007, suggests a set of criteria against which such proposals could be assessed: proliferation resistance, assurance of supply, consistency with equal rights and obligations, and market neutrality.[156]

Important commonalities among the above proposals include the following:

- all proposals originate in supplier states and assume that a global spread of sensitive nuclear technologies increases the nuclear proliferation risk
- proposals focus on enrichment as the first phase of a possible holistic nuclear fuel cycle assurance infrastructure (a step-by-step approach)

---

[150] The text of this proposal can be found at http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc708.pdf; accessed April 6, 2008.

[151] For further information regarding the German proposal, "Multilateral Enrichment Sanctuary Project," see http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc704.pdf, accessed April 6, 2008.

[152] The Nuclear Energy Agency defines the stages of the fuel cycle as follows: "a) the so-called front-end which extends from the mining of uranium ore until the delivery of fabricated fuel elements to the reactor site; b) fuel use in the reactor, where fission energy is employed to produce electricity, and temporary storage at the reactor site; c) the so-called back-end, which starts with the shipping of spent fuel to away-from-reactor storage or to a reprocessing plant and ends with the final disposal of reprocessing Vitrified High-Level Waste or the encapsulated spent fuel itself." For further information, see http://www.nea.fr/html/ndd/reports/efc/efc02.pdf; accessed April 6, 2008.

[153] The text of this proposal can be found at http://www.iaea.org/Publications/Documents/Infcircs/2006/infcirc683.pdf; accessed April 6, 2008.

[154] The text of this proposal can be found at http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc706.pdf; accessed April 6, 2008.

[155] For further information regarding the U.S. Global Nuclear Energy Partnership, see http://nuclear.inl.gov/gnep/index.shtml; accessed April 6, 2008.

[156] International Atomic Energy Agency, "EU Non-paper on the Nuclear Fuel Cycle," IAEA GOV/INF/2007, June 11, 2007.

- most of the proposals have a precondition for consumer states to forego enrichment and/or reprocessing
- the proposals recognize that existing nuclear markets (a) have been functioning well, (b) provide the base-line assurance of a reliable fuel supply, and (c) any additional assurances may be just measures of last resort (a safety net) to use only in case of disrupted commercial supplies when pre-defined material release conditions are met
- the proposals underline the special role and commitments of the supplier states (and the IAEA) in the provision of additional assurances (export licenses, associated costs)

## IAEA SPECIAL EVENT ON ASSURANCES OF SUPPLY AND NON-PROLIFERATION

The importance of this subject was underscored by the IAEA decision to hold a dedicated Special Event in Vienna in September 2006, in conjunction with the 50th IAEA General Conference. The Chairman's Summary of the Special Event pointed out that consumer states would choose different fuel supply policies and solutions.[157] It is of utmost importance to retain flexibility in this area, and not try and suggest solutions perceived to be imposed, particularly on consumer states. Recent proposals for assuring supplies of nuclear fuel can be seen as one stage of the broader, longer-term development of a multilateral framework that could encompass both natural and low-enriched uranium, as well as nuclear fuel and spent fuel management.

An assurance of fuel supply mechanism would:

- address possible consequences of interruptions of supply due to political considerations unrelated to non-proliferation, commercial or other contractual obligations
- reduce incentives for consumer countries to acquire (build new) indigenous enrichment or reprocessing capabilities
- be solely a back-up mechanism to the current normally-functioning market
- not ask or expect from any country to give up or abridge any of their rights provided under the Treaty on the Non-Proliferation on Nuclear Weapons (NPT)[158]

## PRELIMINARY FEEDBACK FROM POTENTIAL CONSUMER COUNTRIES

Following the IAEA Special Event, the Agency secretariat and the countries originating the proposals have been actively seeking feedback from potential users (consumer states) on such a mechanism. Perhaps the most important responses thus far are:

[157] The Chairman's Report may be found at http://www.iaea.org/About/Policy/GC/GC50/SideEvent/report220906.pdf; accessed April 6, 2008.

[158] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

- Few, if any, countries might be prepared to compromise, dilute or give up any rights to develop peaceful nuclear technologies; even if they do not need enrichment technology today, they may need it in the future.
- The NPT has provided a very fragile balance between the rights and obligations of all members, and it would rather not be tipped by attempts to place additional commitments on those countries which do not have nuclear weapons, (so-called "have-nots")
- Export controls (Nuclear Suppliers Group) and IAEA safeguards are the best multilateral approaches to controlling the spread and use of sensitive technologies; proposals on assurances of supply may question their credibility.

## G8 STATEMENT ON NON-PROLIFERATION

On June 8, 2007, at their last summit in Germany, the G8 leaders made a special statement on non-proliferation,[159] where they stressed the importance of developing and implementing mechanisms of multilateral approaches to the nuclear fuel cycle as a possible alternative to pursuing national enrichment and reprocessing activities. They appreciate the initiatives put forward on multilateral approaches to the nuclear fuel cycle (including the INFCC, GNEP, the six-nation proposal, and others). In considering these initiatives, the G8 will be guided by the criteria of added value to the non-proliferation regime, confidence in the reliability of supply assurances, compatibility with Article IV of the NPT, and the need to avoid any unnecessary interference with disturbance of the existing commercial markets. The G8 leaders reiterated that participation in any mechanism dealing with multilateral approaches should be carried out on a voluntary basis and should not preclude any state from purchasing nuclear fuel cycle services on the existing market beyond the frameworks of multilateral mechanisms. The G8 also noted that they were looking forward to the suggestions that the IAEA DG would present to the IAEA BOG in June 2007.

## IAEA DG REPORT ON ASSURANCES OF SUPPLY

At the June 2007 IAEA BOG meeting, the IAEA DG provided to the Board a report developed by the IAEA Secretariat on a "Possible New Framework for the Utilization of Nuclear Energy: Options for Assurance of Supply of Nuclear Fuel."[160] The report had the status of a restricted distribution document and was not discussed by the Board at that meeting in order to give the Governors more time to reflect on it. It was not a formal proposal of the Secretariat but an attempt to structure a possible framework within which the existing and future proposals can be placed for consideration.

---

[159] To read the text of the G8 Statement on Non-proliferation from Heiligendamm, Germany of June 8, 2007, see Appendix D.

[160] For further information, see http://www.iaea.org/NewsCenter/News/2007/nuclenframework.html; accessed April 6, 2008.

Following the recommendations of some potential consumer states, the report assumes that even at this early stage the assurances of supply should cover not only LEU, but manufactured fuel assemblies as well. The suggested framework for the assured LEU supply is as follows:

- Level 1: Existing global nuclear fuel market arrangements
- Level 2: Back-up commitments provided by fuel suppliers, if pre-determined criteria are met following a political disruption, underpinned by commitments from their respective governments to allow such a supply (and not to retaliate on other suppliers)
- Level 3: A physical or virtual LEU reserve(s) (commitments by governments) under IAEA control, which could be used if Level 2 commitments can not be fulfilled, and the same pre-determined and agreed upon criteria are met

The suggested framework for fuel fabrication is based on the same LEU logic.

The report concludes that all assurance of supply frameworks under the Agency's auspices should be open to participation by all member states and suggests possible material release and decision-making principles:

- The release criteria should be the same for all states regardless of a state's future fuel cycle options. This may best be achieved through a procedure whereby the BOG establishes the criteria in advance, thereby ensuring that they are consistent for all states wishing to make use of the framework.
- Once a request for supply is received by the Agency, the DG will decide if the criteria defined by the Board are met, allowing the supply framework to be triggered.

## INTERNATIONAL URANIUM ENRICHMENT CENTER IN ANGARSK

The IUEC in Angarsk is seen as the first step to implementing the initiative of the Russian President Vladimir V. Putin of January 25, 2006, on INFCC. The establishment of the Center is considered to be a logical development of the IAEA multilateral fuel assurance approaches, and correlates well with other related initiatives (RANF, GNEP). The IUEC has three primary objectives:

- to promote the wider use of nuclear energy worldwide, particularly in emerging nuclear energy countries
- to reduce the nuclear proliferation risk by encouraging consumer countries to use the benefits of nuclear energy by relying on international routes for the supply of NFC products and services rather than by acquiring sensitive indigenous NFC capabilities
- to provide additional assurances of nuclear fuel supply to the IUEC member states, which may voluntarily choose to rely on international routes of nuclear fuel supply

In the last year, some important milestones have been achieved in the realization of the IUEC initiative. The IUEC objectives and conceptual approaches on how to achieve them have been widely discussed with the relevant parties in the Russian Federation, potential candidate countries, and with international organizations (at the IAEA and other forums). A decision was made by the Russian government to set up a commercial joint stock company "IUEC" on the site of the Russian uranium enrichment plant in Angarsk; the plant has been added to the list of Russian nuclear facilities to be put under IAEA safeguards. The Russian nuclear legislation has been amended to allow possession of nuclear materials by legal entities, as well as to acknowledge the right of foreign states (legal entities) to possess nuclear materials (and their processing products) imported to and/or procured in Russia. A model intergovernmental agreement, to be concluded between the IUEC and member states to provide the necessary international legal framework, has been drafted; the first IUEC agreement between the Russian Federation and the Republic of Kazakhstan was signed on May 10, 2007. The IUEC implementation status (July-September 2007) was as follows:

- establishment of IUEC organization and management infrastructure
- meeting of IUEC shareholders (TENEX and Kazatomprom)
- signing of IUEC founding documents (Charter and Agreement)
- election of the Board of Directors (chaired by V. Polysaev, Director, Atomenergoprom International Department)
- nomination of the IUEC Director General (TENEX Director General, A. Grigoriev)
- IUEC registration, development of economic and corporate models (in process)
- consultations with potential IUEC customer countries (Armenia, Ukraine, and others), on-going

The Russian-Kazakhstan IUEC Agreement, which may be considered a template for similar agreements with other countries, does not impose any specific non-proliferation limitations on would-be IUEC members, but notes that Kazakhstan did not possess uranium enrichment capacities when the agreement was signed. It provides guaranteed access for IUEC members ("…predominantly from countries not developing domestic uranium enrichment capabilities…")[161] to the Center's enrichment products and services.

The U.S.-Russia Agreement on Nuclear Cooperation (123 Agreement), signed by Ambassador William Burns and Rosatom Director Sergei Kirienko on May 6, 2008, in Moscow, may become an important milestone, providing the legal basis for cooperation between Russia and the United States on the peaceful use of nuclear energy.[162] This Agreement is required by the U.S. Atomic Energy Act of 1954, which governs the transfer of U.S. nuclear technology, equipment and materials to a foreign country. It must be signed and brought into force, for instance, if spent fuel of U.S. origin is to be deposited into a international spent nuclear fuel centre should one be established in Russia. But for the purposes of the IUEC in Angarsk, the 123 Agreement is not necessary as long as a U.S. company joins the IUEC and would like to enrich uranium of U.S. origin in it, which is highly improbable.

LEU produced at the IUEC and exported from Russia is to be used for fabrication of fuel (powders, pellets, fuel elements and assemblies) for nuclear power plants. And last but not the least, on consent of the IAEA, the Parties may establish a governmental stock of natural and low-enriched uranium, which may be used as collateral for IUEC commitments, and as a last resort LEU reserve in the future international security of supply mechanism (see Figure 1).

---

161 Agreement between the Government of the Republic of Kazakhstan and the Government of the Russian Federation on the Establishment of the International Uranium Enrichment Center, May 10, 2007.

162 See the papers by Alexander A. Pikaev and Orde Kittrie in this volume.

# IUEC Organizational and Legal Structure

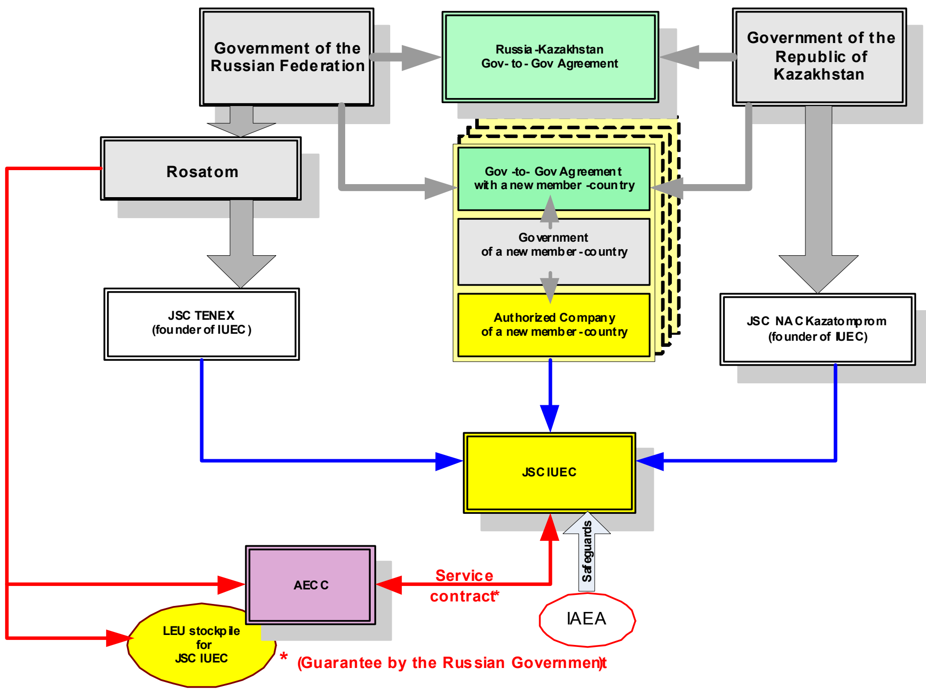



Figure 1 IUEC Organizational and Legal Structure

The IUEC was founded and will be operated on Russian soil according to Russian law as a commercial company co-owned and co-managed by the shareholders (commercial companies authorized by their governments). At present 90 percent of the shares are owned by TENEX, and 10 percent by Kazatomprom. Regardless of the number of IUEC members, the Russian member will always own no less than 51 percent of the shares.

The IUEC shareholders would have a claim to the company's product (LEU/SWU) and the profits. Since transformation of the existing enrichment plant in Angarsk from a state federal unitary enterprise into a joint stock company will take some time, initially the IUEC will not have enrichment capacities of its own, but will have to place orders for enrichment services at the existing plant. When the Angarsk plant transformation into a stock company is complete (in early 2008), the plant could acquire some shares of the IUEC in exchange for its enrichment capacities. At the next stage, the IUEC shareholders may want to expand the Center's production capacities by investing in the construction of new enrichment cascades. In any case, the Russian enrichment technology know-how shall not be transferred to other IUEC shareholders.

The IUEC is believed to meet the above-mentioned EU/G8 acceptance criteria for the following reasons:

- the Center aims to provide additional assurances of supply to its shareholders through:

  - diversification of fuel (LEU/SWU) suppliers
  - commitments of the governments involved, particularly that of the Russian government, to provide necessary support to its operations (regulatory oversight, export/import licenses, etc.)
  - better transparency of operations due to the involvement of shareholders in IUEC management and application of IAEA safeguards
  - robustness and competitiveness of Russian enrichment technology
  - plentiful resources of natural uranium in the member countries

- IUEC market neutrality. It is to become a new commercial fuel supplier at market prices. Should the IUEC enrichment potential exceed the needs of its shareholders it may also play a role in the emerging international assurances of nuclear fuel supply widely discussed now by the world nuclear community. For instance, in case of disrupted market deliveries, in terms of the six-nation (RANF) proposal of June 2006, of which the Russian government is a part, the IUEC may serve as a physical or virtual back-up LEU supplier at level II (collective assurances of commercial suppliers), and/or level III (governmental IAEA-administered LEU reserves).
- the IUEC is consistent with the criterion of equal rights and obligations:

  - the Russia-Kazakhstan IUEC Agreement of May 10, 2007, does not impose any additional non-proliferation requirements on the IUEC members
  - IUEC is open to any company from third countries that meet their obligations under the NPT of July 1, 1968, and share the intent and objectives of the Center
  - the IUEC membership and material release terms are to be the same for all members

- bringing the IUEC into operation is believed to reduce the risk of proliferation by:

  - denying other IUEC members access to Russian centrifuge technology (a black box approach)
  - producing at the IUEC and exporting from Russia LEU is only for fuel fabrication for NPPs
  - providing incentives together with last resort LEU fuel reserves, to participating countries to rely on international routes of LEU fuel supply rather than on developing domestic capabilities

Since non-proliferation is one of the main objectives of the IUEC, it will not be able to operate effectively without IAEA support and involvement, which may materialize in various ways, including:

- implementation of IAEA safeguards over IUEC nuclear materials and/or facilities
- assistance in gaining international recognition and involvement of new countries
- certification of participating countries' non-proliferation records against predefined criteria
- provision of a framework and trigger mechanism for back-up supplies (should the IUEC have this role)

In mid-March 2007, the Russian Atomic Energy Agency (Rosatom) and the IAEA conducted a workshop in Angarsk, where the issues above were discussed and follow-on action plans for both sides were coordinated. They agreed to establish a joint working group, which has already convened several times. The working group is tasked with developing common approaches for IAEA participation in the IUEC and/or LEU reserve operations, and for IUEC involvement in IAEA assurances of supply mechanisms.

## CONCLUSION

Global perspectives on the expanded use of nuclear energy raise concerns about the security of the nuclear fuel supply and increased risks of the proliferation of sensitive nuclear technologies. In recent years, there have been various initiatives put forward by governments and other stakeholders to address this issue. They are largely complementary and may provide valuable input to the development of a new framework for utilization of nuclear energy.

Assurance of supply may become a rare type of insurance, where the insurer (supplier states) pays the premium in the expectation of receiving something from the insured in return (refraining from sensitive activities). It is becoming increasingly clear that no foregoing of rights to develop/use civil nuclear technologies (mandatory and forever) can be acceptable for potential consumer states. Only voluntary options are viable, and only for as long as the consumer states wish to be members of an assured supply mechanism. The mechanism shall guarantee that there are no retaliations (penalties) on those countries, which may choose to refrain from joining the mechanism. Assured supply and non-proliferation objectives can be achieved by a clear demonstration of the benefits (economic, political and others) of being a part of the international assurances of supply mechanism and by peer pressure from the member countries.

The International Uranium Enrichment Centre in Angarsk is the first step in implementing the Russian President's initiative of January 2006, and is believed to be a promising approach to addressing concerns related to the globalization of nuclear power, assurances of supply of NFC products and services, and the risks of nuclear proliferation.

# NUCLEAR POWER OF FAST REACTORS: A NEW START

Victor V. Orlov,
*N.A. Dollezhal Research and Development Institute of Power Engineering (NIKIET),*

There was no acute need for a new energy source in the 20th century. The fuel balance, economics, and safety of nuclear power combined to make the goal of its development much more difficult to attain as compared with the military objectives of nuclear weapons accomplished by the U.S. and then by U.S.S.R. in the 1940s–1950s.[163]

But Enrico Fermi's idea (1944) of a nuclear power industry comprised of fast reactors – which promised a new era of energy production, that of inexpensive electricity derived from cheap and inexhaustible fuel and used in inexpensive nuclear power plants (NPP) – still remains appealing. The experimental EBR-I reactor (Argonne National Laboratory [ANL]) produced the first nuclear electricity as early as 1951, and the first successful NPPs with fast neutrons, the BN-350 (1972-1997) and BN-600 (1980), were developed by Alexander Leipunsky in the 1960s.[164]

In the 1950s, Russia, the UK, the United States, and Canada brought into operation the first power plants with 'military' thermal reactors as a first stage in nuclear power development and as a source of plutonium (Pu) production for fast reactors. Encouraged by the successes of military engineering, nuclear power quickly progressed from a conceptual idea of physics to a technology and an industry with an applied scientific network to serve it. The nuclear engineers, trained to deal with reactors developed in the 1940s–1950s, had to improve the safety of thermal reactor facilities in the 1970s–1980s, which made their cost four times higher. The early fast reactor plants turned out to be even more expensive and saw no succession. Nuclear power entered the 21st century in a state of stagnation, with uncertain prospects for the future.[165]

With oil and gas prices rising, many states are now cautiously returning to electricity based on a new generation of thermal reactors: the United States and Europe, Russia have announced a large VVER construction program, and India and China are actively assimilating the above technologies in their ambitious nuclear programs). However, without returning to the original idea of nuclear power based on fast reactors (FR), it will be difficult to cope with the looming fuel and energy problems of the 21st century. Although resulting in only an incremental increase in their cost, the recent improvements of thermal NPPs will not be sufficient to meet future demands. It will first be necessary to re-examine the reason for the failure of the original idea, which lies in the very 'fast breeder' concept developed by ANL in the 1940s: namely, the

---

163 With costly chemical fuel of limited availability, electricity is much more expensive than heat; it still accounts for a mere 1/6 of the energy consumed (1/3 in fuel consumption) and its share shows slow growth.

164 Fast reactors (FRs) are a scientific concept and may be the basis of future large-scale nuclear power plants. Thermal reactors (TRs) will most likely be used to address local and other needs. It should be noted that the best fuel for TRs is Th-3U from thorium blankets of FRs.

165 Massachusetts Institute of Technology (MIT), "The Future of Nuclear Technology," (Boston: MIT, 2003). Available at http://web.mit.edu/nuclearpower/; accessed July 13, 2008.

underestimation of safety issues.

By the end of the 1980s, analysis of previous industry experience led N.A. Dollezhal Research and Development Institute for Power Engineering (NIKIET) physicists and designers, under the direction of the Director Evgeny Adamov, to abandon the 'fast breeder' in favor of the 'fast reactor of natural safety'[166] (BREST). Based on advances achieved since the 1950s–1960s, these physicists proceeded with engineering designs for the following:

- equilibrium FR operation with breeding ratios (BR) of approximately 1 (the advantages of which were understood as early as the 1960s)
- the use of nitride, rather than the oxide fuels used in the early FR (e.g. metal fuel used at ANL)
- on-site dry reprocessing (Scientific Research Institute of Atomic Reactors; Idaho National Laboratory) instead of the aqueous process used in military applications
- non-combustible, molten Pb coolants (based on experience with Pb-Bi for submarines) rather than Na

By the end of the 1990s, Minatom prepared the Nuclear Power Development Strategy and the technical basis for the Initiative of the Russian President at the United Nations with a brief political statement of objectives.[167]

Compared to other countries, Russia is better prepared to create a fast reactor capable of resolving fuel and energy problems. The technical and financial issues are manageable; more difficult to overcome are the negative connotations and unfavourable economics that came to prevail in the industry during the decades of stagnation.

Although a great deal of Pu has accumulated already and its breeding, in the short-term, will not be necessary, it will be difficult to move forward without revising the 'fast breeder' concept. This could be done by simple estimation, but it would be improper and inconclusive without referring first to the greatest primary source–Fermi.[168]

## THE ORIGIN OF THE FAST BREEDER STEREOTYPE

In April 1944, the separation plant at Oak Ridge was not yet in operation, and in his first outline for fast reactor-based nuclear power Fermi decided against the energy-consuming and expensive separation of uranium isotopes. Fast reactors would not run on natural uranium, so he started with a parent graphite or heavy-water-moderated thermal reactor, which would rapidly consume uranium and produce little Pu. Then, as fast reactors were brought into operation, they would initially run on the Pu from these thermal reactors and then 'multiply' or 'breed' their own

[166] Equivalent to 'inherent safety' extended to waste and proliferation. In the 1970s, Alvin Weinberg predicted a "moratorium" for construction of new nuclear power plants in the U.S. and later envisioned a new start of nuclear power with inherently safe nuclear plants; in reality, however, the whole effort was reduced to the development of "passive" reactor safety features. "Continuing the Nuclear Dialogue: Selected Essays," *American Nuclear Society*, 1985.

[167] United Nations Millennium Summit, 2000. For further information, see http://www.un.org/millennium/; accessed July 13, 2008.

[168] Enrico Fermi, "Discussion on Breeding," *Scientific Works of Enrico Fermi* [Russian translation], (Moscow: Nauka 1972), V. 2, pp. 220–224.

required fuel (uranium blanket, BR>1).

Fermi was not convinced of his preliminary estimates, and the changeover to enriched uranium was not unlikely. Besides, he felt that "the public may not accept an energy source that is encumbered by vast amounts of radioactivity, and that produces a nuclear explosive, which may fall into hostile hands."[169]

Before long, the uranium enrichment process, used for weapons production matured. This was further developed for nuclear submarine and thermal power reactors in the 1950s. Even simple assessments show that it would be better to start fast reactors on enriched uranium if only to reduce uranium consumption, to say nothing of the safety implications (estimates for modern light water reactors are given below).[170] A breeding ratio of approximately 1 would be sufficient (with BR~1.05 being optimal),[171] and fast reactors of moderate power density would naturally go into equilibrium 'burning' of U238, Pu, and minor actinides (MA). This would facilitate the resolution of safety problems (NPP, waste, proliferation) with the ensuing reduction of NPP costs. Although he was present during the start-up of EBR-I in 1951, Fermi himself never returned to the development of fast reactors. Instead, he delegated their development to ANL, where his outline evolved into the fast breeder concept, including:

- Uranium blanket with weapons-grade Pu, and BR>1, which led to the reactivity margin $\Delta K >> \beta_{eff,}$ with the risk of a prompt criticality excursion, and to separation of uranium and Pu in reprocessing
- high fuel power density *P* and breeding rates $\omega$~(BR-1)*P*
- heat removal by light-weight and heat-conducting (but combustible and neutron-moderating) Na, which has a relatively low boiling point ($T_{boil} \sim 900^oC$), close-packed lattice of fuel rods in tight shrouds; worse thermal hydraulics; flow blockage danger

Consequently, the inherent safety properties of FRs were left untapped. As with thermal reactors, the present-day fast neutron machines are also potentially prone to severe accidents, involving a prompt criticality excursion, loss of coolant with the additional hazards of Na exposure to air and water, and positive void effect in the event of rapid Na boiling. Moreover, the problems of waste and proliferation remain unresolved, and the FRs cost even more than the expensive thermal reactor facilities. Nevertheless, the idea of Pu breeding, which appeared correct at first glance, was embraced by major physicists. Eventually, this came into general use, was included in educational programs, and became a universally ingrained stereotype.

---

[169] Ibid.

[170] A 1 gigawatt (GW) light water reactor (LWR) with high burnup consumes 10 kt of natural uranium and generates about 7 tons of fissile Pu over 50 years. The latter allows integrating 1 GW from FRs into a closed nuclear fuel cycle (NFC) with about one year of cooling. The efficiency of U235 in FRs is a factor of 1.3-1.4 lower than that of Pu, so it would take about 10 tons of U235 (derived from 2 kt of natural uranium) to integrate 1 GW from FRs based on natural uranium into a closed NFC, which is 5-6 times less than that required for a "parent" TR, with the same being nearly true for separation work units.

[171] The 16 Mt of "cheap" uranium allows for the deployment of LWRs to a capacity of 1.6 thousand GWe (gigawatts electricity) (~20 percent of electricity) in the 21st century, while FRs would provide more than 8,000 GWe (with more expensive uranium being also acceptable). FRs with a Th blanket in the future could provide another several thousand GW from TRs. Given breeding rations of ω~1 percent per year, nuclear power could grow to a level higher than 105 GWt (10 kW [kilowatt] per capita for 12 billion people, as in advanced countries). It is hardly necessary to seek more, nor is it advisable (from the standpoint of a balance with 108 GW of incident solar radiation).

Plutonium breeding is no longer of importance today, but instead of revising the FR concept and going back to Fermi's idea, some experts are ready to abandon FRs and the closed nuclear fuel cycle (NFC) altogether, thus depriving nuclear power of a future.[172] Others (such as those developing the Global Nuclear Energy Partnership)[173] are looking into possible special applications for fast reactors (incineration of actinides, or small reactors with infrequent refuelling). There is yet a third category of experts (for example, those working within the Generation IV International Forum) who seek to keep the FR option open, and are counting on engineering improvements made by trial-and-error, (some of them rather radical, such as substituting gas, water of Pb for changeover from Na).[174]

Some scientists (of the Kurchatov Institute, and OKBM) are still insisting on high breeding for FRs, carrying this idea to the extreme of a fast reactor as a 'Pu factory' to cater to thermal reactors, which is both physically and economically unsound.

Fast reactors do not have enough neutrons to provide many TRs with Pu (their quantity would be sufficient for potential fusion reactors or expensive accelerator-driven systems). But the FR will also be expensive if its neutrons and design features are keyed to attaining BR>>1 to feed one TR rather than to resolving safety problems; it would be cheaper to use more expensive uranium.

The idea of the 'Pu factory' gave way to one of a 'diverse nuclear power mix' consisting of TRs, FRs, and MA 'burners.'[175] Fast reactors could accomplish the latter if not for the prevalence of TRs for some obscure reasons.

Experts would not be forced to rely on computer models if experimental work on new fast reactors had not been forsaken. Without advancing from the reactors of the 1950s–1960s, Russia will not be able to maintain its leadership, indeed its independence, in nuclear engineering.

Due to the availability of inexpensive fuel, the operation of existing NPPs is profitable and the earnings are sufficient to justify their life extension and renovation. Although it is expensive to build new VVERs, their decommissioning will start after 50-60 years of operation, and it is only a changeover to FRs in a closed NFC that can justify the budgetary expenses. To pave the way for such a changeover, the *Nuclear Power Strategy* made provisions for building BREST-300 and BN-800 on the Beloyarsk NPP site, with both reactors running on nitride fuel and sharing the same fuel cycle facilities with non-aqueous reprocessing.[176]

---

[172] MIT, *The Future of Nuclear Power*. The Russian Corporation TVEL notes that "(t)he closed nuclear cycle envisages transportation of irradiated fuel assemblies to radiochemical plants to extract unburned uranium rather than transportation to disposal site. Recoverable uranium could amount up to 95 percent of initial uranium mass. Then, this material is subject to same processing stages as the one mined." Presently the majority of countries use an open fuel cycle. For more information, see http://www.tvel.ru/en/nuclear_power/nuclear_fuel_cycle/; accessed April 6, 2008.

[173] For further information regarding the U.S. Global Nuclear Energy Partnership, see http://nuclear.inl.gov/gnep/index.shtml; accessed April 6, 2008.

[174] Gas and supercritical water allow a single-circuit design of a FR, but its fuel must feature exceptional reliability. The microfuel concept of TRs is not suitable for FRs which, with no clear alternative, would mean changing one hazard (Na) for another (high pressure). For further information regarding Generation IV International Forum (GIF), see http://gif.inel.gov/; accessed May 1, 2008.

[175] Minor actinide "burners" would be necessary in a small-scale nuclear power industry in which FRs are absent or are a long time in coming.

[176] *Strategy of the Development of Nuclear Power Engineering of Russia in the First Half of the 21st Century. Basic Provisions*, Ministry of the Russian Federation for Atomic Energy, Moscow, 2000, approved by the Government of the Russian Federation on May 25, 2000, Protocol No. 17 (Moscow: Minatom Rossii, 2000).

Implementation of the Strategy's objectives was reduced entirely to the BN-800 alone, which is being built practically along the lines of the oxide-fuelled BN-600 designed in the 1960s. It is still unclear what sort of closed NFC will be used, even though its preparation is the sole purpose for building the expensive BN-800. It will be impossible to exactly monitor the circulation of thousands of tons of $^{5}$U and plutonium should nuclear power expand to produce thousands of gigawatts (GW); the equipment is capable of extracting $^{5}$U and Pu. Therefore only technical and political palliatives can be used to control proliferation. Reprocessing of equilibrium composition fuel in fast reactors (closed fuel cycle) does not involve very deep purification, which can be done by coarse physical extraction methods of light-mass fusion products to avoid separation of mass-like U, Pu, and minor actinides. This makes it possible to exclude the most hazardous technologies of plutonium separation and uranium enrichment to maintain non-proliferation and to adopt a comprehensive ban on and the elimination of nuclear weapons by the states party to the Treaty on Non-Proliferation of Nuclear Weapons.[177]

## CLOSED NUCLEAR FUEL CYCLE OF FAST REACTORS

The enrichment, burnup and, hence, the activity of FR fuel, which are much higher than in TRs, make the aqueous process developed for extraction of weapons-grade Pu (that most suitable for thermal reactors) hardly suitable in a closed NFC of fast reactors due to:

- low critical concentration of Pu in aqueous solutions
- decomposition of organic extracting agents
- easy uranium and Pu separation
- large quantities of liquid radioactive waste
- steep increase in the cost of shipping radioactive and fissile materials
- long cooling periods for spent fuel before transportation and reprocessing
- many-fold increase of Pu quantities required for starting FRs in a closed NFC

Thorough removal of fission products is not essential for FRs, nor is removal of MA.

With the time taken for spent nuclear fuel cooling, transportation, reprocessing, and return to the reactor optimistically estimated at seven years (fuel lifetime for the BN is about 1.5 years, as compared to the above estimate of one year), Pu consumption in starting up a 1 GW fast reactor in a closed cycle would triple from seven to more than 20 times.

In this case, a 1 GW VVER can give rise to 1/3 GW in FRs instead of 1 GW. When the VVERs are then taken out of service in the second part of the $21^{st}$ century, the nuclear generating capacity will drop to 1/3 of its previous level. An increase in the breeding ratios would not correct this, as the average Pu power density in the closed fuel cycle will become three times lower as will the breeding rates (from $\omega \sim$ 3 percent to less than 1 percent per year, given BR = 1.2). Although all of the above was well-known in the 1960s, when the United States and Russia initiated research on on-site 'dry' reprocessing for the closed fuel cycle of FRs, it was apparently forgotten over the past 40 years.

177 To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

There are no grounds for giving up the Strategy target of an on-site NFC for the BREST-300 and BN-800 reactors at Beloyarsk; it is necessary to resume the work interrupted six years ago and to do it urgently, if for no other reason than justifying the budgetary expenses for the costly BN-800. With much time lost already, a provisional solution will have to be found for making the first core for the BN-800, with the enriched uranium option not to be overlooked, if the reactor is going to be commissioned in 2012.

## FAST REACTOR FUEL

The neutron balance, enrichment and, consequently, power density of a FR (which is much higher than in TRs) call for a high-density, heat-conducting, heat- and radiation-resistant ceramic fuel. It is for this reason that in 1965, $PuO_2$ of BR-5 (loaded in 1959) was changed to UC and then to UN, and UPuN fuel rods were tested. The initial purpose was to increase the breeding rate, and the tests were performed under loads far in excess of those for oxides (400-500 W/cm) at temperatures above 1500$^{o}$C, where nitride dissociation begins (with nitrogen pressure growth).

With the idea of high breeding abandoned, moderate loads were adopted for BREST with temperatures in the fuel rod middle below 900$^{o}$C, where neither the above nor other problems, such as Pu transport and interaction with steels, may arise. Given low O and C concentrations, nitride shows insignificant swelling and releases far less gas than oxides; besides, a sufficient gap in the fuel relieves the cladding of mechanical loads and contributes to higher burn-up.[178]

The Bochvar All-Russian Scientific Research Institute for Inorganic Materials developed a process and built a line for BREST fuel rod fabrication, and if this work had not been nearly stopped six years ago, experts in Russia would have approached completion of the tests in BOR-60 and BN-600 today. Yet, the BREST fuel tests in the BOR-60 (with the burnup so far as low as 3 percent) have been staged. Examination of the fuel rods revealed local interaction of the “internal” Pb (without oxygen) with the cladding. It seems clear how the problem may be resolved but there are no funds for conducting the experiments. Given normal funding, completion of the development work and validation of the BREST fuel design would take five or six years at most, which would provide FRs, including the BN-800, with the fuel that can significantly enhance their safety and economics.

Statements to the effect that the fuel that has been studied for four decades will have to be developed over another 20 to 30 years, are coming from a period of stagnation. It is true that serious developments were made a long time ago, but the importance of the objective calls for a resumption of this effort.

[178] The problem of nitrides lies in the formation of the environmentally hazardous 14C from 14N in the (n,p) reaction. A changeover to 15N would eliminate this problem and improve the neutron balance, considering that separation of N isotopes is not overly expensive. However, this option is left for the future: ‘dry’ reprocessing does not give rise to CO2, and if radioactive waste is buried in stable forms, 14C would account for a mere 1 percent of the waste radiotoxicity.

## COOLANT

The situation is equally dire not only for the closed cycle and the fuel of FRs, but also for the completion of the research and development on Pb, started 19 years ago under our initiative at the Institute of Physics and Power Engineering (IPPE), Central Scientific Research Institute of Structural Materials (CNIIKM) and other institutes.

The advantages of non-combustible Pb over Na are obvious from the standpoint of safety, if not entirely so in terms of thermal hydraulics (e.g. weight, heat conductivity). A systems approach – often referred to by F.M. Mitenkov[179] – necessitates that all major factors should be taken into account, including neutron moderation, which is much lower with heavy Pb than with Na. It is therefore possible to considerably increase the Pb volume inside the lattice (and the flow area) and to have a lower flow velocity. As compared with Na, this results in smaller hydraulic resistance and pumping power requirements, and a temperature gain – up to 120$^{o}$C for BREST – with an increase of $T_{in}$ to 420$^{o}$C and a sufficient margin over the melting temperature of 327$^{o}$C (which means that Pb-Bi is unnecessary).

Heavy Pb is actually better than Na in terms of thermal hydraulics, except for the case of high heat fluxes to be removed, where heat conductivity is of substantial importance (which must have been the reason for ANL to choose Na). But this characteristic is not so important if high breeding rates are abandoned, and the cladding temperature in the "hot spot" is reduced in a BREST reactor of moderate power density[180] from over 700 $^{o}$C in BN down to 650$^{o}$C, acceptable for ferritic-martensitic steels, which – besides being low-swelling – are resistant to Pb under proper oxygen control.

The main problems with Pb lie in adapting the Pb-Bi technology developed for submarines and in testing the steels designed for use in Pb-Bi for corrosion resistance to Pb. Positive results have already been obtained for the core materials at IPPE (17 thousand hours) and for the circuits at CNIIKM. It is an important finding that the potential considerable upward and downward variations from the nominal oxygen concentration over hundreds of hours of operation will not lead to dangerous corrosion development. The problems of 'stagnant zones' and mechanical damage to oxide films appear to be resolved by appropriate design, but this conclusion requires experimental verification.

For the prototype BREST-300 to be built it is necessary to complete the suspended equipment development program, which will take five to six years. If not for this interruption, the BREST-300 would already be under construction and Russia would have been building the nuclear power industry on a truly new technological basis.

## CONCLUSION

In the 1940s, it was hard to avoid mistakes, then firmly fixed in a stereotype of fast breeder reactors started with Pu from thermal reactors. As a result, this vision of the nuclear

[179] F.M. Mitenkov, "Prospects for the Development of Fast Breeder Reactors," *Atomic Energy*, V. 92, June 6, 2002, pp. 453-460.

[180] OKBM has also significantly reduced the BN power density in its newer designs and may, hopefully, take other steps towards natural safety.

power industry has not been implemented in the $20^{th}$ century and without new FRs the industry won't be able to considerably influence the resolution of the fuel, energy, and environmental problems facing the world in the $21^{st}$ century.

Although endowed with rich fuel resources, Russia's high per capita energy consumption (on par with other highly developed countries) and low energy efficiency will require a shift to greater innovation in the $21^{st}$ century to overcome the raw materials deviation in the economy, export operations, and society structure. This can be achieved through the development and deployment of fast reactors in the nuclear power industry. *The Strategy 2000* provides for a shift to FRs;[181] it should be updated with time, but more importantly, it should be implemented despite the presence of certain stereotypes and special interests.

Development of a prototype BREST-300 with a closed fuel cycle, followed by the development of the first BREST NPP within the next 20 years would give rise to an innovative new power industry. The objectives underlying the further development of BREST and its associated technologies (with some studies already underway and others to be initiated) include:

- changeover from the supercritical steam-turbine to the medium-pressure gas-turbine cycle consistent with the principles of natural safety
- changeover from chemical removal of fission products to physical (plasma) processes, to rule out the possibility of uranium and Pu separation
- generation of high fast-reactor process heats (800$^{o}$C and up) with Pb ($T_{boil}$ up to 2000$^{o}$C), assuming availability of heat- and radiation-resistant materials (STAR-H2 concept, ANL)
- conversion of the fast reactors to "continuous" refuelling to reduce the reactivity margins, increase the capacity factor, etc. (new refuelling system)
- adaptation of NPP design rules and regulations to the requirements of natural safety for full use of the economic advantages offered by FRs
- future provision of fast reactors with a Th blanket to supply Th-U233 fuel to TRs, which may be preferable in remote regions and smaller countries
- utilization of NPP heat and radionuclides for domestic, industrial, agricultural and medical purposes
- configuration of nuclear power complexes with FRs, a closed fuel cycle, facilities for radioactive waste treatment, radionuclide and heat utilization, and physical protection systems
- radiation-equivalent disposal of waste from the equilibrium NFC of fast reactors in naturally radioactive formations of former uranium mining sites
- scientific and political aspects of transition to nuclear power based on FRs in an equilibrium closed and equilibrated NFC, which offers the prospects of independent energy development to large countries

If ensured of such prospects, nations may be willing, in the common interests of non-proliferation, to resort to the services of nuclear states or international centers for uranium enrichment, reprocessing of TR fuel, and fabrication of the first FR cores during the transition period.

---

[181] *Strategy of the Development of Nuclear Power Engineering of Russia in the First Half of the 21st Century. Basic Provisions*

This would allow more from political palliatives to radical and legal resolution of the problem of a comprehensive ban on elimination of nuclear weapons, with effective measures taken to control and suppress illegal nuclear activities by joint efforts, without nuclear or non-nuclear classification of nations.

# LEGAL ASPECTS OF NEGOTIATION, ENTRY INTO FORCE, AND IMPLEMENTATION OF INTERNATIONAL AGREEMENTS OF THE RUSSIAN FEDERATION ON COOPERATION IN THE FIELD OF PEACEFUL USE OF NUCLEAR ENERGY

Alexander A. Pikaev,
*Institute of World Economy and International Relations*

## LEGAL INSTRUMENTS THAT GOVERN RUSSIA'S PARTICIPATION IN INTERNATIONAL COOPERATION

Since the disintegration of the Soviet Union, Russia has put in place an elaborate body of law that governs its participation in international cooperation. This body of law consists of several types of documents of a constitutional and legislative nature, as well as international treaties and regulations (bylaws). It includes:

- the constitution of the Russian Federation
- federal constitutional laws
- federal laws
- international treaties and agreements subject to ratification and formatted as federal laws on ratification
- international treaties and agreements not subject to ratification
- decrees and edicts of the President of the Russian Federation
- decrees and edicts of the Government of the Russian Federation
- other bylaws and regulations adopted by the federal executive branch

According to Article 15 of the Constitution, international treaties to which Russia is a party are a part of its legal system. If an international treaty to which Russia is a party sets rules that contradict those stipulated in the Russian national law, the rules of the international treaty supersede. Per Article 71, international treaties, quite similarly to the production and use of toxic substances, fall into the purview of federal authorities. The President of the Russian Federation is in charge of the foreign policy of the country, and has the authority to conduct negotiations, sign international treaties, and oversee instruments of ratification (Article 86). The Federal Assembly (Parliament) has the authority to ratify and denounce international treaties (Article 106). These decisions are made in a bicameral fashion by both the State Duma and the Federation Council. First, the issue of ratification or denouncement has to be heard by the State

Duma, and only after the Duma comes to a decision does the process move on to a hearing in the Federation Council (Article 106).

The authority of the Russian Government in this area is spelled out in Article 21 of the Federal constitutional law "On the Government of the Russian Federation."[182] According to this Article, the Russian Government shall, "within the bounds of its authority," enter into international treaties on behalf of the Russian Federation, ensure their implementation, and monitor the compliance by other parties with commitments made in treaties signed with Russia. Additionally, the Russian Government regulates and oversees foreign economic activities and cooperation in science, technology, and culture. In other words, this law gives the Russian Government significant authority to enter into and implement international treaties, as well as regulate relevant foreign economic activities, including cooperation in the peaceful use of nuclear energy.

**Federal Law "On International Treaties [Signed by] the Russian Federation"**

The procedures for entering into, implementing, and denouncing international treaties, as well as specifics of the distribution of authority among federal entities, are stipulated in a federal law "On International Treaties [Signed by] the Russian Federation." The law was passed in the mid-1990s, when the State Duma had a leftist majority that stood in opposition to the Boris N. Yeltsin administration. This is why the document is clearly a product of compromises between the Kremlin and the lower house of the Russian Parliament. The compromises are especially evident in the way in which authority has been distributed between the executive and legislative branches of government.

During the debates that preceded this law, the State Duma was trying to prevent the executive branch from keeping any international agreements outside the legislators' field of view. Therefore, Article 1 of the document contains an exhaustive list of international agreements subject to this law. The list includes virtually all international, intergovernmental, and interagency treaties regardless of their nature and nomenclature (treaty, agreement, convention, protocol, exchanges of letters or notes, or any other kind and variety of international treaties).

Article 3 divides all international treaties into three broad categories. International treaties are concluded with foreign states and international organizations on behalf of the Russian Federation. Intergovernmental treaties are concluded on behalf of the Russian Government. Interagency treaties are concluded on behalf of [individual] agencies in the federal executive branch.

Both chambers of the Federal Assembly have the right to give federal executive agencies recommendations with respect to entry into international treaties (Article 8). At the request of the two chambers, the Russian Government provides information regarding international treaties in preparation for signature (Article 7). The Ministry of Foreign Affairs (MFA) informs the Federation Council and the State Duma about international treaties concluded on behalf of the Russian Federation and the Russian Government, as well as about termination or suspension of such treaties. Interestingly, the MFA does not have to brief the Parliament on any interagency treaties.

The law grants the MFA an important role in concluding international treaties.

[182] Federal Constitution Law of the Russian Federation from December 17, 1997, N2-FKZ – *Sobraniie zakonodatelstva Rossiiskoi Federatsii*, 1997, N. 51, p. 5712.

According to Article 9, the Ministry serves the purpose of providing [independent] recommendations regarding international treaties. In contrast, other federal executive agencies can only do that in tandem with the MFA or after receiving its concurrence. Article 32 places responsibility of overseeing the status of international treaties to which Russia is a party on the MFA.

Article 11 delineates the decision-making authority with respect to commencing negotiations and concluding agreements. The President and the Government of the Russian Federation have this authority, as far as treaties concluded on behalf of the Russian Federation. The Government of the Russian Federation has a similar mandate with respect to treaties concluded on its behalf. According to Article 12, international treaties can be signed by the President, the Chair of the Government (Prime Minister), and the Minister of Foreign Affairs. Other ministers and heads of [federal] executive agencies only have the right to conduct negotiations leading to the signing of interagency treaties. The right to conduct negotiations is also granted to heads of diplomatic missions of the Russian Federation to some countries or certain international organizations.

The law states that an international treaty can enter into force either through parliamentary ratification or other mechanisms of approval. Article 15 specifically enumerates the cases for which ratification of treaties by the Federal Assembly is mandatory. Such cases include those:

1) the execution of which requires changes in currently existing federal laws or the adoption of new federal laws; or international treaties that set rules different from those envisioned by national law
2) the subject of which has to do with basic human and civil rights and liberties
3) which deal with the demarcation of Russia's territory versus territories of other states, including treaties on the national border of the Russian Federation and delineation of Russia's exclusive economic zones and continental shelf
4) which govern the foundations of international relations or issues related to the ability of the Russian Federation to defend itself; or deal with issues of disarmament, international arms control, international peace and security; as well as peace and collective security treaties
5) those which affect the Russian Federation's participation in international alliances, international organizations or any other international entities, if such treaties transfer certain sovereign authorities to the governing bodies of these entities or make their decisions legally binding for Russia
6) those, during the conclusion of which, parties agreed upon required ratification

Ratification of treaties that lie outside the scope of the categories enumerated above is not mandatory. Such treaties may enter into force if and when the President or the Government so decide. Approval and adoption of interagency international treaties are done by federal executive agencies on behalf of which these treaties are signed (Article 20).

Between signing and ratification, the Russian Federation must abstain from actions that would defeat the treaty's object and purpose. In fact, this provision has allowed a number of important U.S.-Russian and multilateral agreements on assisting Russia in the area of non-proliferation and disarmament. For example, it made it possible to extend the basic treaty regarding the Nunn-Lugar program so that it would stay in effect, on a tentative basis, from 1999 to 2006, without submittal for ratification. Similarly, the agreement on immunities concluded with the International Science and Technology Center has never been ratified even though it was submitted for ratification in 1994. The organization has been functioning on a temporary basis ever since. All this time, it has been successful in funding research activities by Russian and other former Soviet experts in weapons of mass destruction and their means of delivery in order to prevent these individuals from moving to countries of concern in search of employment.

According to Article 32, the President and the Government 'take measures' to ensure that international treaties to which Russia is a party are in fact implemented. Federal executive agencies 'ensure' treaty compliance and monitor that other parties stay true to their commitments as well.

In Russia, regional authorities are also required to 'ensure' treaty compliance to the extent that they have a mandate to do so. In other words, a Russian region does not have the right to sabotage an international agreement reached by the federal government even if the agreement provides that a hazardous facility shall be built in that particular jurisdiction. In reality, however, there have been instances whereby regional entities were successful in disregarding Russia's international obligations despite stipulations of Article 32 of the law 'On International Treaties of the Russian Federation.' Early this decade, for example, the Udmurt Republic chose not to approve the construction of a facility for disposal of highly toxic solid rocket propellant on its territory. Similar complications are quite likely to transpire if the United States and Russia were to start implementing an agreement on peaceful use of nuclear energy: the fact of the matter is that this agreement will be associated with a number of hazardous facilities (e.g., plants for reprocessing of U.S.-origin spent nuclear fuel).

## Parliamentary Ratification Procedure

In Russia, the following international treaty ratification practice has taken root. After the signing of an international document, the Government initiates the process of interagency coordination (concurrence). The document is distributed to various ministries and agencies, which issue expert opinions regarding whether or not the ratification would make sense. They also indicate what consequences the ratification would entail from financial, economic, legal, and international standpoints. As a rule, the process is rather lengthy and complex. According to the Russian Constitution, the Office of the President (Presidential Administration) is endowed with very powerful levers of persuasion, including the right to hire and fire high-ranking government officials. This allows the President to influence, if the situation warrants, the speed and outcomes of the interagency coordination process. There have been instances, however, when the Office of the President was disinterested in expediting the process.

After the opinions of various agencies have been received – assuming they do not contain any recommendations to reject the international document – a summary finding is prepared on behalf on the entire Government of the Russian Federation. It is usually accompanied by another round of exchange of opinions among all entities with a vested interest, including the Presidential Administration. It is required that in the summary finding there be a section on what additional means may be necessary to meet the treaty obligations and what federal laws will have to be amended or supplemented to make it happen.

There have been cases when the Government provided erroneous forecasts of required additional financial expenditures or could not provide any forecasts at all because the treaty timelines and international contribution estimates were simply too vague or uncertain. This is thought to have been one of the reasons why the U.S.-Russian Plutonium Disposition Agreement of 2000 was not ratified.[183] International donors were unable to produce a set of clear proposals or determine specific numbers for assistance in this area in a timely fashion.

Even if the international treaty does not require parliamentary ratification to enter into force, interagency coordination is still mandatory.

After the final version of the summary finding has been signed by the Government, which, in effect, means that all agencies have provided their concurrence – the President signs a directive to submit the document for ratification. The directive is a very brief piece of text that states that the document is being submitted for ratification and provides the name of the official who is authorized to represent the President during the parliamentary review of the document. Usually this function is reserved for the Minister of Foreign Affairs. The summary finding by the Government is enclosed and submitted along with the presidential directive.

The presidential directive is sent by courier to the State Duma and is received at the secretariat of the Speaker's Office. The Speaker (or First Deputy Speaker acting in his or her stead) designates the committees that will be responsible for getting the document ratified. As a rule, the Committee on International Affairs plays a leading role in the process. If the document submitted to the Duma has to do with issues of disarmament or non-proliferation, the Committee on Defense and the Committee on Security are also made responsible participants. If the document has an economic dimension, it is sent to committees that oversee the industries relevant in this context.

The designated committees organize parliamentary hearings regarding the expedience of ratifying this international agreement. There may also be joint hearings convened by individual committees. The hearings can be open to the public or conducted in closed session. The latter is the format of choice if some sensitive issues are to be discussed: only officials and experts with a security clearance that allows access to secret and confidential information are invited to attend.

Upon completion of hearings, the responsible committees convene and make an official decision to either support the ratification or reject it. They also discuss possible modifications and additions to the draft of the law on ratification. During preparations for ratification, inputs regarding any such modifications or additions may come to the committees from individual members of Parliament, factions or regional jurisdictions of the Russian Federation. After discussions are complete, the individual committees compile a table listing all proposed modifications and additions and indicate whether or not they have been approved by committee members. Decisions are made by a majority vote of committee members.

Then, the draft federal law on ratification goes to review by various factions in the Parliament. Normally, this takes place several days prior to the plenary session of the State Duma at which the issue of ratification will be put to a vote. A faction can define a decision making procedure independently, but usually can make any of the following three decisions: it can support the bill collectively (all members of that particular faction must vote "yea"), it can reject the law collectively (all members of parliament [MPs] in the faction must vote "nay") or it can let its members vote individually as they see fit. Factions resort to the third option either when they are not interested in making their consolidated position on a treaty known or when there is a major split among the members. Every faction makes its own determination as to which of the three options it prefers.

Sometimes, legislators express interest toward an international treaty even before it has

[183] For further information regarding this agreement, see http://www.nti.org/db/nisprofs/russia/fissmat/plutdisp/puovervw.htm; accessed April 6, 2008.

been formally submitted for ratification. They provide informal input regarding the wording of the law on ratification. These inputs may contain additional conditions under which the treaty should enter into force or some thoughts about circumstances that could lead to the denouncement of the document.

In order to avoid tensions after the adoption of the document, an informal commission comprised of representatives of the executive and legislative branches is set up as early as during the preliminary stage of the process, when interagency concurrence process is still ongoing. Similar commissions have been set up for ratification of such important and contentious disarmament instruments as the Chemical Weapons Convention, the Strategic Arms Reduction Treaty (START II), and the Comprehensive Test Ban Treaty (CTBT).[184] During commission sessions, the text of the law on ratification is passed back and forth to make sure it is acceptable to all participants of the ratification process. First of all, this goes for the conditions and caveats associated with the treaty's entry into force, its implementation and possible denouncement. The concurred text is usually accepted by the entire State Duma with virtually no changes.

According to the procedure, plenary sessions of the State Duma dedicated to ratification of international agreements are always held on the same day of the week. For many years now, the day of choice has been Friday. During such sessions, the floor is given to the President's representative for ratification of a specific international treaty. In the most significant and complex of instances, as was the case for ratification of START II and CTBT, Duma members require that the President be present in person. After representatives of the executive branch have spoken, the bill is discussed along with a list of proposed modifications and additions. Usually, modifications and additions not approved by the select committee are rejected. The draft ratification law has to be approved by a simple majority of votes cast by the MPs listed in the State Duma roster. For the draft to pass, it has to be supported by no fewer than 226 votes out of a total of 450.

Over the last several years, the procedure for review of international treaties by the State Duma has become faster and simpler. The number of hearings has been reduced, and debates in plenary sessions, as well as within factions and committees, have turned into more of a formality. Commissions for preliminary concurrence of draft texts have become virtually extinct. With the Duma under the control of the majority, votes are now cast more as a matter of 'going through the motions.'

After the bill has been approved by the Duma, it moves on to the Federation Council. According to the Russian Constitution, the range of authority of this chamber is rather narrow. The Federation Council may not introduce any modifications to a bill once it has been approved by the State Duma. The only right the Council does have is to cast an up or down vote.

In the Federation Council, ratification of international treaties is primarily the business of the Select Committee for International Affairs. Other committees, such as the Committee for Defense and Security and some committees representing relevant industries, may, however, also participate in the discussion. Similarly to the lower chamber, responsible committees are designated by the Chair of the Federation Council.

There has been not a single case when the Federation Council has rejected a treaty related

---

[184] The text of the Chemical Weapons Convention can be found at http://www.opcw.org/html/db/cwc/eng/cwc_frameset.html; accessed May 1, 2008. The full text of the START II Treaty can be found at http://www.state.gov/www/global/arms/starthtm/start2/stiitoc.html#TREATYTOC; accessed April 8, 2008. The text of the Comprehensive Test Ban Treaty can be found at http://www.ctbto.org/; accessed April 6, 2008.

to non-proliferation or disarmament. According to Russian laws, if the Council rejects a bill, a joint bicameral conciliatory commission shall be set up to produce a version acceptable to both chambers. Also, the State Duma has the right to override the Federation Council's veto by two thirds of the votes (300 out of a total of 450).

After both chambers have approved the bill, it goes to the President for signature. Since there has never been an instance of non-participation by the Office of the President in the process of preliminary coordination of the treaty, usually the Kremlin does not have any grounds to throw the bill out.

According to Article 24 of federal law 'On International Treaties Signed by the Russian Federation,' official announcements regarding Russia's joining an international treaty concluded on behalf of the Russian Federation or the Russian Government are published in the press.

## MECHANICS OF CONCLUDING, ENTERING INTO FORCE, AND IMPLEMENTING AN AGREEMENT BETWEEN RUSSIA AND THE UNITED STATES ON PEACEFUL USE OF NUCLEAR ENERGY

An agreement between Russia and the United States on peaceful use of nuclear energy[185] must comply with provisions of Article 1 of the law 'On International Treaties of the Russian Federation.' According to the law 'On the Government of the Russian Federation,' the conclusion and implementation of treaties fall into the purview of the Russian Government. It therefore follows that, pursuant to Article 3 of the federal law 'On International Treaties of the Russian Federation,' this agreement may be intergovernmental or even interagency in nature. This means that, per Article 15, it can be negotiated by the head of the federal executive entity with expertise related to this agreement or by the Russian Ambassador to the United States. At the time of writing this article the relevant stakeholder in the federal government was the Federal Agency for Atomic Energy known as Rosatom and headed by Sergei Kirienko. In the event that this document should be given the status of an intergovernmental agreement, it shall have to be signed by the Russian Prime Minister (currently, Victor Zubkov). Alternatively, if the agreement preserves its interagency status, Mr. Kirienko's signature will suffice.

In theory, Article 15 of the federal law 'On International Treaties of the Russian Federation,' permits the non-ratification of intergovernmental and interagency agreements unless they have a specific clause on mandatory ratification. If there is no such clause, the agreement may enter into force after it is approved by the Prime Minister or the head of Rosatom. Having said this, Article 15 contains a long list of cases in which parliamentary ratification is mandatory. It has been said that the legislators insisted on including this list into Article 15 so that the executive branch could not waive ratification by saying that an international agreement was not an international one.

[185] The 123 Agreement refers to Section 123 of the U.S. Atomic Energy Act of 1954, which requires a bilateral agreement between the United States and any country wishing to receive U.S. exports of technology and equipment related to civilian nuclear energy. The U.S. Atomic Energy Act of 1954, can be found at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf; accessed April 8, 2008. The 123 Agreement was signed May 6, 2008, in Moscow and submitted for ratification. For further information, see *Vestnik Atomproma*, N. 5, May 2008. See also the papers by Orde F. Kittrie and Alexander Pikaev in this volume and Appendix E for the text of the U.S.-Russian 123 Agreement.

The nuclear energy industry happens to rely on one of the most sensitive technologies. As such, it occupies a prominent place in the ranking of national security-related priorities. Therefore, the agreement in question may very well be put into one of the categories specifically enumerated in this Article. These categories are:

- ability of the Russian Federation to defend itself
- disarmament or international arms control
- ensuring international peace and security

This means that Russian law does not permit the unequivocally conclusion that this agreement will not require ratification by the State Duma and the Federation Council. However, the option of ratification comes with a whole host of legal and political caveats. The federal law 'On International Treaties of the Russian Federation' does not spell out a procedure according to which the Parliament could compel the executive branch to submit a treaty for ratification if the executive branch does not want to do it. According to Article 7 of the law, the Parliament is only authorized to ask the Russian Government and Ministry of Foreign Affairs to provide information with respect to new international treaties. It is not authorized to demand a mandatory submittal of these treaties for ratification.

Under present political conditions, the probability of having the Parliament demand that an interagency or intergovernmental agreement be submitted for ratification – unless the executive branch decides to do so of its own volition – is very low. The executive branch enjoys the support of a parliamentary majority, and the legislators are hardly inclined to get into a fight with the executive branch over this issue. At the same time, however, after the December 2007 parliamentary and March 2008 presidential elections in Russia, a different configuration may emerge in Russian domestic politics. If this happens, there may not be an ironclad guarantee that the Parliament will not seek to strengthen its institutional stance and attempt to get a seat at the table when it comes to deciding on how international agreements should enter into force.

Practical implementation of international cooperation in the field of nuclear energy is subject to Russian national law. Following a U.S.-Russian agreement on peaceful use of nuclear energy, this cooperation may expand. In the event that modifications or additions in existing federal laws may be required as a result of this agreement, Article 15 of law 'On International Treaties of the Russian Federation' will apply. The Article states in no uncertain terms that the international treaty must be ratified.

### The Federal Law 'On the Use of Nuclear Energy'

The federal law that governs activities in the field of nuclear energy was passed in 1995. It is entitled 'On the Use of Nuclear Energy.' This document regulates the relationship that exists between peaceful and military uses of nuclear energy. The law specifically limits its jurisdiction by excluding all activities associated with nuclear weapons and military-purpose nuclear power units (Article 1).

According to Article 9, issues of nuclear exports and imports, including importation of spent nuclear fuel, are deferred to the Government of the Russian Federation. These export and import activities are conducted on the basis of Russia's international nuclear non-proliferation commitments as well as Russia's international treaties in the field of nuclear energy use. Rules regarding importation of spent nuclear fuel are stipulated in Russian national law and in international treaties.

The treaty reflects a serious opposition toward the idea of Russia's importing foreign spent nuclear fuel, but underscores the [nuclear] industry's interest in such a proposition. Article 65 contains quite an unusual norm: it states that if an international treaty to which Russia is a party sets rules that are different from those stipulated in the [national] law, the international treaty takes precedence. In other words, this Article establishes absolute priority of the international treaty over the national federal law.

While Article 65 reflects the interests of the [nuclear] industry, Article 64 contains a series of measures intended to neutralize environmentalists' concerns with respect to importation of irradiated nuclear fuel. Per Article 64, importation of irradiated fuel assemblies of foreign origin may be done only with the concurrence of a Special Commission appointed by the Russian President. The Commission is comprised of a chair and 20 commissioners: the Office of the President, Federation Council, State Duma, and the Russian Government each provide five representatives. The procedure for proposing candidates from the Federation Council and State Duma is left to the discretion of the appropriate chamber of the Parliament. The Special Commission presents to the President and to both chambers of the Parliament annual reports detailing the state of affairs with respect to importation into Russia of irradiated fuel assemblies of foreign origin.

As far as the author knows, this part of the federal law 'On the Use of Nuclear Energy' is partially working. On the one hand, the Special Commission has been formed and is headed by Academician Nikolai P. Laverov. On the other hand, no information is available on the situation when this Commission decided to reject the importation of irradiated nuclear fuel. To some extent, this is happening because the Parliament is more interested in strengthening its bureaucratic positions through the Commission's activities. Another reason is that the Commission really cannot make any actual decisions with respect to spent nuclear fuel importation: a decision to reject it would be in contravention of an international treaty and would automatically invoke Article 65, giving absolute priority to international legal instruments.

Therefore, no international agreement regarding nuclear energy cooperation requires any modifications or additions to the law under discussion. Hence, the invocation of Article 15 of the law 'On International Treaties of the Russian Federation' with its parliamentary ratification provision is legally indefensible. At the same time, the prospect of changes in the political environment after the 2007 parliamentary and 2008 presidential elections may push legislators to invoke the 'Commission Provision' of the 1995 law. So, too, may the possibility of a considerable expansion of importation of spent nuclear fuel pending the signing of a U.S.-Russian agreement regarding cooperation in the field of peaceful nuclear energy. It could conceivably perform functions consistent with Article 65 such as preparing annual reports regarding importation of reprocessed fuel or providing an advisory opinion regarding each individual instance of such imports. Under certain circumstances, it is conceivable that the Article 65 provision regarding absolute priority of international treaties could be repealed. If this happens, the Commission would become the guardian of decision-making authority regarding every single international transaction in this field.

As a result of the U.S.-Russian agreement under discussion, export of nuclear materials and technologies will expand. However, it will remain subject to the 1999 federal law 'On Export Control,' as well as to a whole series of presidential decrees and government resolutions. This national legal regime was created in order to curb the leaks of sensitive materials and technologies which could conceivably inflict damage on the interests of the Russian Federation or undermine its international commitments, including those in the field of non-proliferation of nuclear weapons.

The export control regime per se is quite flexible. It makes it possible for federal executive agencies to either prohibit or allow export of materials and technologies subject to export restrictions. At the same time, this regime requires that decisions governing exports of nuclear goods and services, including those going to the United States, be made on a case-by-case basis. This may slow on the implementation of certain specific transactions or even cancel them altogether.

# PROSPECTS FOR RUSSIA-U.S. COOPERATION IN THE AREA OF NUCLEAR NON-PROLIFERATION IN THE CONTEXT OF PROBLEMS ARISING FROM A NUCLEAR POWER RENAISSANCE

Evgeny N. Avrorin,
*All-Russian Scientific Research Institute of Technical Physics*

Recent years have demonstrated global changes in attitudes toward nuclear power. Russia and the United States put forward important initiatives concerning global nuclear power development (International Project on Innovative Nuclear Reactors and Fuel Cycles, Generation IV International Forum [GIF], Global Nuclear Energy Partnership) and started the deployment of their national programs.[186] The south-east Asian nations (first of all, China and India) declared ambitious plans concerning their construction of nuclear power plants. Latin American countries also show reviving interest in nuclear power.

In addition to quantitative changes, we expect almost all nuclear power technologies to be fundamentally revised. An extremely important step here is lifting the ban on the use of the closed nuclear fuel cycle in the United States, which will open possibilities for shifting to fast neutron reactors with full utilization of uranium resources in the future.[187] Under consideration are reactors of different types (for example, six types of reactors are proposed for consideration in the GIF) as well as advanced spent nuclear fuel technologies. Effective technologies for radioactive waste immobilization and disposal will also be needed.

Great changes have also occurred in the international situation, specifically in relation to nuclear power and non-proliferation. We have de facto horizontal proliferation and have to reckon with not only the possibility of proliferation on the national level, but also the peril of a terrorist group acquiring or developing nuclear weapons.

At the same time we see tendencies for a weakening of international law: the U.S. withdrawal from the ballistic missile defense treaty, U.S. policy to deny new verification agreements, North Korea's withdrawal from the Treaty on Non-Proliferation of Nuclear

---

[186] For further information regarding International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), see http://www.iaea.org/OurWork/ST/NE/NENP/NPTDS/Projects/INPRO/index.html; accessed May 1, 2008. For further information regarding Generation IV International Forum (GIF), see http://gif.inel.gov/; accessed May 1, 2008. For further information regarding the U.S. Global Nuclear Energy Partnership, see http://nuclear.inl.gov/gnep/index.shtml; accessed April 6, 2008.

[187] The Russian Corporation TVEL notes that "(t)he closed nuclear cycle envisages transportation of irradiated fuel assemblies to radiochemical plants to extract unburned uranium rather than transportation to disposal site. Recoverable uranium could amount up to 95 percent of initial uranium mass. Then, this material is subject to same processing stages as the one mined." Presently the majority of countries use an open fuel cycle. For more information, see http://www.tvel.ru/en/nuclear_power/nuclear_fuel_cycle/; accessed April 6, 2008.

Weapons (NPT), Russia's threat to withdraw from the Treaty on Intermediate-Range Nuclear Forces and the Treaty on Conventional Armed Forces in Europe, and an application of sanctions (including military) outside of the United Nations Security Council.[188]

Double standard policies are practiced more and more widely: the development of nuclear weapons by Pakistan and India and reasonable suspicion that Israel was developing nuclear weapons did not cause any serious sanctions compared with those applied to Iraq or those which may be applied to North Korea or Iran. Some countries develop nuclear technologies including uranium enrichment without hindrance, while other countries are refused these technologies.

Nuclear weapons may be attractive for many countries as a guarantee of their national security and higher status. Not even an absolutely reliable (or fully successful) test of nuclear weapons revived negotiations with North Korea. Nuclear weapons development by a country may turn it into a rogue state, causing international condemnation and sanctions, including military (Iraq, Iran, North Korea), but the authority and status of that country enhance once it has acquired nuclear weapons. The nuclear-haves maintain their nuclear stockpiles as a safeguard of their security and sovereignty, but they deny other countries the right of this safeguard. A mechanism of compensation to the countries that refuse nuclear weapons is still to be devised.

The nuclear "haves" did not pay considerable attention to protecting information on scientific principles and basic technologies required for nuclear weapons development. Many irresponsible publications made this information public. The unconstrained freedom of speech and freedom of information in this area degenerates into danger to all humanity.

Also the illegal market of nuclear material and technology constitutes a real danger. In some cases commercial and political interests interpreted unilaterally have facilitated proliferation. In this regard the attempt to punish the buyer (Iran) rather than the seller (Pakistan) for illegal export of the enrichment technology seems very odd.

In the realm of non-proliferation, as perhaps in no other realm, myths proliferate.

Nuclear power is often thought to be a key (and even unique) source of proliferation. But we forget that the first atomic bombs were built on either side of the ocean long before nuclear power came into being. Nuclear power seems to be the most expensive and irrational way to nuclear weapons. Suffice it to say that in order to manufacture a nuclear charge similar to that used in the bomb dropped on Hiroshima, one would need about 2-3 percent of the initial raw material natural uranium, and about 3-4 percent of the enrichment work required for the start of a nuclear power plant of the Buesher type.

Under the veil of non-proliferation it is required that accumulated plutonium (especially weapons useable Pu) should be disposed of as soon as possible. But already in the next decades plutonium will be needed to start fast neutron reactors. To burn (and burn ineffectively) plutonium as MOX-fuel in thermal reactors means to rob our future generations. The general path of nuclear power development is to change over to fast neutron reactors with the closed fuel cycle and breeding, but some nuclear countries (first and foremost, the United States) propose that countries not develop nuclear power in this way, a way that could increase nuclear fuel resources hundreds of times.

[188] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008. To read the text of the INF Treaty, see http://www.state.gov/www/global/arms/treaties/inf2.html; accessed April 6, 2008. To read the text of the Treaty on the Conventional Forces in Europe, see http://www.state.gov/t/ac/trt/4781.htm; accessed April 6, 2008.

The maintenance of the non-proliferation regime is hampered by objective or artificial contradictions. The non-proliferation regime includes different aspects:

- political (treaties, agreements, sanctions)
- economic (fuel price, verification and security costs)
- technological (proliferation resistance)
- control (verification and inspection)

None of these aspects alone can ensure non-proliferation. It would be naïve to believe that, for example, some technology can guarantee non-proliferation and rule out the threat of nuclear terrorism.[189] However the successive phase-out of the most hazardous technologies would certainly facilitate non-proliferation.

Uranium enrichment to weapons grade is the most hazardous technology. Most of the separation work is spent on the enrichment of natural uranium to the power reactor grade. Further enrichment to the weapons grade does not require modifications in technology or equipment and does not radically increase the costs. The cost of source uranium is small compared to the total cost of weapons development and it is therefore possible to use uranium from low-grade or alternative (even seawater) deposits. The complex needed to obtain weapons-grade uranium for a limited number of nuclear devices does not require enormous construction and can be arranged secretly. Weapons-grade plutonium can be obtained by replacing a number of standard fuel assemblies in a power reactor, by assemblies with natural or depleted uranium, or by extracting plutonium from fuel with the limited exposure period. It would seem wise to give more care to the proposals that could help rule out or at least strongly restrict the use of uranium enrichment and back-end technologies in the future (BREST type reactors, molten-salt reactors). Unfortunately the bounds between military and civil technologies are seen to be only quantitative, not qualitative. They can easily be overstepped if verification measures are disabled.

For terrorist groups interested in nuclear weapons, the transportation of the fresh and spent nuclear fuel of power reactors may become the most attractive stage of the nuclear fuel cycle. It is comparatively easy to finish the former and to extract plutonium from the latter. Transportation is much more difficult to secure than stationary objects. Recently the feasibility of using medium- and low-power reactors to supply small countries or hard-to-reach regions with energy has been widely discussed. Such stations may be very attractive to nuclear terrorists. Radioactivity which would accumulate with time due to operation would protect these stations against intrusion and theft, but during the start-up period this barrier would be absent.

Why do countries developing nuclear power aim to have a complete nuclear fuel cycle? There are both political and economic reasons. What attracts them is the independence of nuclear fuel supplies and the possibility to fabricate fuel at a price that would be lower than that in the highly-monopolized world market. A complete domestic cycle is estimated to become economic from a total nuclear power of 20 gigawatts, and changes in the cost of natural uranium and fuel cycle improvements may reduce this threshold. Some countries are certainly interested

---

[189] The threat from low-enriched uranium (LEU) or spent nuclear fuel (SNF) usage can not be eliminated by simple organizational means. International Atomic Energy Agency (IAEA) control is not an absolute barrier although it hinders illegal LEU and SNF usage. Significant efforts by countries with nuclear power industries as well as those of the world community are required to eliminate these threats.

in retaining the possibility of using nuclear fuel technology for nuclear weapons development, if necessary.

## WHAT MEASURES CAN BE APPLIED TO REDUCE THE RISK OF PROLIFERATION?

If we speak about proliferation at the level of states, it is first necessary to eliminate or, at least, weaken incentives to have nuclear weapons. It is necessary to enhance international respect for the sovereignty of any state regardless of its government. Diligent work to reduce threats to all threshold countries and to develop international safeguards against any aggression may eventually eliminate interest in nuclear weapons.

What may greatly help strengthen the non-proliferation regime is progress in nuclear disarmament (as provided by the NPT).

It is necessary to develop a nuclear power plant (NPP) and nuclear fuel market that would be open to all countries without political discrimination.

The improvement of International Atomic Energy Agency (IAEA) safeguards must produce a generally recognized, all-embracing list of verification and protection measures required for nuclear power development. The costs of these measures must not be a liability of countries developing nuclear power. These non-proliferation measures must be taken either by the international community (for example, through the IAEA), or by nuclear powers most interested in non-proliferation.

Encouraging countries to refuse proliferation hazardous technologies requires the development of a system of material considerations.

The Global Nuclear Energy Partnership and, in a less explicit form, the international nuclear fuel cycle, proposes that countries be categorized into two groups.

1) Exporting countries are those with all nuclear technologies, including those which are a proliferation danger. These countries are to guarantee a free market of NPP equipment and nuclear fuel. It would seem that these countries must undertake obligations to guarantee the sovereignty and security of all countries and to defray the cost of non-proliferation measures. These countries should also build fast neutron reactors to transmute long-lived isotopes and to produce fuel for thermal reactors as resources of cheap uranium are exhausted.
2) Importing countries are those which voluntarily refuse hazardous technologies, but have free access to purchase or lease NPP equipment and nuclear fuel. By way of compensation for their refusal of hazardous technologies, they must be given international guarantees of sovereignty and security, as well as internationally assured supplies of nuclear fuel (a free market in fuel, IAEA reserve, etc.). Fuel could possibly be supplied at preferential prices. However, it may be considered sufficient compensation if exporting countries take obligations to receive and recycle spent nuclear fuel and take waste for long-term storage (possibly after transmutation), and require no payment for verification and protection measures.

Pluses and minuses of categorizing countries into two groups include:

- (+) a reduced risk of hazardous technology proliferation
- (+) a path toward civilized NPP and nuclear fuel markets
- (-) enhanced discrimination between countries
- (-) the need for effective verification and protection measures
- (-) increased nuclear material transportation (vulnerable to terrorists)
- (-) such a division will only be effective for a limited time because traditional thermal-neutron NPPs are to be replaced by fast-neutron ones as technology improves and resources of cheap uranium are exhausted

So these proposals cannot radically resolve the problem of proliferation.

It would seem that the risk of proliferation can be eliminated only if the international mentality gradually changed. The policy of using a 'stick,' such as suspicions, threats, and, sanctions must be ruled out of international practice. Instead we must turn to the policy of using 'carrots,' such as assistance in the development of nuclear power, the establishment of and payment for verification measures, and material considerations for refusal of hazardous technologies.

Placing hope on such an improvement of the international climate would possibly seem too optimistic, but this is apparently the only way to bring the non-proliferation dead-lock to an end. In this way it would be possible to start departing from national nuclear power systems to a completely international one (such as Dwight Eisenhower's Atoms for Peace Concept). Most of the non-proliferation measures proposed require concerted (or, still better, joint) actions by nuclear powers, the first by the United States and Russia. These actions need to be implemented at different levels including:

- intergovernmental
- lab-to-lab
- bilateral expert groups
- scientific exchanges
- International Science and Technology Center projects
- joint participation in IAEA inspections and other verification measures

Competition in the market for nuclear technology and equipment must proceed within the framework of unified non-proliferation standards, including criteria to identify hazardous technologies, requirements for exported reactors, an all-embracing list of verification and protection measures for importing countries, nuclear fuel supply conditions, the status of international enrichment and recycle centers, and the status of a nuclear fuel reserve. The United States and Russia could initiate the development of such standards.

Joint scientific and technological developments could be of great help for the development of advanced nuclear power technologies. These include:

- innovative, higher proliferation resistant reactor projects
- innovative nuclear fuel cycle technologies (especially for international nuclear fuel cycle centers)
- developments and improvements in methods for mathematical modeling of nuclear reactors and the nuclear fuel cycle

- methods to quantitatively assess proliferation risks for various nuclear power options
- improvement of technical means for nuclear materials protection, control, and accounting
- long-lived product transmutation methods
- radioactive waste immobilization and disposal methods

One of the most important tasks in the cooperation is skill formation, including joint development of programs to train nuclear power specialists, development of training aids, and the exchange of students and postgraduates.

# CREATIVE SOLUTIONS TO TOMORROW'S CHALLENGES: OPPORTUNITIES FOR BI-LATERAL AND MULTI-LATERAL COOPERATION

# NUCLEAR TERRORISM THREATS AND RESPONSES

Cristina Hansell,
*James Martin Center for Non-proliferation Studies,*
*Monterey Institute of International Studies*

Concerns about nuclear terrorism have risen substantially over the past five years. However, while world leaders have consistently mentioned these concerns both at home and in international fora, there appears to be no common understanding of "nuclear terrorism"—the term is applied to threats ranging from sabotage of a nuclear facility that may or may not result in a release of radiation, to use of a radiological dispersal device, to use of a true nuclear device (producing explosive energy through nuclear fission reactions). This paper begins with a brief overview of U.S. and Russian statements related to the threat of nuclear terrorism, in order to show that the understanding of this threat diverges. It then focuses on expert assessments of the possibility of non-state actors constructing a nuclear device. Finally, it turns to current actions that address this latter threat, and what remains to be done today, as well as the possible changes in this threat in future years.

## OFFICIAL VIEWS OF NUCLEAR TERRORISM IN THE UNITED STATES AND RUSSIA

Official U.S. statements tend to refer to "Weapons of Mass Destruction (WMD) terrorism," without clearly breaking down the risks of each type of threat. As far as nuclear terrorism is concerned, official statements mainly focus on the threat of terrorist use of a radiological dispersal device or of an improvised nuclear device,[190] with the former seen as more likely. Sabotage of nuclear facilities is mentioned less often. The unclassified version of the most recent *U.S. National Intelligence Estimate* (July 2007) indicates that al-Qa'ida will remain the most serious threat to the United States and that the group will continue attempts to acquire and deploy unconventional weapons: "We assess that al-Qa'ida will continue to try to acquire and employ chemical, biological, radiological, or nuclear material in attacks and would not hesitate to use them if it develops what it deems is sufficient capability."[191] This general

[190] The definition of an "improvised nuclear device" used by the U.S. Department of Energy is: "a device, incorporating fissile materials, designed or constructed outside of an official Government agency and which has, appears to have, or is claimed to have the capability to produce a nuclear explosion." DOE Order 457.1, approved February 7, 2006, available at http://www.directives.doe.gov/pdfs/doe/doetext/neword/457/o4571.pdf; accessed May 1, 2008.

[191] *National Intelligence Estimate: The Terrorist Threat to the U.S. Homeland,* available at http://dni.gov/press_releases/20070717_release.pdf; accessed May 1, 2008.

assessment, including nuclear, chemical, and biological weapons, and radiological threats together (though possibly not including sabotage) is echoed in the October 2007 *National Strategy for Homeland Security*,[192] while the September 2006 *National Strategy for Combating Terrorism* calls for "deny[ing] terrorists access to the materials, expertise, and other enabling capabilities required to develop WMD," mentioning in particular weapons-usable fissile materials—a fact that points to construction of a nuclear explosive, not a radiological device, as the greatest concern.[193]

Like in the United States, there is a great deal of official concern in Russia about the possibility of nuclear terrorism. However, over the past few years the threat of sabotage to nuclear facilities and radiological terrorism appears to have been seen as more of a threat than that of a nuclear device, in contrast to the U.S. view. For example, Russia's 2006 White Paper on non-proliferation states that "although the probability of independent production of nuclear explosive devices by terrorists is low, given its technical complexity, it is possible that terrorists might develop primitive weapons using radioactive materials (so-called 'dirty bombs')."[194] Further, the White Paper explains that the International Convention for the Suppression of Acts of Nuclear Terrorism—a Russian initiative—is "designed to ensure the protection of both civilian and military nuclear facilities against terrorists."[195]

It should be noted, however, that neither Russia nor the United States are a monolith. Stances on the threat vary from agency to agency and official to official. This naturally affects views of what must be done to alleviate the threat. In order to better understand the expert opinions that are informing policymaker stances, I now turn to assessments of the possibility of non-state actors constructing a nuclear device.

## CONSTRUCTION OF AN IMPROVISED NUCLEAR DEVICE BY NON-STATE ACTORS: EXPERT ASSESSMENTS

Although no serious terrorist attempts to construct an improvised nuclear device (IND) have yet been uncovered, terrorism experts cite increasing indications of terrorist groups desiring to create and use such devices.[196] This is a distinct change from a decade ago, when there appeared to be little demand for such a capability, making the technical possibility of creating such a device a moot question.[197] Today, however, a very few groups, generally associated with

---

192 *National Strategy for Homeland Security*, available at http://www.whitehouse.gov/infocus/homeland/nshs/2007/index.html, accessed May 1, 2008.

193 *National Strategy for Combating Terrorism*, available at http://www.whitehouse.gov/nsc/nsct/2006/sectionV.html.

194 *The Russian Federation and Nonproliferation of Weapons of Mass Destruction and Delivery Systems: Threats, Assessments, Problems and Solutions*, English translation by Cristina Chuen, available at http://cns.miis.edu/pubs/other/rusfed.htm; accessed May 1, 2008.

195 Ibid.

196 For a brief history of terrorist attacks and insightful assessment of terrorist trends, predicting that terrorist groups are more likely to seek weapons of mass destruction (WMD) in the future than they were in the past, see Richard Falkenrath, "Confronting Nuclear, Biological, and Chemical Terrorism," *Survival*, V. 40, N. 3, Autumn 1998, pp. 42-65.

197 For an interesting overview of early al-Qa'ida efforts in the nuclear sphere, see David Albright, "Al Qaeda's Nuclear Program: Through the Window of Seized Documents," available at http://www.nautilus.org/archives/fora/Special-Policy-Forum/47_Albright.html; accessed May 1, 2008.

al-Qa'ida, have voiced this desire, though it is not clear how determined they have been at acquiring the capability. The trends are not encouraging, however: terrorists appear to be seeking ever-increasing levels of destruction in order to increase the impact of each new attack. In addition, increasing ties have been observed between these groups and elements in states that might be able to help the terrorists achieve their goals. Even without state assistance, U.S. nuclear weapons experts agree that some terrorist groups would be technically capable of constructing a primitive nuclear device, if they were able to obtain the necessary fissile materials. Former director of Los Alamos National Laboratory, Siegfried Hecker, has noted that some Russian weapons experts agree that from a technical point of view the construction of the simplest type of first-generation nuclear device is within the capabilities of certain non-state actors.[198]

In examining the steps for terrorist acquisition of such a device, experts from the U.S. Department of Energy (DOE) have noted that the key difficulty facing such an endeavor is obtaining "access to *special nuclear material"* – highly enriched uranium (HEU) or plutonium.[199] The Department of Homeland Security (DHS) has stated that its experts do not believe that terrorists can enrich uranium or breed plutonium. Therefore, DHS avers that the only way a terrorist could access this material is by theft from a fuel cycle facility, purchase on the black market, or transfer from a state sponsor.[200] An additional possible pathway to obtain HEU suggested by a Russian study is the re-enrichment of low-enriched uranium. While this runs contrary to the U.S. view that terrorists do not have access to enrichment technology, re-enrichment might be a risk if non-state actors receive assistance from someone with access to a state program. The Kurchatov Institute study of the risks of the proliferation of various nuclear materials concluded that the risks posed by low-enriched uranium (LEU) exceeded those of HEU by a factor of 39.[201] While the underlying assumptions behind this estimate are not made public, it appears that they were assuming that those stealing the nuclear materials had access to enrichment capabilities. It is probable that the study was focusing on proliferation to state actors, not terrorists. While even states have had difficulty creating enrichment capabilities, they clearly have a better chance of doing so than non-state actors at present.

A gun-type device is easier to construct than a nuclear implosive device.[202] Since a gun-type bomb that employed HEU would have a yield of 10-15 kilotons, while a similar plutonium-based gun-type device would result in a "fizzle yield" of 10-20 tons, preventing terrorist

---

198 Siegfried Hecker, comment made during his presentation of "Toward a comprehensive safeguards system: Keeping fissile materials out of the terrorists' hands." Pir Center Conference on G8 Global Security Agenda: Challenges and Interests Toward the St. Petersburg Summit, Moscow, April 22, 2006.

199 See K. Todd Wilber (National Nuclear Security Administration Office of Emergency Response), "Overview of Radiological/Nuclear Devices and Response," available at http://www.nlectc.org/training/nij2003/Wilber1.pdf; accessed May 1, 2008.

200 "Nuclear Smuggling," Department of Homeland Security Nuclear Assessment Program, available at http://www.exportcontrol.org/library/conferences/1379/005_Proliferation_Threat_Brief-Nuclear_Smuggling_-_Zachary_K.pdf; accessed May 1, 2008.

201 See Nikolai Ponomarev-Stepnoi, "Stsenarii razvitiia atomnoi energetiki Rossii v XXI veke" (Scenarios for the Development of Atomic Energy in Russia in the 21st Century), *Biulleten' po atomnoi energii*, December 2001, p. 7.

202 This view is widely held by U.S. experts. Sergey Pertsev, Head of the 12th Central Scientific Research Institute of the Russian Defense Ministry has agreed with this view; conversation with author, October 4, 2007, Moscow. It should be noted that a crude gun-type device would not likely result in an efficient use of the nuclear material, but would create a nuclear yield.

acquisition of this material is particularly critical.[203] Unless technological advances, which are not currently foreseen, should put enrichment capabilities within the reach of non-state actors, this implies securing HEU should be the top priority. The other aspects of constructing a nuclear device—the design and engineering aspects—despite their complexity, can be solved by sophisticated terrorist groups. The Department Homeland Security notes that information on gun-type and implosion-type designs is publicly available, though misinformation is as well.

While enriching uranium is very difficult, both from a technical and—especially—from an engineering standpoint, U.S. experts do not view transforming civilian-use HEU materials into the metal needed for an IND as overly difficult, given adequate knowledge of chemical metallurgy (post-graduate chemistry studies appear to be viewed as sufficient). Further, other than the uranium material itself, additional necessary materials are fairly readily available. As one Argonne scientist put it, "it's only a matter of chemistry and time."[204] In the civilian sphere, HEU is used both as research reactor fuel and as targets for medical isotope production. In the case of the latter, the U235 content in irradiated targets is typically still above 90 percent, due to their relatively low burn up, while the spent target material can be contact handled after a fairly short period of time due to the minimal amount of long-lived fission products in this material. A recent study indicated that after three years of storage, the dose a terrorist would receive from handling the material would be just 13-37 mrem/hour per gram (depending on the processing), while 5-8 million mrem are required to cause immediate disorientation.[205] (It should be noted that it would not be necessary to handle more than 25 grams or so at a time, and after processing the material would be even less radioactive.)

While U.S. experts concur with their Russian counterparts in the assessment that the risk of a radiological attack is far greater than that of the use of an IND, the consequences of an IND are so much greater that this latter risk remains an important U.S. concern. It is not clear whether the Russian view of this risk is different, or whether it is risk tolerance in Russia that is actually the driver behind the different level of concern focused at this threat. Nor have U.S. experts ignored the possibility of sabotage of a nuclear facility. The DHS Nuclear Assessment Program concerns include reactor attacks, as well as illegal dumping and scams, noting that scams too can pose health and safety risks, as well as waste and/or divert time and effort from more significant threats or enlarge search areas.[206] However, DHS concludes that radiological devices would create panic, but are not weapons of mass *destruction*, while it views a nuclear attack as "a real possibility," noting that "there are no insurmountable technical barriers to designing and building an IND."[207]

[203] Stanislav Rodionov, "Could Terrorists Produce Low-Yield Nuclear Weapons?" *High-Impact Terrorism: Proceedings of a Russian-American Workshop* (Washington, DC: National Academy Press, 2002), pp. 156-159.
[204] Interview of Argonne National Laboratory nuclear fuel specialist by author, April 2007.
[205] George Vandegrift and Edward Fei, "Mo-99 Production Using LEU," presented at the Institute of Nuclear Materials Management Annual Meeting, Tucson, Arizona, July 2007.
[206] Ibid.
[207] Ibid.

## CURRENT ACTIONS TO REDUCE THE IMPROVISED NUCLEAR DEVICE THREAT

The U.S. and Russian governments are both party to a variety of international agreements that address the threat of nuclear terrorism, several of which are or could be used to reduce the threat of terrorist acquisition of an IND. In addition, both countries have improved physical security of nuclear sites, though more could be done. The United States has also committed to the minimization of the use of HEU in the civilian sector, promising to convert all civilian research reactors to LEU by 2014, while Russia has been involved in converting Soviet-supplied research reactors abroad and repatriating Soviet-supplied HEU (though there is no similar program in Russia to convert reactors and consolidate and secure HEU).

One of the first international actions came at the Moscow Nuclear Safety and Security Summit in 1996, when a program was announced "on preventing and combating illicit trafficking in nuclear material to ensure increased cooperation among our governments in all aspects of prevention, detection, exchange of information, investigation and prosecution in cases of illicit nuclear trafficking."[208] There have been many additional agreements since, which have publicly committed Russia and the United States to sharing intelligence on illicit trafficking incidents.[209] However, the exchange of information in cases involving nuclear and radiological materials remains inadequate, both bilaterally and with international organizations such as the International Atomic Energy Agency (IAEA).

The International Convention for the Suppression of Acts of Nuclear Terrorism,[210] sponsored by Russia, is another tool that could be used to reduce IND risks. In its explanatory note on the draft convention, Russia noted that the 1980 Convention on the Physical Protection of Nuclear Material had substantial gaps when it came to countering acts of nuclear terrorism, both at the stage of stopping the terrorist act and in eliminating its consequences. The nuclear terrorism convention requires parties to take all practible measures to prevent and counter preparations for nuclear terrorist attacks, though these are neither defined nor prioritized.[211]

Another recent initiative that may prove useful is the Global Initiative to Combat Nuclear Terrorism, proposed by Presidents George W. Bush and Vladimir V. Putin in July 2006. In the Joint Statement made at the June 2007 meeting on the initiative in Astana, they stated key priorities included "preventing the availability of nuclear material to terrorists; minimizing the use of highly enriched uranium and plutonium in civilian facilities and activities; [and] strengthening our response capabilities to minimize the impact of any nuclear terrorism

[208] Moscow Nuclear Safety and Security Summit, further information available at http://www.g7.utoronto.ca/summit/1996moscow/declaration.html; accessed May 1, 2008.

[209] In addition to joint statements, treaties, and commitments to international organizations such as the IAEA, the two countries established a Counterterrorism Working Group in 2000, one of the goals of which is to improve intelligence sharing.

[210] The convention entered into force on July 7, 2007, and has been ratified by Russia but not yet by any other nuclear weapons state. The text of the Convention can be found at http://www.un.int/usa/a-59-766.pdf; and http://www.un.org/Pubs/chronicle/2007/webArticles/072407_nuclear_terrorism.htm; accessed May 1, 2008.

[211] It should be noted that the Convention does not include a definition of terrorism, though it does indicate that sabotage of a nuclear facility, as well as the use of INDs or radiological devices are all considered nuclear terrorism. For further information on the Convention, see "International Convention for the Suppression of Acts of Nuclear Terrorism," *Inventory*, available at http://cns.miis.edu/pubs/inven/pdfs/nucterr.pdf; accessed May 1, 2008.

attack."[212] It should be pointed out, however, that the language on minimizing the use of HEU and plutonium was apparently proposed by DOE officials in the division working on reactor conversion and spent nuclear fuel return, and does not seem to have been vetted by those in either the United States or Russia that are concerned with future nuclear power plants. If they were, there would likely have been objections to including plutonium minimization. Nor is it clear that this statement can be taken as official Russian acceptance of a need to reduce HEU use, at least domestically.

The international agreements noted above are just a few examples of the agreements, joint statements, and other international initiatives that exist in this sphere. However, it is not clear how the international agreements interact, thus gaps or overlaps are possible. Further, not enough has been done to implement the agreements domestically. Russia has improved its national legislation related to controlling nuclear energy, export controls, and other related areas dramatically over the past two decades, but continues to work on implementing regulations in some areas (in particular, physical protection might be noted). The United States has a more mature system, but has recently changed some measures to implement tighter security, due to assessments that threats have increased. In 2008, the U.S. Nuclear Regulatory Commission implemented new security rules for non-power reactors, which will likely mean significant cost increases. Indeed, the pulse reactor III at Sandia National Laboratory was shut down due to the costs of implementing new physical protection measures (the increase in physical protection costs at eight U.S. national laboratories since September 2001 have been estimated at $500 million per year).[213] Security costs in other countries are also significant. The government of Saxony, Germany, reported security savings of $13 million a year after repatriation of HEU fuel from the reactor at Rossendorf back to Russia. Security costs must be paid every year, and are only likely to increase. While improving security is one way to minimize the risk of HEU theft, removing the material is likely to be the far more economical choice is most cases. A calculation of the risks, costs and benefits should be done for each facility, and clear regulations developed that are standardized worldwide, since each country is vulnerable to threats at other sites. The United States and Russia, like other countries, must then do everything possible to make legislation and regulations effective. Where nuclear trafficking is concerned, for example, convictions and sentences in accordance with strict laws requiring serious penalties are necessary if they are to have any impact on the terrorist threat. Furthermore, these sentences must be publicized to have the desired deterrent effect.[214]

## FUTURE MEASURES, FUTURE THREATS

As noted above, DOE and DHS experts do not believe that terrorists are capable of enriching uranium, the material needed to create the simplest type of nuclear device. While

[212] For further information regarding the G8 Global Initiative to Counter Nuclear Terrorism, see http://www.g8.gc.ca/2002Kananaskis/gp_stat-en.pdf; accessed on April 6, 2008. See also, http://www.state.gov/t/us/rm/69124.htm; accessed May 1, 2008.

[213] Estimate cited by Frank von Hippel, "HEU in Critical Assemblies, Pulsed Reactors and Propulsion Systems," Technical Workshop on HEU Elimination, Oslo, June 17-18, 2006.

[214] This is a problem both in Russia as well as in many other countries. For example, in the western European court cases related to the A.Q. Khan trafficking ring there have been suspended sentences when individuals were convicted at all. In South Africa, an individual was convicted but given no prison time.

technological advances could make this capability more accessible in the future, this is not likely to happen anytime soon. Thus, at the present time securing HEU is the most effective way to prevent terrorists from creating such a device. Both Russia and the United States have made progress in reducing access to HEU, but more needs to be done.[215] The Soviet Union recognized the need to reduce the accessibility of HEU when it decided to replace 80 percent enriched uranium in research reactors sold to other countries with 36 percent HEU back in the 1970s. Since that time, Russia has cooperated with the United States, other countries, and the IAEA to remove HEU from a variety of Soviet-built research reactors abroad, and developed the technologies to convert these reactors from HEU to LEU.[216] However, consolidation of HEU within Russia and conversion of Russian research reactors is sorely needed. Thanks to the successes of the Reduced Enrichment for Research and Test Reactors and fuel take-back programs, along with reactor shutdowns, the amount of HEU in civilian use has been significantly reduced over the past decades. An increasing percentage of the HEU holdings in civilian hands are in Russia, which has five of the top 20 civilian steady-state research reactors in terms of HEU consumption.[217] Of the remaining 15, only one will continue to use HEU fuel for the foreseeable future (Germany's FRM-II, which will be converted to use fuel with under 50 percent enrichment but cannot be converted to LEU using current technologies; it uses one 8 kg fuel rod).[218]

Current plans for the expansion of nuclear energy may well pose additional risks in terms of nuclear terrorism. One of the ways the international community is trying to improve the monitoring of new nuclear facilities is through the introduction of "safeguards by design" – incorporating the latest in enhanced safeguards technologies in facilities during the design stage, to enhance proliferation resistance and improve the efficacy of IAEA monitoring and verification of nuclear materials. It should be noted that new technologies can provide additional warning signs and more time for inspectors to detect irregularities, but are not a cure-all. The new technologies offer opportunities, but will only be meaningful if policymakers decide on widespread adoption, and IAEA activities are altered to take advantage of the extra time and information provided by the technologies. To date, however, the technology to build proliferation-resistant reactors is as yet unproven; moreover, it must be remembered that current programs like the Global Nuclear Energy Partnership are designing new reactors that are

---

[215] The United States has increased requirements for the security of facilities with HEU. This is why the decision was made to shut down the pulsed reactor at Sandia National Lab and use computer simulations instead – to reduce security costs. Then U.S. Secretary of Energy Spencer Abraham stated in 2004, "[A]fter operations of three years or perhaps less, the Sandia Pulsed Reactor will no longer be needed, since computer simulations will be able to assume its mission.… When its mission is complete, this reactor's fuel will be removed from Sandia National Laboratories, New Mexico, allowing us to reduce security costs at Sandia and further consolidate our nuclear materials." "Remarks Prepared for Energy Secretary Spencer Abraham for the Security Police Officer Training Competition," May 7, 2004.

[216] For further information, see Russian Research Reactor Fuel Return Program, available at http://www.nnsa.doe.gov/na-20/rrrfr.shtml; accessed May 1, 2008. For further information regarding the Reduced Enrichment for Research and Test Reactors Program (RERTR), see http://www.rertr.anl.gov; accessed May 1, 2008. See also the paper by Philipp Bleek and Laura Holgate in this volume.

[217] These reactors are the SM-3, MIR M1, WWR-TS, IVV-2M, and WWR-M.

[218] Four of the top 20 reactors are in the United States—of these, the Missouri University Research Reactor is currently undergoing conversion, but the remaining three—the ATR (Idaho), HFIR (Oak Ridge), and NBSR (National Institute of Standards and Technology, Dept. of Commerce)—are awaiting the development and qualification of new LEU fuels. For further information on the RERTR Program, see http://www.rertr.anl.gov; accessed May 1, 2008.

proliferation-*resistant*, not proliferation-proof, and the designs may not prove economically attractive to all global customers. It seems clear that before (and perhaps even when) these reactors become available, significant construction of current power reactor designs and related fuel cycle facilities will occur. This not only poses considerable materials, protection, control, and accounting challenges, but will require great efforts to handle the back end of the fuel cycle, and could dramatically increase sabotage risks.[219] While these reactors are not likely to employ HEU, plans call for the increased use of MOX fuel. Further, the study of new reactor fuels has, to date, involved the use of both HEU and plutonium in critical facilities.

While many of the measures that might be taken to reduce the risk of terrorist acquisition of an IND, from reducing the use of HEU and consolidating HEU holdings to improving physical protection and intelligence sharing, are generally known, there is as yet no consensus on precisely what such efforts should entail and how to prioritize them. An international understanding on prioritization may not be possible, if a common definition of nuclear terrorism cannot be found. However, even if Russia and the United States continue to have different views of the relative threat posed by the risk of sabotage, use of a radiological dispersal device, or use of an IND, they should still be able to work out a common understanding of how each of these threats should be tackled. In some areas, a domestic consensus on risks, threats, and measures is also necessary.

Plans to develop proliferation-resistant reactors could potentially help to reduce the threat that terrorists acquire HEU. However, the sabotage threat requires measures to ensure that facilities can withstand a terrorist attack. While there has been a great deal of discussion of making certain that reactors can, for example, withstand an aircraft impact, there is as yet no common definition of standards for anti-terrorist measures or a full understanding of what the terrorist threat may entail. It should be noted that today, many nuclear reactors have containment vessels but spent fuel stores can not withstand attack—if radiation release is a concern, this sort of facility will have to be redesigned, as will requirements for future facilities.

As noted above, there are three pathways for terrorists to acquire the fissile material needed for a nuclear device: theft from a fuel cycle facility, purchase on the black market, or transfer from a state sponsor. Measures that can be taken to block these pathways include: 1) eliminating HEU (the most certain way to prevent its acquisition by terrorists); 2) increasing security (including both technical measures and security culture at facilities); 3) improving intelligence sharing; and 4) increasing penalties for trafficking and related offenses, along with enforcement and publicity. As key users and suppliers of nuclear technology, Russia and the United States have a critical role to play in leading efforts to prevent terrorist use of an IND. At a Russian State Duma seminar on nuclear terrorism issues on September 27, 2007, Russian Deputy Foreign Minister Anatoly Safonov observed that while it is probably impossible to prevent all terrorist attacks, governments must at least be able to tell their publics that they can prevent nuclear terrorist attacks—and to do so must prevent access to WMD components.[220]

---

[219] The Nuclear Energy Agency defines the stages of the fuel cycle as follows: "a) the so-called front-end which extends from the mining of uranium ore until the delivery of fabricated fuel elements to the reactor site; b) fuel use in the reactor, where fission energy is employed to produce electricity, and temporary storage at the reactor site; c) the so-called back-end, which starts with the shipping of spent fuel to away-from-reactor storage or to a reprocessing plant and ends with the final disposal of reprocessing Vitrified High-Level Waste or the encapsulated spent fuel itself." For further information, see http://www.nea.fr/html/ndd/reports/efc/efc02.pdf; accessed April 6, 2008.

[220] For more information on the international seminar on Countering Nuclear and Radiological Terrorism, hosted by the Russian State Duma Security Committee, see Cristina Hansell Chuen, "CNS Researcher Speaks on Nuclear

This insightful statement goes to the heart of the matter: can we agree on the nature of the attack we seek to prevent, the measures that can potentially be taken to prevent it, and ways to prioritize and coordinate our preventive efforts?

---

Terrorism at Russian Duma," October 4, 2007, available at http://cns.miis.edu/pubs/week/071005.htm; accessed May 1, 2008.

# PUBLIC AND PRIVATE SECTOR PARTNERSHIP RELATIONSHIPS: FUNDAMENTAL ISSUES, PROMISING DIRECTIONS AND METHODS OF RUSSIAN-AMERICAN COLLABORATION IN THE FIELD OF NON-PROLIFERATION OF NUCLEAR WEAPONS

Rear-Admiral Vyacheslav M. Apanasenko,[221]
*Russian Academy of Rocket and Artillery Sciences*

"We do not reject the idea of public-private partnership, on the contrary, we welcome it."
*Vice-Prime Minister of Russia*
*S.B. Ivanov, November 8, 2007*[222]

The above quotation underscores the idea that strategies and programs directed only toward utilizing federal funds will not enable government agencies to implement large-scale projects. The joint project under the aegis of the U.S. National Academies (NAS) and the Russian Academy of Sciences (RAS) dedicated to the future status of nuclear security in the year 2015, undoubtedly falls under the rubric of such large-scale projects.

At a seminar in August 2007, "The Fundamental Issues, Long-Range Trends, and Tools for Russian-American Collaboration in the Sphere of Non-proliferation of Nuclear Weapons," questions concerning new tools and new efforts for creating committees on both the Russian and the American sides were raised. In particular, the idea of considering the possibility of developing proposals for the effective interaction between government agencies and private business for the purpose of solving problems related to nuclear security in the year 2015 was expressed.

Members of the Russian and American committees agreed with this approach but noted that the term "nuclear security" needs to be treated more broadly, with the understanding that it includes real security as it relates to the production and utilization of nuclear components both in the military and in the civilian sectors, as well as security in general, bearing in mind the elimination of other existing threats as well. Thus, the issue of partnership relations between the government and the private sector becomes relevant to making decisions about fundamental issues, long-range trends, and tools for Russian-American collaboration.

---

[221] V. Apanasenko's diverse professional experience includes affiliations with current Russian industry and financial institutions. This experience has also informed his perspectives reflected in this paper.

[222] "Holdings of four aviation engine builders will be developed – V. Putin," Press-conference held August 11, 2007. For further information, see www.prime-tass.ru/news/show.asp?id=710236&ct=news, accessed July 13, 2008.

Moreover, it is obvious that this position might be utilized for virtually all questions brought to light at past seminars and set forth in *Overcoming Impediments to U.S.-Russian Cooperation on Nuclear Non-Proliferation: Report of a Joint Workshop.*[223] It was noted therein that "(b)arriers and impediments to cooperation take many forms, but the impediments identified within the workshop can be understood in terms of six kinds of issues: 1) political issues, 2) legal issues, 3) issues related to scientific and technical cooperation, 4) issues related to program organization and management, 5) issues related to the legacy of the Cold War mentality, and 6) funding issues."[224]

An attempt has been made in this paper to address only two types of issues named above: (4) organization and management issues, and (6) funding issues.

## PRIOR HISTORY OF THE ISSUE: CONTENT AND FAVORABLE EXPERIENCES OF PUBLIC-PRIVATE SECTOR PARTNERSHIPS

The necessity of developing public-private partnerships in our country is supported by the Addresses of Russian Federation President Vladimir V. Putin to the Federal Assembly of the Russian Federation, and in his speech at the XIV Congress of the Russian Union of Industrialists and Entrepreneurs (2004).[225] The Chairman of the Russian Government has on many occasions declared the necessity to develop public-private partnerships as an effective mechanism for achieving government objectives. The development of this kind of partnership has also been given consideration in a variety of government documents and programs.[226] In addition, numerous dissertations have been written and defended on this very subject.[227]

However, despite the fact that both government and business place high hopes on public-private partnerships, viewing them as important tools for increasing national (and regional) competition, the development of mechanisms for public-private partnership in Russian practice is moving ahead at an extremely slow pace. The failure to resolve a number of methodological issues concerning the transition to partnership relations between government and business, the absence of the experience necessary for such partnerships, the lack of sufficient legislative and regulatory bases on all levels, and bureaucratic impediments hamper the establishment of PPP in the Russian Federation. Moreover, even the question of terminology remains open.

Public-private partnerships are a comparatively new phenomenon in the political and management practices of the new Russia. Various aspects of the essence of this concept, as well as processes for the development of technology for the operation of public-private partnerships

[223] Joint National Academies' – Russian Academy of Sciences' Committees on U.S-Russian Cooperation on Nuclear Non-Proliferation, *Overcoming Impediments to U.S.-Russian Cooperation on Nuclear Non-Proliferation: Report of a Joint Workshop*, (Washington, DC: National Academies Press, 2004). The full text of the report is available at http://www.nap.edu/catalog.php?record_id=10928; accessed April 6, 2008.

[224] Ibid, p. 23.

[225] Materials of the XIV Congress of the Russian Union of Industrialists and Entrepreneurs (2004). For further information, see www.atiso.ru/content_files/doc/soisk/Xardinoj.doc, accessed May 26, 2008.

[226] Federal Law "On Concession Agreements," No. 115, of July 21, 2005. For further information, see www.government.ru/content/ and http://govportal.garant.ru; accessed July 13, 2008.

[227] For furthermore information, see http://www.atiso.ru/content_files/docs/soisk/Xardinoj.doc; http://www.RosenkovDA.doc; and http://www.mesheryakova.pdf.

have been rather extensively studied by foreign researchers, among whom the works of T. Barnekov, R. Boyle, L. Dzhezirusky, M.B. Gerrard, S. Kitadzim, F. Cook, and D. Rich stand out.[228] The conception of a public-private partnership is determined to a large extent by the nature of the government, relative to which there are two basic points of view in western scientific literature. The first reflects the image of the government as an instrument for ensuring hegemony of the ruling class, and the second enunciates the neutrality of the government and its service for the good of the entire society. In keeping with this understanding of the essential nature of government, some authors assert that a public-private partnership is an instrument created by the government and responsive to the interests of the dominating class, while others argue that partnership is a mechanism that reflects the interests of a wide range of social groups.

The subject of public-private partnership in Russia originally appeared in a very broad context and was applied to specific industries: transportation, road construction, technology, and investments among others. A considerably large interest in the subject of public-private partnership has been demonstrated by the Council on Competition and Entrepreneurship of the Russian Federation, as well as by several government agencies, expert councils created to address this issue, local governing bodies, and consulting companies.

Authoritative scholars maintain that "the analysis of speeches given by Russian officials on the question of public-private partnership make it possible to direct interest toward this subject, but it does not make possible a determination of the context of this term. It is understood that the term relates to some kind of collaboration between government and business; however, in general this type of collaboration is possible even without any special terminology."[229]

The characteristics of a public-private partnership both as a phenomenon and as a concept are examined in the works of O.S. Belokrylova, V.G. Varnavsky, L.I. Efimova, V.A. Mikheev, T. Sannikova, B. Stolyarov, and A. Sharmov.[230] The important political and legal aspects of a public-private partnership in Russia have been examined in the works of M.V. Vilisov, S.S. Sulakshin, E.A. Khrustaleva, and V.I. Yakunin.[231]

Nonetheless, the substance and forms of public-private partnerships, as well as the means of their effective utilization within the Russian government administration and economic policy to date have not been sufficiently researched. Contemporary political science has not adequately encompassed such issues as: possible utilization in Russia of international experience relating to public-private partnerships; various implementation mechanisms for these projects; comprehensive development of regulatory and legal foundations for public-private partnerships; securing of government support and guarantees for business with respect to funds invested; a higher level of communication among all parties involved, and active public outreach in this process.[232]

Issues surrounding partnership relations between the public and private sectors in the context of fundamental problems, long-range trends, and tools for Russian-American collaboration in the sphere of non-proliferation of nuclear weapons have become a topic of interest thanks only to the general development of intergovernmental relationships in implementing joint programs. First and foremost are programs to reduce the risk and eliminate

---

228 For further information, see http://www.atiso.ru/content_files/docs/soisk/Xardinoj.doc; accessed May 26, 2008.
229 Ibid.
230 Ibid.
231 Ibid.
232 Ibid.

the repercussions of the Cold War. In the course of implementing these and other programs, the parties have gained favorable experience, improved the quality of their relationships, and achieved a higher level in their development.

It is for this reason that the joint committee of the RAS, and NAS has reached the following conclusions and recommendations:

> Cooperative efforts are at a turning point. No longer should or can the Russian Federation be solely the recipient of assistance. It is now able, politically and economically, as well as militarily, to take its place as a true partner of the United States in the effort to contain the proliferation of nuclear weapons in the world.
>
> It is therefore time for the two sides to forge a full partnership in this regard. To accomplish this, a two-pronged program is required. First, the remaining impediments to existing and contemplated programs of cooperation must be removed or, at the least, their effects must be diminished. Second, a long-term approach to the establishment of a true partnership is required to reduce and eliminate the threat of the further proliferation of nuclear devices, the material needed to construct them, and their delivery systems. As the nations with the world's largest stockpiles of nuclear weapons and fissile material, the United States and Russia have not only an opportunity but also an obligation to strengthen their cooperative nuclear non-proliferation programs and make them as effective as possible.[233]

These conclusions are not only enumerated in the final documents of the NAS-RAS joint committees, they also may serve as a methodological foundation for developing new tools for collaboration.

The joint committees of scientists from the RAS and NAS, on behalf of the joint committees on *Overcoming Impediments to U.S.-Russian Cooperation on Nuclear Non-Proliferation*, noted on this matter that:

> (J)ust as scientists in different countries need to work together more closely to address the technical challenges of the new security environment, new impediments to international scientific collaboration are emerging. Impediments to the implementation of joint nonproliferation and threat reduction programs are particularly problematic and counterproductive. These impediments to cooperation, and the political, bureaucratic, and structural problems that are behind them, are so complex and interwoven that no one solution will solve the problems. Instead, decision-makers need a variety of options upon which they can draw to address specific problems.[234]

It is indeed true, and analysis shows, that even given the current state of affairs, there are examples of effective and constructive collaboration to find solutions to issues of interaction. This paper will examine three of them: a resolution of the North Korean problem; collaboration between the European Bank for Reconstruction and Development (EBRD) and Russian agencies; and meetings among technical experts of the working group of Russia and the United States on civilian nuclear power engineering.

---

[233] *Overcoming Impediments,* p. 6.
[234] Ibid, p. 102.

## RESOLUTION OF THE NORTH KOREAN PROBLEM

As is well known, at one time the United States banned American financial institutions from conducting financial transactions through Banco Delta Asia, located in Macao. The Treasury Department declared, that "the bank is a spineless pawn in the hands of the North Korean government."[235]

U.S. sanctions against the bank and several other companies from North Korea became the primary stumbling block to the resumption of international negotiations concerning North Korea's nuclear program, which made the unfreezing of accounts and access to their funds one of the primary conditions for the country's nuclear disarmament. Pyongyang agreed to shut down the nuclear reactor in Yongbyon only after funds were deposited into accounts of the Democratic People's Republic of Korea (DPRK).

Thus, the problem could not be resolved only at the government level. The situation was mitigated when private groups rendered assistance in concert with the public sector. Money was transferred from Macao to the Federal Reserve Bank of New York, forwarded from there to the Central Bank of Russia, and then transferred to the Far Eastern Commercial Bank ("Dalkombank"), where North Korea maintains accounts.[236] Moreover, to the credit of the parties involved, the primary bureaucratic delays were eliminated relatively quickly at the government level. Hence, in June 2006, the U.S. Treasury Department gave a written guarantee not to place financial sanctions on the Russian bank that was to participate in the transfer of monies to the DPRK from the Bank of Macao. Overall, thanks to a rational combination of public and private capabilities, a complex problem with North Korea was resolved, and the nuclear reactor in Yongbyon was shut down.[237]

## COLLABORATION BETWEEN THE EUROPEAN BANK FOR RECONSTRUCTION AND DEVELOPMENT AND RUSSIAN ENTITIES

The EBRD has had a long and fruitful collaboration with a variety of Russian entities. The first step was taken several years ago and mostly led to collaboration in the banking sphere. The EBRD closely followed the development of private banks in Russia. It analyzed their work, chose the most promising banks for future collaboration, and with their consent conducted a very detailed audit of their financial activities. In the majority of cases, given positive results of the audit, the EBRD obtained a portion of the bank's stock, and became one of the bank's owners. Such actions as a rule produced good results. For example, the EBRD and "Transkapitalbank" (closed JSC) have been collaborating for an extended period of time, and this collaboration has allowed the latter to actively promote its products to small and medium-sized businesses. The investment corporation DEG became part of the Transkapitalbank capital in March of 2007. This collaboration should make it possible for the bank to strengthen its position in international

[235] "Investigation of Banco Delata Asia, located in Macao, is Still Underway in the U.S." *K2Capital,* June 5, 2006, available at http://www.k2kapital.com/news/fin/detail.

[236] "North Korea Withdrew Money from Bank in Macao," June 14, 2007, available at http://www.nr2.ru/economy/124045.html.

[237] For further information, see the paper by Joel Wit in this volume.

markets and to reduce the cost of international borrowing. The entrée of the EBRD and DEG into the cast of owners signifies a high evaluation of the strategy and long-range developments for the bank on the part of western investors.

The second favorable factor is the fact that the dynamic development of a branch network and the rapid growth in the volume of lending transactions has not affected the qualitative characteristics of the bank's lending portfolio. The index for outstanding debt for the credit portfolio is generally just below market rates, and on January 4, 2006, it equaled 0.93 percent.[238] This notably positive influence on the credit rating for Transkapitalbank causes the bank's own capital to be of high quality and the structure of its resource base to be well diversified.

The bank's development strategy proposes further growth in the volume of lending transactions, in part due to the expansion of its operations in a broader geographic area and an increase in the number of points of sale. An increase in the resource base is assumed based on attracting funds from domestic and foreign institutions, and also the issuance of Eurobonds and bonds denominated in rubles.[239]

The EBRD did not stop there in its collaboration with Russian banks; it began to collaborate with the public sector. In December of 2006, the EBRD began working very closely with the Russian Federation Ministry of Economic Development and Trade, when it organized a road show in London for the first Russian concession project, called "The Western Speed Diameter." Currently, the results of the preliminary selection of companies interested in this project have been tallied. They include: ALPINE Mayreder Bau GmbH, FCC-Contryccion S.A. Strabag AG, Bouygues Travaux Publics S.A., Hochtief PPP Solutions GmbH, Mostotryad, OBRASCON HUARTE LAIN, S.A., OHL Concesiones, S.L., Transstroi, Bechtel International Inc., Enka Kholding B.V. and others.[240]

In June 2007, the Russian Federation Ministry of Economic Development and Trade and the European Bank for Reconstruction and Development signed a memorandum on financing infrastructure projects in the Russian Federation. The document was signed as part of the XI St. Petersburg International Economic Forum. On behalf of the Ministry of Economic Development of the Russian Federation, the memorandum was signed by the Russian Federation Minister of Economic Development and Trade, the Director of the EBRD from Russia, German Gref, and on behalf of the EBRD the memorandum was signed by the bank's president Jean Lemirre. The purpose of this document is to develop the strategic intentions of the bank to expand funding for large-scale investment projects geared toward developing Russian infrastructure. As per the memorandum, by July 1, 2007, the EBRD promises to provide Russia with a list of requirements identified by the bank for financing infrastructure projects. A team of experts will be created to review the investment projects, and, according to the press center of the XI St. Petersburg Economic Forum, both sides will bring in qualified specialists.[241]

The memorandum strengthens strategic commitments that were secured in Kazan in May of 2007, during the EBRD Board Meeting. It is expected that by 2010, the sum total of bank financing dedicated to implementing large-scale infrastructure projects in Russia will be approximately five billion dollars. And, if the long-range prospects of a public-private

---

[238] "Rating Agency 'Extra RA' Gave Transkapitalbank a Credit Rating of 'A+'. A high level of creditworthiness with stable prospects"; available at http://www.transcapital.com/about/news/2007/08/detailed/506.

[239] Ibid.

[240] "RBK, ERBD, and MERT signed a memorandum on financing infrastructure projects in the Russian Federation," June 10, 2007, available at http://www.rambler.ru/news/economy/0/20543623.

[241] Materials of the Ministry of Economic Development and Trade, 2007, available at www.economy.gov.ru/.

partnership in the country are considered, then the size of this figure might be significantly greater.

Special attention should also be given to the unique Strategic Master Plan developed, under the leadership of Academician Ashot A. Sarkisov, on Utilizing Military Seafaring Vessels in the Northwestern Region of the Russian Federation.[242] This work too was conducted by contract with the European Bank for Reconstruction and Development, within the framework of the Statement by G8 Leaders "The G8 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction," signed by the G8 in 2002 during the meeting in Kananaskis, Canada.[243] As a result, we have practical examples of how to effectively solve this problem, namely, by means of establishing partnership relations between government agencies and private business.

## MEETING BETWEEN U.S. AND RUSSIAN TECHNICAL EXPERTS FROM THE WORKING GROUP ON THE CIVILIAN NUCLEAR POWER INDUSTRY

At the beginning of 2006, the Presidents of Russia and the United States launched similar initiatives (Global Infrastructure for Nuclear Power Engineering – Russia;[244] Global Nuclear Energy Partnership – U.S.[245]), directed toward collaborative efforts to develop the nuclear power industry on a national and a global scale. Both initiatives encompass three interrelated elements:

1) The creation of favorable terms for introducing new nuclear power plants with thermal reactors in their respective countries in the very near future.
2) The development of closed nuclear fuel technologies[246] to solve the problems of accumulating spent nuclear fuel (SNF) from thermal reactors, and fuel supply for the long-term development of nuclear power.
3) The introduction of new institutional measures directed toward solving problems of non-proliferation by limiting the use of technologies to enrich uranium and process SNF.

Given the similarities in both the goals and the approaches to reaching those goals, the presidents of Russia and the United States at the G8 meeting in St. Petersburg on July 15, 2006, made the decision to form a Russian-American Working Group to determine the directions of

[242] See the paper by Academician Ashot A. Sarkisov in this volume.

[243] For further information regarding the G8 Global Initiative to Counter Nuclear Terrorism, see http://www.g8.gc.ca/2002Kananaskis/gp_stat-en.pdf; accessed on April 6, 2008. See also, http://www.state.gov/t/us/rm/69124.htm; accessed May 1, 2008.

[244] For more information, see: www.ippe.obninsk.ru; accessed July 13, 2008.

[245] For further information regarding the U.S. Global Nuclear Energy Partnership, see http://nuclear.inl.gov/gnep/index.shtml; accessed April 6, 2008.

[246] The Russian Corporation TVEL notes that "(t)he closed nuclear cycle envisages transportation of irradiated fuel assemblies to radiochemical plants to extract unburned uranium rather than transportation to disposal site. Recoverable uranium could amount up to 95 percent of initial uranium mass. Then, this material is subject to same processing stages as the one mined." Presently the majority of countries use an open fuel cycle. For more information, see http://www.tvel.ru/en/nuclear_power/nuclear_fuel_cycle/; accessed April 6, 2008.

global, bilateral, and mutually beneficial collaboration in the civilian nuclear power industry.[247] The co-chair of the Working Group from the Russian Federation is the deputy director of the Federal Agency on Atomic Energy (Rosatom), N.N. Spassky. On December 15, 2006, the Working Group created a Plan of Bilateral Action with the goal of strengthening global and bilateral collaboration in nuclear power engineering.

By order of Decree No. 86 dated February 20, 2007, Rosatom is responsible for coordinating the scientific and technical work and the technical support for planned Working Group activities in Russia has been placed upon the Federal Government Monopropellant Enterprise of the Government Scientific Center of the Russian Federation–Physics and Power Engineering Institute. The Director General, A.V. Zrodnikov, has been appointed deputy co-chair of the Working Group on behalf of the Russian Federation on issues of coordinating scientific-technical work.

In accordance with the Working Group action plan developed March 13-14, 2007, the first meeting of the subgroup of technical experts on the overall vision, transuranium fuel, fast reactors, new technologies for processing SNF and waste management, as well as the export-quality of small- and medium-capacity NPPs, and nuclear data on actinides was held in the city of Obinsk. Russian and American experts discussed technical issues, as a result of which specific reporting materials were defined, and a preliminary agreement was reached with respect to objectives at the highest level for collaborative work in 2008.

## ORGANIZATION AND MANAGEMENT OF PARTNERSHIPS BETWEEN PUBLIC AND THE PRIVATE SECTORS

In this section it seems advisable to focus on what are several important circumstances. First, there is the matter of existing obstacles and dangers, which should certainly be taken into consideration when organizing public-private sector partnerships. Second, the tools for this organizational process are of the utmost importance. And, third, the organizational-management schematics cannot function effectively without corresponding mechanisms of interaction.

### Obstacles and Dangers in the Area of Organization and Management of Public-Private Sector Partnerships

In this particular kind of relationship, as in no other, bureaucratic red tape and programming, and procedural obstacles to collaboration hold a firm grip. As a rule, all of these are based on the danger of lapsing into customary corruption. Indeed, this is a real danger by virtue of the fact that the establishment of partnerships between the private sector (business) and the public sector (government) is done by people.

According to data from the Center for Reputation Technologies, people involved in such relationships should be specialists in their own fields.[248] A special term has even been coined to describe them: GR-shiks. GR—government relations—means a connection to government

[247] For texts of the Joint Statements between Russia and the U.S. during the St. Petersburg G8 Summit, see Appendix D.

[248] Igor Dmitrev, "A GR in Russia is more than PR," *Center for Reputation Technologies*, available at http://stra.teg.ru/library/econ/38/1/4.

agencies without whose help not a single serious political or business project can be implemented. A GR specialist should form close, trustworthy relations between his employer and the government. This work should not have anything in common with common bribery. The task of the GR is to establish an informal dialog between public and private organizations in the interests of resolving specific problems. This is an extremely difficult task. According to an aphorism uttered by Assistant to the Minister of Industry and Power Engineering, Stanislav Naumov, GR is "Public relations and lobbying in a single small bottle: you can shake it up, but you can't mix it up."[249] GRs are builders of strong bridges stretching from corporations into government offices.

Effectively functioning partnerships between the private economic sector and the government should be established between partners who clearly understand their roles and the goals placed before them, and they should be given a clear set of rules of interaction. At the same time it should always be remembered that there is an inherent danger that the partnerships between the public and economic agents might be misused exclusively to serve their own interests. The process described here is observable in the majority of countries with a transitional economy, and it takes the form of corruption.

These obstacles must be borne in mind when rendering assistance in forming partnerships between the private and public sectors in countries with transitional economies. Negative experience bears witness to the fact that the obstacles described herein can be overcome if partnerships operate within the environment of a strong civil society, in which the relationships function as a part of that society. The development of partnerships between the private and public sectors should therefore be built within the framework of a much broader goal, which can only be achieved on the basis of a long-term, step-by-step approach. International organizations could make a decisive contribution to this process.

In the course of organizing partnerships, one inevitably comes up against internal difficulties that are inherently interagency in nature. Accordingly,

> Neither the United States nor the Russian government is organized for maximum efficiency in implementing cooperative nuclear non-proliferation programs. Some American participants argued that the interagency structure in the United States is fairly well defined, but that the process is often weak or non-existent, resulting in poorly coordinated project activity and, at times, duplication of effort. Such duplication, of course, leads to sharp criticism and even greater consequences, such as budget cuts, at the hand of Congress. In the Russian case, the interagency structure has been in considerable flux in recent years, with frequent reorganizations hampering understanding of exactly which agencies must participate in the decision-making process. Agencies not directly responsible for implementation have, as a result, had opportunities to hamper progress or, in some cases, to veto it outright.[250]

Moreover, in our case there are still legal obstacles in the form of an insufficiently mature legislative base in Russia and the absence of corresponding organizational structures and mechanisms. First and foremost a tax-relief mechanism for program participants is needed.

---

[249] Ibid.
[250] *Overcoming Impediments*, p. 28.

Another extremely important organizational obstacle is the matter of establishing responsibility for the organization and management of public-private partnerships. This has not been resolved.

As previously, there is still the impediment of visa issues in terms of establishing partnerships. The current system of issuing visas hinders both specific and overall goals of Russian-American collaboration in the sphere of fostering partnerships.

And, above all of the impediments "reigns" the obstacle of financing, or more precisely, the difficulties in organizing allocation of funds. In essence, the difficulties accurately specified in *Overcoming Impediments* still exist, in particular those such as the length of time the procedures take to obtain a decision on funding even for International Science and Technology Center projects, the complexity of the mechanisms themselves for allocation and flow of monies, and export control.

**Tools for Overcoming Obstacles to Public-Private Sector Collaboration**

The impediments examined in the preceding section can be overcome with the aid of the following mechanisms:

- appropriate allocation of bureaucratic leverage and obligations
- establishment of strict responsibility among project managers for concrete results
- official appointment of specific project managers with a very clear definition of the scope of their obligations and responsibilities
- strict reporting for each period of work
- control over the activities of GRs and the results of their activities
- inclusion of a broad range of scientific and social institutions to work on well-grounded proposals to present to heads of state and parliamentarians on how to eliminate political obstacles to partnership relations
- perfection of regulatory and legal foundations for maintaining public and private sector partnerships
- development and introduction of changes to national legislation or new laws
- perfection of mechanisms to develop and execute detailed Master Plans for concrete programs and specific topics
- incorporation of new GR methods
- development of new mechanisms of financial and economic support for ongoing projects with the participation of both the public and private sectors

Each tool is worthwhile only when it is in the hands of a master. The most important organizational and managerial task here is the selection of this master and the assignment of his corresponding rights and specific responsibilities. To solve this task, the following are deemed possible:

- Creation (for each specific problem) of a small joint coordinating committee at the ministerial level and at the level of joint consulting/coordinating groups comprised of leading scholars, specialists, and independent experts from both sides.
- The joint coordinating committee will prepare, submit for approval to the interested parties, and report to its organizers for project approval (be it an algorithm, a

mechanism, or a detailed plan), a resolution of the problem with proposals for candidates for the project manager position, his authorities, rights, and obligations.
- Based on the results of the project review, the ministries will prepare an interagency, and when necessary, an intergovernmental agreement to approve the project manager, a detailed solution to the problem, and mechanisms to ensure fundability.

Taking into account that the current question concerns attracting both governmental and private participants, a necessary requirement for creating joint consulting/coordinating groups is the inclusion within them of the most competent and responsible representatives of those private participants who came to this project.

### Mechanisms for Public and Private Sector Interaction

Within the framework of the assigned topic, it does not seem possible to examine mechanisms for public-private sector interaction without taking into account the general interaction between states. As was previously noted, the interaction between Russia and the United States, both in political as well as in several other areas of interaction requires strengthening. The situation described in *Overcoming Impediments* not only remains relevant but the situation is actually deteriorating because of the bill passed in the United States entitled, The Iran Counter-Proliferation Act of 2007, H.R. 1400.[251] It is for this reason that before all parties to the program lay massive and painstaking work in order to improve the situation. Independent of this, it is critical to bring to fruition the work of implementing all mechanisms of interaction, both between the governments themselves as well as within each government to complete collaboration between the public and private entities. Mechanisms of interaction could be implemented at various levels through:

- intergovernmental collaboration
- work within joint coordinating committees and consulting and coordinating groups
- interagency agreements
- interaction within the framework of the international community
- perfection of methods by which project managers work
- informal conferences, seminars, meetings, and other similar events to attract independent scholars, specialists, and experts
- personnel exchanges
- joint selection of project topics and funding from federal monies earmarked by the governments to eliminate repercussions from the Cold War
- disseminate positive experiences of interaction
- joint definition of priorities within the framework of joint projects
- joint decisions on the issue of defining concessions and exemptions
- “special” decisions with the goal of moving work on jointly selected projects forward
- designing and implementing funding algorithms (diagrams) approved to carry out projects and programs

[251] Arkady Orlov, “U.S. Congress Toughened Sanctions Against Iran and Banned Nuclear Collaboration with the Russian Federation,” *RIA Novosti,* September 25, 2007.

Not to under appreciate the role of all mechanisms of collaboration, it is necessary to note that in all practical terms, funding is the most important issue. This is particularly relevant, in light of the latest events in Russia to create completely new structures—government corporations. Currently, the President of Russia has introduced a bill the State Duma to create a government corporation called *Rostekhnologiia*. Plans are being discussed to create government corporations out of Rosatom and Rosavtodor. According to experts, structural changes are expected in other industries as well. On the one hand government corporations represent the interests of the state, and on the other hand they could create stock companies, engage in entrepreneurial activities, purchase shares of stock, take controlling interest of government shares, and so forth. Thus, it may be stated that in Russia a new form of ownership is coming into existence together with the creation of entirely new organizational structures, that of government corporate ownership.[252]

In the context of this paper, it would be entirely logical to suppose that their activity nearly corresponds to the topic at hand, namely, the establishment of partnerships between the public and private sectors.

**Project Funding Issues in the Area of Implementing Public and Private Sector Partnerships**

The basis for analyzing project funding issues in implementing public and private partnerships is described in *Overcoming Impediments*. There it is stressed that "Financial issues are central to cooperation, which brings both problems and opportunities. It is important to attain a sufficient level and balance of resources (financial, intellectual) from both sides for project implementation/management to succeed."[253]

A. Problems

1. Risk that program goals will be subverted to financial goals: if those responsible for implementing a program are primarily interested in spending funds up before the end of the fiscal year ('pumping the money out'), they are likely to subvert the program's goals if real progress is not achieved.
2. Risk that political needs and goals will overtake program goals.

B. Opportunities

1. Diversification of the funding sources (stakeholders) may improve chances for success and increase project managers' control over the use of resources. Programs funded from multiple sources come with their own built-in constituency of people and organizations for whom successful cooperation is in their own best interest.
2. If a program is funded by private, non-profit groups, it can have a distinct advantage, particularly when it only involves work in the former Soviet Union and can be successful independent of U.S. government action or inaction.
3. As Russia's economy slowly grows stronger, opportunities for cost-sharing between the United States and Russian Federation will increase.

---

[252] Ivan Ilov, "A Military-Industrialist Courier," October 10, 2007, and "New Mechanism for Managing the Economy. The Scope of Work of State Corporations Requires Comprehensive Financial Security of their Interests."
[253] *Overcoming Impediments*, p. 104.

4. The incentive to proliferate may be reduced via creative methods of reducing or eliminating the profitability of proliferation. The "HEU Deal" might be seen as an example of this approach.[254]
5. The pro-business, anti-government stance of the U.S. administration predisposes it toward commercial approaches to addressing problems. Advocates of cooperation should therefore look for opportunities to accomplish goals through commercial endeavors. But such programs are only successful in situations where the paths toward accomplishing program goals and making a profit are indistinguishable. It is unrealistic to expect this to be true in most of the cooperative threat reduction work that remains to be done.
6. Programs are most effective when the United States is willing to spend the money necessary to accomplish goals and is prepared to pay fairly for work that gets done. Program staff should be aware of their Russian colleagues' perspective about money, be able to see through Russian modesty to the roots of a funding request, and be as supportive as possible. Missed cues can lead to setbacks in cooperation that are much more costly than the requested help would have been.[255]

### Difficulties Related to Implementing Mechanisms for Project Financing in Public-Private Sector Partnerships

In general terms, when addressing the subject of funding difficulties on a large scale, one could add to the difficulties and obstacles enumerated above. Emphasizing and elucidating several of them, and specifying new ones. Undoubtedly, one could include the following:

- selection and approval of project and program topics to be financed and implemented by both the government and the private sector
- approval and distribution of funds among (project) executors
- creation and approval of a mechanism for determining the manner in which funds will flow, ensuring complete transparency of financing and reporting
- resolution of the issue of overhead expenses
- establishment of a procedure for unsecured lending
- creation of a mechanism of incentives and encouragement for experts to work on approved projects and programs
- establishment of steps for comprehensive financial protection (insurance) for customers of joint projects and programs

### Possible Tools and Mechanisms for Overcoming Funding Challenges

Undoubtedly, the tools and mechanisms indicated above, can also be applied to the elimination of obstacles in funding projects and programs whose implementation has made public and private entities operational. It follows then that it is necessary to consider the experience in overcoming difficulties in executing work to salvage Nuclear Powered Ballistic Missile Submarines, Nuclear Powered Cruise Missile Submarines, Nuclear Powered Torpedo

[254] For further information regarding the HEU Agreement, see http://www.nti.org/db/nisprofs/russia/fissmat/heudeal/heudeal.htm; accessed April 6, 2008.
[255] Ibid.

Submarines, as well as the International Project on Innovative Nuclear Reactors and Fuel Cycles, Multilateral Nuclear Environmental Program in the Russian Federation, International Nuclear Safety Program, and other projects and programs. The experience gained by Russian institutes such as the All-Russian Scientific Research Institute of Theoretical Physics, All-Russian Scientific Research Institute of Experimental Physics, Nuclear Safety Institute, RAS, and the Kurchatov Institute should also be considered when conducting a host of research and development projects. In addition, the following algorithm seems entirely logical:

1) Within the framework of the RAS and the NAS, a competition could be announced to select topics for joint projects and programs. The process for finding topics for joint projects and programs might proceed as follows:

    - nonprofit organization "A" forms and presents a draft work program to create a technology and an experimental sample of a laser complex for deactivating salvaged metalwork, nodes, and reactor elements from nuclear power plants, nuclear submarines, and factory equipment for the nuclear fuel cycle by using laser radiation
    - State Monopropellant Factory proposes a project to create laser complexes to control atmospheric pollution by using physiologically active substances
    - open Joint Stock Company of Scientific Research Institute "S" requests the review of two programs at once: the development of a clean and safe "Resonance-dynamic fission and resonance-dynamic synthesis plasma electronuclear reactor;" and a work program to create the means to protect people and equipment from the effects of ionizing radiation sources and means to effectively protecting employees at nuclear power plants without destroying the nuclear energy installation and others

2) Scientific research institutes, companies, ministries, agencies, banks and other organizations would then submit for review their joint projects and programs, along with a feasibility study demonstrating the need to fund these projects and programs with funds provided by the G8 and other organizations to reduce the nuclear threat, and to eliminate repercussions of the Cold War, and so forth.
3) Committees from the RAS and NAS could then review the proposed topics of joint projects and programs for competition at joint meetings, and by a simple majority vote, select the most practical of them.
4) At subsequent joint meetings, the RAS and NAS committees could prepare proposals for the composition of the joint coordinating committee for each individual problem, and they would be approved at the ministerial and agency level.
5) The joint coordinating committee could prepare and coordinate with interested parties, and report to their organizers for project approval (algorithm, mechanism, detailed plan) a solution to the problem, along with recommendations for candidates for the project managers, a detailed plan for solving the problem, and mechanisms for funding it.
6) Assuming, for example, that through the process, the "S" project were to be approved, the company would become the chief implementer of the work. The Director General of "S" would be appointed Project Manager.

7) The project manager could present a detailed work plan, deadlines, a more precise technical feasibility study, and a timeline for the financial feasibility study to the joint coordinating committee, as well as to the executors.
8) The EBRD, having funds obtained from the G8 and other countries, could draw up a diagram for reliable cash flow to implement the program work selected. It is logical to presume that it would be most expedient for these funds to be sent through the Russian bank of which the EBRD is a shareholder, and in which there are employees formerly involved in activities related to the topic of the program selected.[256] We will assume for a moment, that this is shareholder commercial bank "T" and that it employs a specialist, specialist "N." Then the EBRD, bank "T," and its specialist are approved in the financial-economic schematics to fund the work on the approved program. Specialist "N" hence is included in the joint coordinating committee and becomes the bank curator for the chief execution of the work, and he opens settlement accounts with bank "T." Bank specialist "N," using his past and current experience, can effectively control the spending and competently inform the joint coordinating committee of this spending, which will in turn be in charge of the project manager and his staff.

A necessary condition for the process above to work effectively is compensation for the work of all the participants as early on in the functioning stages as possible.

It goes without saying that the algorithm presented above is simply a preliminary outline of a real, possible mechanism to implement a project within the framework of genuine government partnerships, in this case also involving the RAS, NAS, ministries, agencies and others, together with the private sector, the open JSC NII "S," Bank "T" and the cooperative of executors.

## CONCLUSIONS AND RECOMMENDATIONS

1. Obstacles to establishing public-private sector partnerships truly exist; however, it is possible not only to mitigate them but also to eliminate the majority of them altogether.
2. There are hopeful prospects for the development of public-private partnerships in Russia. An affirmation of this is the creation of government corporations.
3. An important and essential element of developing partnerships between public and private entities is perfecting the legislative and regulatory bases.
4. The highest priority, and the most important element in the business of creating partnerships between the public and private sectors, is to expedite the development of instruments and mechanisms to provide financial and economic support to joint projects and programs.
5. The author is in full agreement with the conclusions of *Overcoming Impediments*:

[256] Former military personnel work for a whole series of shareholder commercial banks in Russia and are in essence doing what they used to do, working on issues of using nuclear power installations on nuclear submarines, nuclear weapons, disarmament, and providing technical safety to personnel, weaponry and military technology.

- "the overall tenor of the cooperation would improve if the United States and Russia could return to a vigorous agenda of confidence-building activities"[257]
- "both nations would do well to draw from a variety of solutions to problems"[258]
- "a solution set is a useful goal, rather than a single right answer"[259]

6. In order to resolve problems related to the topic being discussed in Russia, it is entirely possible to use entities such as state corporations, including the state corporation *Rostekhnologiia*, which is being created.

[257] *Overcoming Impediments*, p. 118.
[258] Ibid.
[259] Ibid, 119.

# U.S. AND RUSSIAN COLLABORATION IN THE AREA OF NUCLEAR FORENSICS

Michael J. Kristo,*
*Lawrence Livermore National Laboratory*[260]

Nuclear forensics[261] has become increasingly important in the fight against illicit trafficking in nuclear and other radioactive materials.[262] The illicit trafficking of nuclear materials is, of course, an international problem; nuclear materials may be mined and milled in one country, manufactured in a second country, diverted at a third location, and detected at a fourth. There have been a number of articles in public policy journals in the past year that call for greater interaction between the United States and the rest of the world on the topic of nuclear forensics.[263] Some believe that such international cooperation would help provide a more certain capability to identify the source of the nuclear material used in a terrorist event. An improved

* I want to thank David Smith and Dr. Mona Dreicer for their leadership and helpful discussions about this work. This work was performed under the auspices of the U.S. Department of Energy (DOE) by Lawrence Livermore National Laboratory (LLNL) under Contract DE-AC52-07NA27344. Our work in the area of nuclear forensics has been conducted over the past few years with support from the Department of Homeland Security/Domestic Nuclear Detection Office (through both the NTNFC and NAP programs), DOE/NA-242, DOE/NA-241, and DOE/NA-22.



261 The term "nuclear forensics" does not seem to have a direct Russian equivalent. It is sometimes translated as "nuclear criminalistics" or "identification of nuclear material." Neither of these terms gives the precise meaning of the English term. Consequently, the definitions of the terms "nuclear forensics" and "nuclear attribution" provided in the second section of the paper should be linked to whatever Russian words are used in the rest of the paper to translate these terms.

262 International Atomic Energy Agency (IAEA), "Nuclear Forensics Support," *IAEA Nuclear Security Series* No. 2, (2006).

263 For example, see: M. May, J. Davis, R. Jeanloz, *Nature*, Vol. 443 no. 7114, page(s) 907-908 (October 25, 2006); William Dunlop and Harold Smith, "Who Did It? Using International Nuclear Forensics to Detect and Deter Nuclear Terrorism," *Arms Control Today*, October 2006, pp. 6-10; Graham Allison, "Deterring Kim Jong Il," *The Washington Post*, October 27, 2006; D. Chivers, "International Nuclear Forensics Regime: A Framework for a New Strategic Deterrence," presentation to the U. S. House of Representatives Foreign Affairs Committee, February 2, 2007; and, S. Niemeyer and D. Smith, "Following the Clues: The Role of Forensics in Preventing Nuclear Terrorism," *Arms Control Today*, Vol. 37, No. 6 (July/August 2007), pp 14-15.

international nuclear forensics capability would also be important as part of the International Atomic Energy Agency (IAEA) verification toolkit, particularly linked to increased access provided by the Additional Protocol.
Not all countries have signed the Additional Protocol, so such sampling may be limited. However, under the Treaty on the Non-Proliferation of Nuclear Weapons,[264] Special Inspections allow for sampling as well, although this type of inspection is not often used.

A recent study has found that, although international progress has been made in securing weapons-usable highly enriched uranium (HEU) and plutonium (Pu), the effort is still insufficient.[265] It found that nuclear material, located in 40 countries, could be obtained by terrorists and criminals and used for a crude nuclear weapon. Through 2006, the IAEA Illicit Trafficking Database (ITDB) had recorded a total of 607 confirmed events involving illegal possession, theft, or loss of nuclear and other radioactive materials.[266] Incidents confirmed to the ITBD involving weapons-useable material total over 8.3 kg of HEU and 370 g of Pu. Although it is difficult to predict the future course of such illicit trafficking, increasingly such activities are viewed as significant threats that merit the development of special capabilities. As early as April 1996, nuclear forensics was recognized at the G8 Summit in Moscow as an important element for monitoring and deterring illicit nuclear trafficking. Given international events over the past several years, the value and need for nuclear forensics seems greater than ever.

Determining how and where legitimate control of nuclear material was lost and tracing the route of the material from diversion through interdiction are important goals for nuclear forensics and attribution. It is equally important to determine whether additional devices or materials that pose a threat to public safety are also available. Finding the answer to these questions depends on determining the source of the material and its method of production. Nuclear forensics analysis and interpretation provide essential insights into methods of production and sources of illicit radioactive materials. However, they are most powerful when combined with other sources of information, including intelligence and traditional detective work. The certainty of detection and punishment for those who remove nuclear materials from legitimate control provides the ultimate deterrent for such diversion and, ultimately, for the intended goal of such diversion, including nuclear terrorism or proliferation. Consequently, nuclear forensics is an integral part of "nuclear deterrence" in the 21st century.

Nuclear forensics will always be limited by the diagnostic information inherent in the interdicted material. Important markers for traditional forensics (fingerprints, stray material, etc.) can be eliminated or obscured, but many nuclear materials have inherent isotopic or chemical characteristics that serve as unequivocal markers of specific sources, production processes, or transit routes. The information needed for nuclear forensics goes beyond that collected for most commercial and international verification activities. Fortunately, the international nuclear engineering enterprise has a restricted number of conspicuous process steps that makes the interpretation process easier. Ultimately, though, it will always be difficult to

---

264 To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

265 Matthew Bunn, *Securing the Bomb 2007* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, September 2007).

266 See Anzelon, G., Hammond, W., Nicholas, M., "The IAEA's Illicit Trafficking Database Programme," Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radioactive Sources (Proc. Conf. Stockholm, 2001), *C&S Papers Series* No. 12, IAEA, Vienna (2002); and, International Atomic Energy Agency, "Illicit Trafficking Database (ITDB)," Vienna, (2003).

distinguish between materials that reflect similar source or production histories, but are derived from disparate sites.

Due to the significant capital costs of the equipment and the specialized expertise of the personnel, work in the field of nuclear forensics has been restricted so far to a handful of national and international laboratories. There are a limited number of specialists who have experience working with interdicted nuclear materials and affiliated evidence. Therefore, a knowledge management system that utilizes information resources relevant to nuclear forensic and attribution signatures, processes, origins, and pathways, and allows subject matter experts to access the right information in order to interpret forensics data and draw appropriate conclusions, is essential. In order to determine the origin, point of diversion of the nuclear material, and those responsible for the unauthorized transfer, close relationships are required between governments who maintain inventories and data of fissile or other radioactive materials. Numerous databases exist in many countries and organizations that could be valuable for the future development and application of nuclear forensics. The contents of many of these databases may never be shared directly, but even the development of a worldwide, "distributed" database would greatly benefit international efforts. Only by sharing information about nuclear processes and materials can participants benefit from collective experience and knowledge to evaluate and prosecute nuclear trafficking cases. By encouraging the participation of those states where nuclear materials originate, the international community of nuclear forensics scientists gain important insights into the material required to deter future acts of nuclear smuggling.

## DEFINITIONS

Historically, the terms "nuclear forensics" and "nuclear attribution" have been used interchangeably. Over the past few years, however, nuclear forensics experts have emphasized a distinction between the two terms.

***Nuclear attribution*** is a process to identify the source of nuclear or other radioactive materials used in illegal activities, determine the point-of-origin and routes of transit involving such material, and ultimately contribute to the prosecution of those responsible. Nuclear attribution utilizes many inputs including: 1) results from nuclear forensic sample analyses; 2) understandings of radiochemical signatures and environmental signatures; 3) knowledge of the methods for production of nuclear materials and nuclear weapons development pathway; and 4) information from law enforcement and intelligence sources. Nuclear attribution is the integration of all relevant forms of information about a nuclear smuggling incident into data that can be readily analyzed and interpreted to form the basis of a confident response to the incident. The goal of the attribution process is to answer policy makers' needs, requirements, and questions in their framework for a given incident.

***Nuclear forensics*** is the analysis of intercepted illicit nuclear or radioactive materials and any associated materials to provide evidence for nuclear attribution. The goal of nuclear forensics analysis is to identify forensic indicators in interdicted nuclear and other radioactive samples or its surrounding environment, e.g., the container or transport vehicle. These indicators arise from known relationships between material characteristics and process history. Thus, nuclear forensics analysis includes the characterization of the material and correlation with production history.

# KEY U.S., RUSSIAN, AND INTERNATIONAL ACTORS

## United States

There are several U.S. governmental departments and organizations with an interest in nuclear forensics. The National Technical Nuclear Forensics Center (NTNFC) has the central coordinating role for nuclear forensics in the U.S. government. In addition, they provide direct financial support to the material nuclear forensics research and development program. The NTNFC is a part of the Domestic Nuclear Detection Office (DNDO) in the Department of Homeland Security (DHS).

As the primary investigative arms of the U.S. Department of Justice, the Federal Bureau of Investigation (FBI) has lead responsibility for investigating domestic incidents of nuclear trafficking and terrorism. As such, the FBI is responsible for supervising the collection, handling, and analysis of nuclear forensics evidence.

The U.S. Department of State is the lead department for all interactions with foreign governments. There are a number of groups within the State Department with an interest in nuclear forensics, including the Nuclear Trafficking Response Group, the Nuclear Smuggling Outreach Initiative, the Preventing Nuclear Smuggling Program, the Office of Cooperative Threat Reduction, and the Global Initiative to Combat Nuclear Terrorism.

The Defense Threat Reduction Agency, a part of the Department of Defense, primarily funds activities in post-detonation nuclear forensics, that is, activities aimed at providing information for attribution of a detonated nuclear device (nuclear yield) or radiological dispersal device.

The National Nuclear Security Agency (NNSA) within the Department of Energy (DOE) also has several organizations interested in nuclear forensics:

- A new organization (NA-45) has been created with the responsibility for interdicted, but unexploded, nuclear devices. This mission includes not only ensuring that the device is rendered safe, but also for enabling the analysis of the device and its constituent materials necessary to determine its origin.
- In the Defense Nuclear Non-proliferation Program, different offices have funded research and development in some areas of nuclear forensics as part of their mission area in Dismantlement and Transparency (NA-241); international initiatives as part of their mission in Global Security Engagement and Cooperation (NA-242; and research and development activities with direct application to nuclear forensics (NA-22).

As experts in the technology of nuclear weapons and the civilian and military fuel cycles, the DOE national laboratories provide technical support for these U.S. government programs. Laboratories conducting research and development in the area of nuclear forensics include Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory, Pacific Northwest National Laboratory, Argonne National Laboratory (ANL), Savannah River National Laboratory (SRNL), Oak Ridge National Laboratory (ORNL), Sandia National Laboratory, and Idaho National Laboratory.

## Russia

In the Russian Federation, the Ministry of Foreign Affairs is responsible for interactions with foreign governments and is the counterpart to the U.S. Department of State. Delegations from the U.S. Department of State and the Russian Ministry of Foreign Affairs form the bilateral Counter Terrorism Working Group.

Rosatom is the Federal Atomic Energy Agency and is responsible for the Russian nuclear enterprise. Rosatom provides policy guidance and control to the many Russian institutes and nuclear manufacturing sites.

The Bochvar All-Russian Scientific Research Institute of Inorganic Materials (VNIINM) has been designated as the leading institute for nuclear forensics in Russia. However, all of the Russian institutes and combines have expertise relevant to the nuclear forensics mission, including All-Russia Scientific Research Institute of Technical Physics (VNIITF), the All-Russian Research Institute of Experimental Physics (VNIIEF), the Angarsk Electrolytic Chemical Combine, the Mayak Production Association, Novosibirsk Chemical Concentrate, Elektrostal, etc.

Russian law enforcement organizations would be expected to play a major role in any nuclear smuggling or terrorism incident. In particular, the Federal Security Service of the Russian Federation would be expected to play a major role as the organization responsible for internal and border security, as well as counter-terrorism.

## European Union

The Institute for Transuranium Elements (ITU) is the nuclear forensics laboratory for the European Commission. Nevertheless, many of the countries of the European Community have their own national nuclear forensics laboratories. For example, the French nuclear forensic laboratory is the Commisariat à l'Énergie Atomique. The British nuclear forensics laboratory is part of the Atomic Weapons Establishment.

## International Technical Working Group

Many international nuclear forensics laboratories are cooperating to develop common technical strategies and knowledge bases that catalog nuclear processes for use in interpretation. The Nuclear Smuggling International Technical Working Group (ITWG) was formed in 1996 to foster international cooperation in combating illicit trafficking of nuclear materials.[267] More than 30 nations and organizations have participated in 11 international meetings and two round-robin analytical trials to-date. Technical priorities for the ITWG include the development of accepted protocols for the collection of evidence and laboratory investigations, the prioritization of techniques and methods for forensic analyses for nuclear and non nuclear samples, the organization of inter-laboratory forensic exercises, the development of forensic databases to assist in interpretation, and technical assistance for requesting countries.

The nuclear forensics laboratories participating in the ITWG are committed to undertaking the characterization of nuclear or other radioactive materials that have been confiscated and submitted to analysis by legal prosecution authorities. These laboratories have pledged to cooperate closely among themselves and with prosecuting authorities in order to

[267] Nuclear Smuggling International Technical Working Group (ITWG), Terms of Reference, (June 1997).

facilitate the elucidation of illicit events involving nuclear and other radioactive materials. U.S. participation in the ITWG is sponsored by the U.S. State Department. Scientists from LLNL and PNNL have represented the United States from a scientific and technological perspective, while federal employees from the U.S. Department of State, DHS, and DOE have represented U.S. policy interests over the years. Historically, the Russian Federation has been represented by attendees from Rosatom, although there was broader Russian participation at the ITWG Meeting in Obninsk in 1996. At ITWG-10 in Umea, Sweden, in 2007, two scientists from the Bochvar Institute accompanied the Rosatom representative and immediately became active participants in the meeting.

The IAEA is an active participant in this group and serves as an intermediary between individual countries and the ITWG as necessary. The IAEA also keeps track of the nuclear smuggling problem through the ITDB.

## AREAS OF POTENTIAL COLLABORATION

### Improved Methods of Analysis

Scientific analyses are the source of all nuclear forensic data. In general, improving methods of analysis is considered a purely scientific endeavor – with few, if any, security restrictions. Therefore, improving our methods of analysis might be an easy place to begin collaboration. However, incremental improvement in the precision and accuracy of existing analytical techniques (Part 2 of this paper) are not likely to produce significant improvements in the nuclear forensic conclusions. Techniques that measure new properties of the material, which are independent from currently measured properties and strongly influenced by manufacturing process or location, would be particularly valuable.

Techniques that are significantly more sensitive or have significantly greater spatial resolution may also be valuable. Some analytical techniques currently require more sample material than is typically available; research and development to reduce the amount of material required would be important. So also, techniques that reduce the limit of detection or improve spatial resolution may reveal signatures that are hidden from us now. Previous efforts have moved signature discovery from the realm of bulk signatures (mm spatial scale) to micro-signatures (μm spatial scale); now, we need to move into the realm of nano-signatures (nm spatial scale).

### Signature Discovery

More important to the nuclear forensics enterprise than improved analytical techniques, though, is the discovery of new signatures – properties of the material that reveal the creator, how it was made, why it was made, and so on. Signatures provide meaning to the analytical data. However, for the same reason that signature discovery is more critical to nuclear forensics, it is also subject to more concerns – proprietary concerns, security concerns, etc. We still may be able to make progress, despite these concerns, in two ways. First, we can start by working together to identify signatures for lower-threat nuclear materials, e.g., uranium ores, uranium ore concentrates (yellowcake), $UCl_4$, $UF_6$, or reactor fuel pellets. The material characteristics of these materials will not be as sensitive as higher-threat nuclear fissionable materials, such as HEU or Pu. As we build trust in our cooperative enterprise, we may be able to move toward these higher threat materials. Second, we can start developing generalized signatures, which cause less security concerns, and work toward more specific ones. For example, we may feel very comfortable in saying that "we find that the concentrations of Nb, Re, and W in reactor fuel pellets are very indicative of the fuel manufacturer," but not comfortable in saying that "this specific manufacturer always has between 30 and 40 ppmw (part per million by weigh) of Nb in their material."

## Knowledge Management and Analysis Techniques

Knowledge management is one area that is both important for the future of nuclear forensics and one that can be approached independently from concerns about data security. The fully populated nuclear forensics database is expected to be vast, particularly considering the broad range of nuclear materials to be covered and the extensive list of materials properties that may be important. We hope that the signatures discovery process will be able to reduce the number of properties required for adequate identification, but, until that proves to be the case, nuclear forensic data is likely to include as many properties as can be measured, given time and funding. In addition to raw nuclear forensics data, we also need the ability to store information about production processes and locations throughout the history of nuclear materials production.

Areas of productive collaboration might include methods for storing and managing all of this information, and methods for analyzing these large amounts of multidimensional data in order to extract signatures using new, or at least newly applied, mathematical and statistical techniques. For example, at LLNL, we are exploring the use of principal components analysis and partial least squares discriminant analysis for reducing the dimensionality of the data to allow the user to visualize patterns and groupings in the data.

## Confidence Articulation

Ultimately, national decision makers will want clearly stated answers with an appropriate estimate of the reliability of that answer. Conclusions will, no doubt, be reached by the application of multiple signatures, each with its own estimate of reliability, to multiple material analyses, each with its own measured precision and accuracy. All of these uncertainties must be reduced to an overall level of confidence. This end goal will require the development and application of very sophisticated statistical methods. These research and development projects could, again, be conducted independently of tightly held data and signatures.

## Education and Training of Scientists for Nuclear Forensics

Nuclear forensics requires scientists and engineers with highly specific skills, for example, in nuclear engineering, radiochemistry, analytical chemistry, and geochemistry. Many of the existing experts in these fields are at, or near, retirement age. Because the demand for these skills decreased markedly after the cessation of nuclear weapons testing, new scientists and engineers with these skills have not been trained in great numbers. Many university programs in these disciplines have disappeared or have decreased markedly. Now, these skills are once again needed for research, development, and execution of nuclear forensics analysis. Therefore, training of young scientists and engineers is an area in which the Russian Federation and the United States could collaborate, with the goal of having a workforce in 2015 with the skills necessary to continue improving nuclear security.

## Future Nuclear Fuel Cycles

The Global Nuclear Energy Partnership, recently announced by DOE Secretary Samuel Bodman,[268] poses significant new challenges with regard to securing, safeguarding, monitoring and tracking nuclear materials. In order to reduce the risk of nuclear proliferation, new technologies must be developed to reduce the risk that nuclear material can be diverted from its intended use. Regardless of the specific nature of the fuel cycle, nuclear forensics and attribution will play key roles to ensure the effectiveness of non-proliferation controls and to deter the likelihood of illicit activities. Ensuring that individuals or organizations participating in illicit trafficking are rapidly identified and apprehended following theft or diversion of nuclear material will continue to provide the best deterrent against unlawful activities. Key to establishing this deterrent is developing the ability to rapidly and accurately determine the identity, source and prior use history of any interdicted nuclear material.

Taggants offer one potentially effective means for positively identifying lost or stolen nuclear fuels. Taggants are materials that can be encoded with a unique signature and introduced into nuclear fuel during fuel fabrication. During a nuclear forensics investigation, the taggant signature can be recovered and the nuclear material identified through comparison with information stored in an appropriate database. Unlike serial numbers or barcodes, taggants can provide positive identification with only partial recovery, providing extreme resistance to any attempt to delete or alter them. The concept of taggants has been previously employed in the manufacture of explosives[269] and in the prevention of counterfeiting.

We have investigated the characteristics of a number of elements for use as potential taggants by modeling their behavior under irradiation using a standard reactor depletion code. We concentrated our efforts on elements that lie on either side of the fission yield curve (masses below ~70 or above ~170) to avoid overwhelming the taggant signature with the resulting build-up of fission products. In evaluating the results of these simulations, we looked for elements with multiple isotopes of low neutron absorption cross-sections. The ratios of these elements will not change very much during irradiation and can be used to encode information about the fuel. It would also be desirable to have a few isotopes that do change markedly under irradiation, since the relative abundance of these isotopes in irradiated fuel could serve as a measure of the neutron energy spectrum of the reactor and the fluence experience by the fuel.

Many questions regarding the behavior of the taggant during reprocessing and the effect of low levels (tens of ppmw) of the taggant on fuel fabrication and performance have yet to be addressed. These studies would be excellent areas for joint research and development activities.

---

[268] For further information regarding the U.S. Global Nuclear Energy Partnership, see http://nuclear.inl.gov/gnep/index.shtml; accessed April 6, 2008.

[269] Office of Threat Assessment Study, “Taggants in Explosives,” April 1980 (U.S. Government Printing Office: Washington, D.C., 1980)

### International Leadership

In 2005 and 2006, Presidents George W. Bush and Vladimir Putin announced the Bratislava Initiatives and the Global Initiative to Combat Nuclear Terrorism, respectively.[270] In the name of nuclear security cooperation and building capacity to combat terrorism, these initiatives call for enhancing ability to detect and suppress illicit trafficking and other illicit activities involving nuclear and radiological materials. Bi-lateral cooperation in this area would improve technical capabilities, by bringing together our countries excellent expertise in the area of nuclear forensics. Such cooperation would also set a significant precedent that might encourage greater international cooperation and sharing in this important non-proliferation and counterterrorism arena, particularly as the future international nuclear fuel cycle framework evolves.

## CHALLENGES TO ADDRESS

### Security

The primary obstacles to greater nuclear forensics collaboration between the United States and the Russian Federation are security concerns regarding sharing of data and knowledge. To further complicate this challenge, the security restrictions placed on information sharing are not symmetrical. For example, the United States considers the isotopic composition of its HEU to be unclassified, while the Russian Federation considers it a state secret. On the other hand, the United States considers the mass of certain components of its nuclear weapons to be classified, while the Russian Federation does not.

Under some circumstances, the U.S. and the Russian Federation have shared classified or sensitive information with each other. For example, as part of the HEU Transparency Program, some of the isotopic data that the Russians consider classified was shared with the U.S. Further consideration of the ability to share information should balance the risk of disclosure with the benefit of disclosure. Balancing the potential benefits, for both Russia and the U.S., of a greatly improved nuclear forensics system, enabling rapid identification of nuclear material to improve counter-terrorism and non-proliferation capabilities, with national security concerns, should be explored more fully in the near future.

### Funding

The U.S. has greatly increased the level of funding for nuclear forensics research and development since the terrorist attacks of September 11, 2001. Prior to this event, nuclear forensics was funded in a small way by far-sighted managers in the DOE and by internal investments by a few national laboratories. However, despite this significant increase, the

[270] Presidents George W. Bush and Vladimir V. Putin, Joint Statement, St. Petersburg, Russia, July 15, 2006, found at http://www.state.gov/p/eur/rls/or/69021.htm; accessed May 1, 2008. The text of the G8 Global Initiative to Counter Nuclear Terrorism can be found at http://www.g8.gc.ca/2002Kananaskis/gp_stat-en.pdf, accessed on April 6, 2008. For further information, see http://www.state.gov/t/us/rm/69124.htm; accessed May 1, 2008. See also Appendix D.

overall level of funding is small compared to the vastness of the technical issues that need addressing. There are multiple efforts, both inside and outside of the U.S. government, to assess the state of the U.S. nuclear forensics program, including the determination of the appropriate funding levels.

Nuclear forensics research and development performed in the Russian Federation appears to be largely funded by the U.S. In order to gain high-level support within the Russian government for increased funding of this area, we may need to emphasize the relevance of nuclear forensics to anti-terrorism efforts, which seems to be an area of greater concern to Russians than non-proliferation.

Looking to the future, this area of cooperation seems to be ideally suited for new U.S.-Russian partnerships bilaterally and with third countries, should adequate national funding be obtained.

## Legal and Policy Framework for Cooperation

Much of our collaborative work in nuclear forensics has been conducted so far with reference to technical cooperation under the nuclear material protection, control, and accounting (MPC&A) program. Although MPC&A is quite different from nuclear forensics, often the master task agreements negotiated under the MPC&A program are broad enough to accommodate nuclear forensic activities. Another umbrella agreement that has been used is the Warhead Safety and Security Exchange Agreements. This agreement, in negotiation for renewal, provides for the exchange of unclassified technical information to enhance nuclear safety and security in both Russia and the United States.

The International Science and Technology Center (ISTC), established in 1992, is a program that the U.S. has used to fund cooperative research projects with Russian institutes. The ISTC coordinates the efforts of numerous governments, international organizations, and private sector industries, providing weapons scientists from Russia and the Commonwealth of Independent States with new opportunities in international partnership. Through its political, legal, and financial frameworks, the ISTC contributes to Fundamental Research, International Programs and Innovation and Commercialization, by linking the demands of international markets with the exceptional pool of scientific talent available in Russian and Commonwealth of Independent States' institutes.

There are several bilateral and international agreements that support the ultimate goal of nuclear forensics, i.e., the deterrence of nuclear smuggling and ultimately nuclear proliferation and terrorism. United Nations Security Council Resolution 1540 obligates states to take steps to prevent the spread of weapons of mass destruction and supporting technologies.[271] The Global Initiative to Combat Nuclear Terrorism, originally signed by Presidents George W. Bush and Vladmir V. Putin in 2006, has broad enough coverage to support many collaborative activities in nuclear forensics and related activities. In the context of these agreements, new bilateral agreements between the U.S. and Russia may be needed to support the data exchange necessary for a completely successful collaboration in nuclear forensics.

---

[271] To read the text of United Nations Security Council Resolution 1540, see http://daccessdds.un.org/doc/UNDOC/GEN/N04/328/43/PDF/N0432843.pdf?OpenElement; accessed April 6, 2008.

# CONCLUSIONS

There are many challenges that the United States and Russia can work to overcome in the coming years. Bilateral and multilateral cooperation is needed to advance an international forensics capability, and is needed to combat terrorism and stop nuclear weapons proliferation. Whether we pursue the establishment of an international sample archive or an actual sample library, with an internationally managed data and knowledge base, solutions will require a long time and many difficult negotiations to gain approval from all of the relevant countries. The U.S. and Russia can work together to initiate an approach that will advance international cooperation.

No collaboration in the area of nuclear forensics can be more important than that between the United States and Russia. We are the two largest nuclear weapons states in size and capability. We have the largest stockpiles of weapons and material, the greatest number of experts in all facets of the nuclear enterprise, and both face the unacceptable risk of weapons-usable material falling into the wrong hands. With proper funding from both governments and with the appropriate bilateral agreements that allow appropriate data exchange while still protecting each country's national security interests, we can make great progress together in improving our mutual nuclear forensics capabilities and strengthening the deterrence effect that it engenders and set an example for greater international cooperation.

# PART II: LAWRENCE LIVERMORE NATIONAL LABORATORY COLLABORATIONS WITH RUSSIAN AND INSTITUTES OF THE FORMER SOVIET UNION

## Analysis of Interdicted HEU Sample

Lawrence Livermore National Laboratory (LLNL) and the Bochvar All-Russian Scientific Research Institute for Inorganic Materials (VNIINM) collaborated on the analysis of an HEU sample from 2004-2006. Bulgarian customs officers interdicted the sample on May 29, 1999. The sample was transferred to LLNL for analysis on February 24, 2000. Extensive analysis of the sample was performed by LLNL, ORNL, ANL, and SRNL. These analyses confirmed that the material was HEU (~73 percent U235) from irradiated reactor fuel reprocessed around 1993. Nuclear and forensic signatures suggested an origin in Russia or the former Soviet Union.

The U.S.-Russian Counter Terrorism Working Group sought to establish a model for real-time interaction between U.S. national laboratories and Russian institutes on a real nuclear forensics case. They established an action item during their meeting on July 22-23, 2003, for the United States to provide a portion of the "Bulgarian" HEU sample to a Russian institute for nuclear forensic analysis, including confirming laboratory analyses, reactor modeling, and material identification. This was considered to be a first step towards a new mechanism for sharing information and analysis relating to illicitly trafficked nuclear material. As part of this first step, the United States would provide funding for the Russian analysis of the sample and interpretation of the results.

LLNL was identified as the U.S. technical lead on the project. The Bochvar Institute was identified as the Russian nuclear forensics laboratory for the project. Accordingly, LLNL negotiated a contract with the Bochvar Institute for the analysis and interpretation of a 0.59 gram aliquot of the original sample. Because of the small sample size, the Bochvar Institute was not able to perform a full radiochemical analysis, similar to that performed by LLNL. The contract between LLNL and VNIINM was signed on July 8, 2004, by both parties.

The analyses by the Bochvar Institute confirmed the findings of the U.S. national laboratories in all respects. In addition, the Russians found a minor, Al-containing phase in the sample that was not found in the U.S. analyses. This phase could possibly be important in the attribution process. The Russians agreed with the general interpretations of the U.S. researchers: that the material was reprocessed HEU, that it was irradiated in a reactor to extremely high burn-up, and that it was probably being prepared for research reactor fuel. However, they felt that this sample could have been produced by any nuclear state possessing the appropriate processing facilities and could not be attributed uniquely to any country.

At the post-project meeting, both sides agreed on the following areas for future cooperation:

- better understanding of each other's methodologies and techniques
- improved data sets (databases)
- Bochvar's participation in nuclear forensic analytical round robins
- enlightening both country's policy makers on areas in which mutual cooperation is possible and areas in which mutual cooperation is not possible

## Identifying Characteristics of Research Reactor Fuel

LLNL collaborated with the Federal State Unitary Enterprise-Russian Federal Nuclear Center, All-Russian Scientific Research Institute of Technical Physics (VNIITF), located in Snezhinsk, in the area of identifying characteristics of research reactor fuel. Research reactor fuel is one of the most significant nuclear threats because the material is frequently HEU and weapons-usable, and many research reactors are pulse reactors that experience very low burn-up. Consequently, the radioactivity in the fuel elements decays very quickly after use so the HEU parts can often be picked up by hand after only a few days without any adverse consequences. In addition, research reactors are frequently not protected at a level commensurate with the risk of diversion of a significant quantity of HEU.[272]

VNIITF conducted detailed materials analyses of three research reactor fuels. However, VNIITF had difficulty in obtaining export approval for the resulting data and eventually provided a report compiled from fuel design specifications and "binned" experimental data. The researchers at VNIITF, after discussions with Rosatom, believe that a database on research reactor fuel could be populated as part of a bilateral U.S. and Russian effort. A current contract between LLNL and VNIITF is exploring this possibility. This contract is funded by the NTNFC, an organization in DNDO of DHS. This FY07 contract consists of three tasks:

[272] See paper by Philipp Bleek and Laura Holgate in this volume.

1. Development of data structures and format for a bilateral U.S./Russian database for research reactor fuel. The key goal of this task is the test-loading of the database with data from one U.S. and one Russian research reactor.
2. Development of animations of one U.S. and one Russian research reactor. It is felt that these animations are necessary to understand the mechanical structure of the research reactor fuel. Research reactor designs are highly individualized and typically consist of many fissile and non-fissile parts.
3. Development of methods for reconstructing the original geometry of research reactor parts from fragments of the original fuel.

We believe that the success of this project will lead to a larger effort that must necessarily involve the participation of multiple Russian institutes and U.S. national laboratories. It will also require high-level approval from the U.S. and Russian governments in order to populate the database with information about some of the more sensitive reactor designs.

## LLNL Collaboration with the Former Soviet Union

Over the past fifty years, Central Asia has supplied the majority of uranium to the military and civilian nuclear fuel cycle of the Soviet Union and subsequently to the republics of the former Soviet Union. Therefore, uranium ores, ore concentrates, and reactor fuels collected from Central Asia are critical elements for any sample reference library for nuclear forensics.

Over the past three years, DHS has funded LLNL to collaborate with specialists with the Kazakhstan National Atomic Agency, Kazatomprom, to understand the characteristics of their uranium ore concentrate. In addition, the same project funds a project at the ULBA Metallurgical Plant, a subsidiary of Kazatomprom and one of the largest nuclear fuel manufacturers in the world, to conduct research on the identifying characteristics of low-enriched uranium oxide fuel pellets.

The Global Security Engagement and Cooperation (GSEC) Office of NNSA is supporting efforts to combat international nuclear smuggling through widening the knowledge base of uranium ore, uranium ore concentrates, and uranium tailings in Central Asia. In FY06, GSEC and LLNL teamed with technical experts from Vostokredmet in Tajikistan to sample and characterize uranium ore and uranium tailings from the country's Taboshar and Karta 1-9 uranium mining and milling sites. In FY07, GSEC and LLNL expanded this work to Kyrgyzstan, where they partner with the Ministry of Emergencies to sample and analyze uranium ores and uranium ore concentrates from the Kara Balta and Ming Kush sites. All of these samples have been, or will be, analyzed for major, minor, and trace elements, as well as the isotopic composition of the uranium.

Our initial results indicate the ability of the forensics signatures to differentiate unique sources of Central Asian uranium. For example, in Tajikistan, concentrations of the alkali elements (Na), alkaline earth elements (Ca), trace elements, such as Zn, Pb, V, and Ni, light rare earth elements (Ce, La, Nd) and U-234 isotopic content vary uniquely and distinguish individual sources of uranium. Based on these results, sampling is being expanded to include other sites in Kyrgyzstan and Uzbekistan. Together, this collaboration and these results are the foundation of a comprehensive nuclear forensics program in Central Asia.

Since 2002, LLNL has also partnered with the Uzbekistan Institute of Nuclear Physics in Tashkent, with funding provided by the Institute for Science and Technology of Ukraine, in a number of projects aimed at improving Uzbekistan's capabilities to detect and analyze illicit nuclear material. For example, one project funded the deployment of a network for radiation monitors at the over 400 border checkpoints in Uzbekistan for the detection of the movement of radioactive materials across their borders. Another project funded the development of a mobile laboratory to provide interdiction support to these checkpoints, as well as rapid response in the event of accidents releasing contamination. Still another project funded the development of modern nuclear forensic methods for detecting, determining, and origination of materials seized in illegal trafficking cases.

## PART III: THE NUCLEAR FORENSIC PROCESS[273]

### Incident Response

IAEA-TECDOC-1313 "Response to events involving the inadvertent movement or illicit trafficking of radioactive materials" provides detailed recommendations for the initial response to the interdiction of illicit nuclear material.[274] There are 3 key goals to any response:

- minimization of any radiation hazards associated with the incident site
- control of the nuclear or other radioactive material
- preservation of both nuclear and associated traditional forensic evidence

From the standpoint of nuclear forensics, preservation of the evidence is vital. All activities should be sequenced to minimize destruction or contamination of the evidence. Furthermore, the collection of traditional forensics evidence should be performed in a manner that preserves the integrity of the nuclear forensics evidence and *vice versa*. It is essential that appropriate thought be given to the timing of the collection of radioactive evidence relative to traditional forensic evidence. However, the collection of forensic evidence must always be consistent with good radiological safety practice. Because of these detailed considerations, the incident investigators should be trained as, or accompanied by, a forensic scientist.

Due consideration must also be given to the legal ramifications of evidence collection. For example, the incident investigators must maintain appropriate chain-of-custody procedures during the evidence collection process. The nuclear forensic laboratory must then maintain the chain-of-custody paperwork that will tie the analytical results and conclusions to specific samples and crime scene locations.

### Sampling and Distribution

Evidence should be sent for analysis at a nuclear forensics laboratory, which is equipped to receive and process such samples. It is highly likely that the evidence would be commingled,

---

[273] For more information, see IAEA, "Nuclear Forensics Support," *IAEA Nuclear Security Series,* No. 2, Vienna (2006).

[274] For more information, see IAEA, "Response to events involving the inadvertent movement or illicit trafficking of radioactive materials," IAEA-TECDOC-1313, sponsored by the IAEA, World Customers Organization, Europol, and Interpol, Vienna, (September, 2002).

that is, that the traditional forensic evidence would be contaminated with radioactive material and that the radioactive material contains some forensic evidence. Therefore, the receiving laboratory should be able to handle radioactive material and carefully separate the traditional forensic evidence from the radioactive material for later analysis by experts in each discipline. Nuclear forensics laboratories are outfitted and staffed to handle contaminated evidence and accommodate the requirements of both traditional forensics and nuclear analysis.

The nuclear analysis laboratory should be an appropriately accredited and recognized facility with analytical procedures and staff qualifications that are documented and can withstand both scientific peer-review and legal scrutiny. The receiving laboratory must be able to receive and handle large amounts of nuclear materials (e.g., in hot-cells), yet still be able to analyze trace levels of the material constituents and environmental types of materials (e.g., in clean rooms). It should be fully qualified to current standards in environmental, safety, and health protocols, hazardous waste disposal procedures, and hazardous materials handling and storage. The nuclear analysis laboratory should be intimately familiar with the requirements of a legal investigation, including the ability to perpetuate the sample chain-of-custody that began in the field.

## Analysis of Material

The forensic scientists would first develop an initial experimental plan, including methods for preventing contamination or cross-contamination of the evidence. Because of the dynamic nature of the forensics process, the scientists would modify the experimental plan as new information about the sample or the investigation is obtained. Since nuclear material is often not homogeneous, a single bulk analysis may not be appropriate to fully categorize, characterize, or attribute the sample. Good sampling techniques would be required to adequately characterize the radioactive evidence. Particles of stray minerals, unique industrial materials, pollen, spores, etc., may become associated with the package along the trafficking route. The unique signatures of such particles may provide strong evidence of the route taken by the package. In addition, when the amount of material being sampled is small, the experimental plan must allocate the limited amount of sample. In this case, it is important that all non-destructive analyses be performed first and that trace and microanalytical techniques be favored over techniques that require large amounts of material.

### *Nuclear Material Analysis*

Nuclear forensics involves an iterative approach, in which the results from one analysis are used to guide the selection of subsequent analyses. In this way, radioactive materials analysis applied to nuclear forensics proceeds in a manner not unlike that of traditional forensic analysis. It is important to emphasize that all sampling and analysis must be performed with due regard for preservation of evidence and perpetuation of the chain-of-custody. The sampling process can equally extract and obliterate evidence. Many of the analytical tools used in radioactive materials analysis are destructive, that is, they consume some amount of sample during analysis. Therefore, the proper selection and sequencing of analyses is critical.

The nuclear forensic scientist has a wide array of analytical tools to use for detecting signatures in radioactive material. These individual techniques can be sorted into three broad categories: bulk analysis tools, imaging tools, and microanalysis tools. *Bulk analysis* tools allow the forensic scientist to characterize the elemental and isotopic composition of the radioactive material as a whole. In some cases, bulk analysis is necessary to have sufficient material to adequately detect and quantify trace constituents. *Imaging analysis* tools provide high magnification images or maps of the material and can confirm sample homogeneity or heterogeneity. Imaging will also capture the spatial and textural heterogeneities vital to fully characterize a sample. Such morphological information can often provide additional insight into the nature of the material. If imaging analysis confirms that the sample is heterogeneous, then *microanalysis* tools can quantitatively or semi-quantitatively characterize the individual constituents of the bulk material. The category of microanalysis tools also includes surface analysis tools, which can detect trace surface contaminants or measure the composition of thin layers or coatings, either of which could be important for interpretation.

The ITWG has achieved general consensus on the proper sequencing of techniques so as to provide the most valuable information as early as possible in the interpretation process (see Table 1). This consensus was achieved through discussion and consultation at regular meetings, as well as from experience developed from two round robin analyses.

Table 1 Sequence for Nuclear Forensics Techniques/Methods*

| **Techniques/Methods** | **24-Hours** | **1-Week** | **2-Months** |
|---|---|---|---|
| Radiological | Estimated total activity<br>Dose Rate (α, γ, n)<br>Surface Contamination | | |
| Physical Characterization | Visual Inspection<br>Radiography<br>Photography<br>Weight<br>Dimension<br>Optical Microscopy<br>Density | SEM (EDX)<br>XRD | TEM (EDX) |
| Traditional Forensic Analysis | Fingerprints,<br>Environmentally sensitive samples | Fibers | |
| Isotope Analysis | γ-spectroscopy<br>α-spectroscopy | Mass spectrometry (SIMS, TIMS, MC-ICP-MS) | Radiochemical separations |
| Elemental/Chemical | | ICP-MS<br>XRF<br>Assay (titration, IDMS) | GC/MS |

*All times above refer to time after receipt of sample(s) at the nuclear forensics laboratory.

## *Traditional Forensic Analysis*

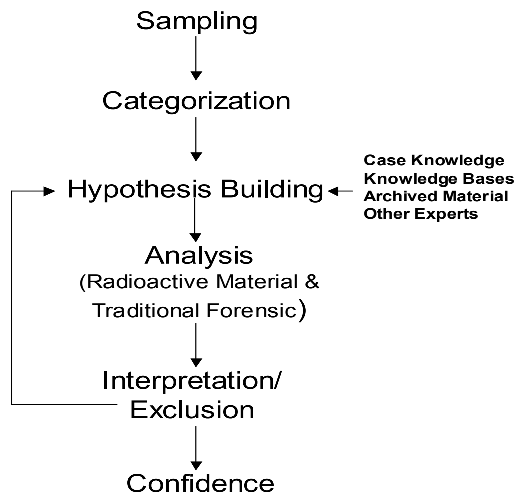
Traditional forensic analysis, like radioactive materials analysis, is an iterative process, in which the results from one analysis are used to guide the selection of subsequent analyses. The forensic analyst must carefully examine all of the items seized at the incident site in order to uncover as much information as possible. Unlikely and apparently unrelated evidence often are key to the successful prosecution of a case. Once again, all sampling and analysis must be performed with due regard for preservation of evidence and perpetuation of the chain-of-custody. The collection of traditional forensic evidence on radioactively contaminated materials must also be performed in a manner consistent with good radiological safety practice.

The variety of traditional forensic evidence, as well as the methods of collection and evaluation, is almost limitless. For example, evidence such as tissue, hair, fingerprints, and shoeprints can often associate a specific individual with a specific place or object. The analysis of fibers, pollen, or chemical substances found at the incident scene can provide information about motives or transportation routes. Documentary evidence provides useful information not only in the content of the communication itself, but also in the incidental details of its creation (paper, ink, film type, extraneous noises, and accents). Similar to collection of radioactive evidence, the international community has agreed upon a sequence for traditional evidence collection. In Table 1, the collection of fingerprint and environmentally sensitive samples, e.g., gunshot or high explosive residues or DNA bearing samples, must occur within the first 24 hours after sample receipt. Fingerprint evidence should be collected by non-destructive means first (laser and photographic methods), then by dusting and lifting. The chemical analysis of other evidence by techniques, such as gas chromatography/mass spectrometry, may occur up to two months after the recovery of evidence.

## Nuclear Interpretation

Case development is very much a deductive process (see Figure 1). The nuclear forensic expert develops a hypothesis or set of hypotheses based upon the results to that point. This hypothesis suggests additional signatures, which either might or must be present if the hypothesis is true. The expert then devises tests to verify the presence or absence of the signatures. Access to other experts around the world, to forensics knowledge bases, and to archived sample libraries are important tools that allow the nuclear forensics expert to formulate the hypothesis and the method to test it. If these tests show that the signature is absent, then the nuclear forensic scientist must abandon or adjust his hypothesis to fit the new results. If the tests show that the signature is present, then either a unique interpretation has been achieved or additional tests must be devised to exclude the other possible scenarios. At the beginning of the nuclear forensics process, the results from the radioactive materials analysis and traditional forensic analysis will most likely be consistent with many scenarios. As the process continues and new results prove inconsistent with those scenarios, certain scenarios are excluded. In the optimum case, only a single scenario will eventually prove consistent with all results.

Figure 1 Flow Chart of Interpretation Process




Analytical results should be interpreted by experts representing a spectrum of all forensic specialties. Nuclear forensic experts use both an empirical approach, through the previous analysis of nuclear and other radioactive materials, and a modeling approach, based upon the chemistry and physics of nuclear processes to predict relevant signatures from those processes. They also use their knowledge of analytical science to select the appropriate methods to verify the presence or absence of predicted signatures. It is important to remember that all interpretations must follow the rules of evidence appropriate to the jurisdiction of the case.

## Relevant Signatures

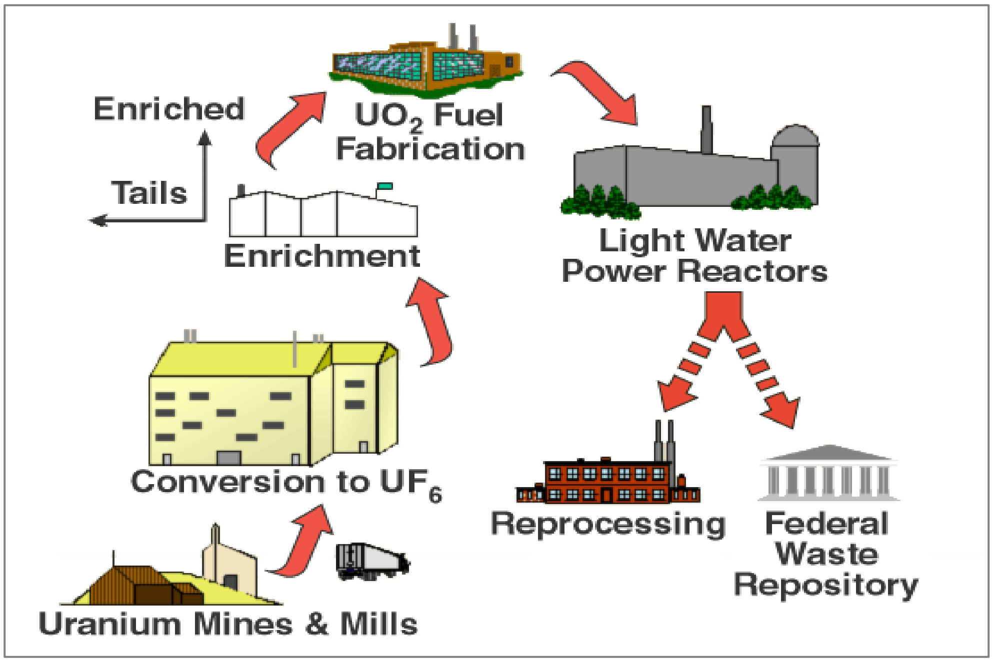
Signatures are the characteristics of a given nuclear or other radioactive material that enable one to distinguish that material from other materials. These signatures enable one to identify the processes that created the material, aspects of the subsequent history of the material, and potentially the specific locales in the history of the material. Forensic scientists classify signatures as either *comparative* or *predictive*. Comparative signatures allow the comparison of an unknown or "questioned" sample versus a set of known samples. Predictive signatures allow deductions about the source, purpose, manufacturing method, etc., of a sample from basic chemical and physical principles without reference to a known sample.

Signatures include *physical*, *chemical*, *elemental*, and *isotopic* characteristics of the material. *Physical* characteristics of the material include the texture, size, and shape of solid objects and the particle size distribution of powder samples. For example, the dimensions of a fresh nuclear fuel pellet are often unique to a given manufacturer. The particle size distribution of uranium oxide powder can provide evidence about the uranium conversion process. Even the morphology of the particles themselves, including such anomalies as inclusions, can be indicative of the manufacturing process. For example, the typical particle size is different in the acidic versus basic process in uranium ore processing. *Chemical* characteristics of the material include the exact chemical composition of the material or the association of unique molecular components. For example, uranium oxide can be found in many different forms, e.g., $UO_2$, $U_3O_8$, or $UO_3$, each of which can be found at various points in the uranium fuel cycle. *Elemental* signatures of the material include the determination of major, minor, and trace elements in the material. Major elements, of course, help define the identity of the nuclear material, but minor elements, such as erbium or gadolinium that serve as burnable poisons, help define its function. Trace elements can also prove to be indicative of a process. *Isotopic* signatures of the material include the detection of fission or neutron-capture products, which are indisputable evidence that the material has been in a nuclear reactor and serve as a fingerprint for the type and operating conditions of a given reactor. Other isotopes are decay products from radioactive "parent" isotopes in the material. For example, Th230 is a decay product of U234 and U235 is a decay product of Pu239. Because radioactive isotopes decay at a rate determined by the amount of the isotope in the material and the half-life of the parent isotope, one can use the relative amounts of decay products and parent isotopes to determine the "age" of the material (time since the parent isotope was last chemically separated from its decay products).

Access to knowledge from the broadest collection of experts increases the chances of a unique and successful interpretation of the data. Sharing of information between international nuclear forensics laboratories leverages the extensive experience and newly developed capabilities of each laboratory to derive new and valuable information from the material analysis. The participation of other nuclear forensics laboratories also allows for a peer review of the nuclear interpretation process, increasing confidence in the validity and impartiality of the interpretation effort. As already noted, international collaboration is essential to the worldwide problem of control of nuclear material. By their very nature, nuclear incidents can be dynamic and itinerant, with nuclear material sourced in one site and transported to another. The ability to share some details of specific incidents, unique analytical capabilities, and knowledge databases is important for countering the nuclear threat.

There are many possible nuclear fuel cycles, depending on the exact process used for each step. Figure 2 depicts one of the most common of the nuclear fuel cycles. It is important to remember that different signatures exist for different materials at different points in the nuclear fuel cycle. Each processing step has the ability to both create new signatures in the product material and destroy signatures present in the incoming feed material. Currently, no signature has been identified that persists throughout the nuclear fuel cycle. Therefore, any signature must be referenced to a specific material and point in the fuel cycle.

Figure 2 The Typical Nuclear Fuel Cycle




**Knowledge Bases**

Extensive knowledge bases of nuclear processes and nuclear forensic data are necessary for effective interpretation of the laboratory results and their successful application to existing information on the sources, methods, and origin of nuclear materials throughout the world. This ability to compare signatures with existing knowledge and data is at the heart of the interpretation process. These knowledge bases are presently maintained by a variety of international, national, and non-governmental entities.

There are current efforts to develop and organize knowledge bases that catalogue nuclear processes for use in nuclear forensics investigations. Many of the basic nuclear processes are documented in textbooks, reports, and papers in the open literature. These documents can be found in technical libraries, as well as the Internet. The IAEA web-site (http://www.iaea.org/), for example, has a number of databases that document publicly available information about nuclear facilities around the world. Proprietary or classified processes, though, may only be documented in the so-called "closed" literature. Companies are often willing to share proprietary information with national nuclear forensics laboratories after the execution of an appropriate non-disclosure agreement. In addition, national laboratories are usually able to access the classified literature of their own country, but obviously not those of other countries. This makes international cooperation between nuclear forensics laboratories of vital importance to solving certain cases.

In some cases, such as the combined ITU-Bochvar Institute database for commercial nuclear fuel,[275] these knowledge bases contain components that can be freely shared among the

[275] Y. Bibilashvili, V. Kositsyn, N. Chorokhov, I. Chkaboura, Y. Dolgov, L. Koch, and K. Mayer, "Methodology of the Analysis of Nuclear Materials of Unknown Origin at VNIINM Moscow," *Proceeding of the 21st Annual*

participants, as well as components that contain proprietary information to which access is restricted. Experts from each participating country or organization, as part of a worldwide network, maintain access to their own databases and knowledge bases to which they have full access. In response to queries for information from other experts in the network, they can respond by releasing the results of the queries without compromise of any of the restricted information or data that underlie the response. Thus distributed data can be used to create information for the network with due consideration for data security.

Comparative analyses of interdicted material and archived samples (samples stored and available for analysis) can also be particularly helpful. These analyses allow the nuclear forensic expert to establish connections between the interdicted and the archived material or between the processes used to create them. As new signatures are discovered that depend on new analytical methods, it becomes increasingly important that databases be accompanied by archived material. Then, the old material can be re-analyzed by the new analytical methods and the resulting data analyzed for the presence or absence of the newly discovered signatures. Sample archives can include "real world" nuclear forensic samples, reactor fuel stock, other nuclear materials, and industrial radiation sources.

## Statistical Techniques

Any knowledge management system will rely on analytical tools and methods that are strongly mathematically based to elicit pattern, temporal trends, and group membership analyses. Multivariate analysis techniques e.g. multi-dimensional feature extraction, variable discrimination, and pattern classification, are used to investigate multidimensional data and form the "mathematical brain" enabling comparative and predictive signature analysis. Confidence articulation, based upon the results of these multivariate analyses, is an important requirement for these multivariate techniques.

## Timelines

As production processes change, the signatures inherent in the material will also change. Therefore, methods are needed to capture process knowledge and subject matter expertise as a function of time, e.g., material production process changes, to enable ready discrimination of signatures. The development of material production timelines is one method that should be effective in capturing the relevant process knowledge that would impact signatures throughout the nuclear fuel cycle. Comprehensive materials production timelines enable 1) narrowing of the applicable information field by using age dating information from a questioned sample and 2) capturing of the characteristics of relevant processes and process changes from cognizant experts that would impact signatures during material production.

---

*Meeting of the Symposium on Safeguards and Nuclear Materials Management*, Sevilla, Spain, May 4-6, 1999, pp. 821-829; Y. Dolgov, Y. Bibilashvili, N. Chorokhov, A. Schubert, G. Janssen, K. Mayer, and L. Koch, "Installation of a Database for Identification of Nuclear Material of Unknown Origin at VNIINM Moscow," *Proceeding of the 21st Annual Meeting of the Symposium on Safeguards and Nuclear Materials Management*, Sevilla, Spain, May 4-6, 1999, pp. 831-838; and, "Development of a Nuclear Material Database for Support of Nuclear Forensic Analysis," *ITU Annual Report* 1996 (EUR 17296), pp. 22-23.

## Confidence in the Conclusion

### *Analytical Quality*

Because the results of the nuclear forensics analysis and interpretation could be used as evidence in a criminal prosecution or affect international estimates of proliferation and threats of terrorism, it is essential that the data and their interpretation is credible. Adherence to chain-of-custody procedures will ensure that the analytical results correspond to evidence collected at the incident site. Proper quality assurance and quality control procedures within the nuclear forensics laboratory will ensure confidence in the analytical data. Nuclear forensic laboratories typically implement a recognized quality system, such as ISO 9000, ISO 17025, or ASCLD International.[276] A quality system encourages the establishment of documented procedures for sample control and analysis, which improves the repeatability of results and provides an enabling mechanism for continuous quality improvement. The establishment and registration of a quality system is important not only for its internal benefits, but also for the confidence that it inspires externally.

When discussing analytical quality, it is important to acknowledge the importance of certified reference materials and standard methods and protocols. There are many national and international sources for certified reference materials, such as the National Institute for Standards and Technology, the New Brunswick Laboratory, and the Institute for Reference Materials and Measures in the European Community. Standard methods are published by organizations such as the American Society for Testing and Materials, the International Standards Organization, and the International Atomic Energy Agency.

### *Precision and Accuracy*

As required by good analytical protocol, all analytical results should state the precision of the measurement and any potential sources of error not reflected in the precision. In the absence of bias, the precision of the measurement can place bounds on which sources and processes could produce material with the given signature. Although increasing the precision of a given measurement could narrow the field of potential sources or processes that produced the material as shown in Figure 3, it is often more efficient to perform additional measurements using independent techniques (techniques that verify the presence or absence of different signatures than the initial technique). The confidence in, and the specificity of, the interpretation often increase as more independent measurements are made as shown in Figure 4.

[276] ISO 9000:2000, "Quality Management Systems – Fundamental and Vocabulary," International Organization for Standardization, 2000; ISO/IEC 17025:1999, "General Requirements for the Competence of Testing and Calibration Laboratories," International Organization for Standardization, 1999; and, American Society of Crime Lab Directors/Laboratory Accreditation Board International, available at http://www.ascld-lab.org.

Figure 3 The Effect of Improved Precision on the Quality of Nuclear Forensics Conclusions

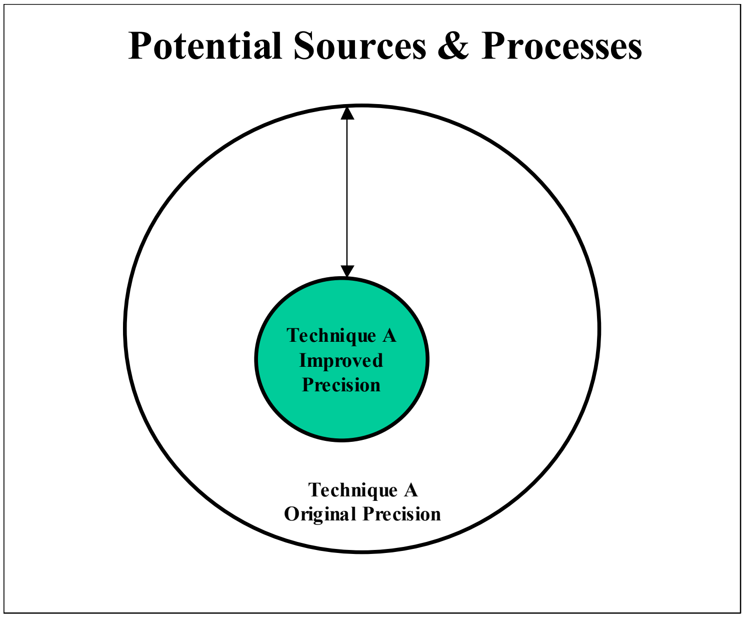
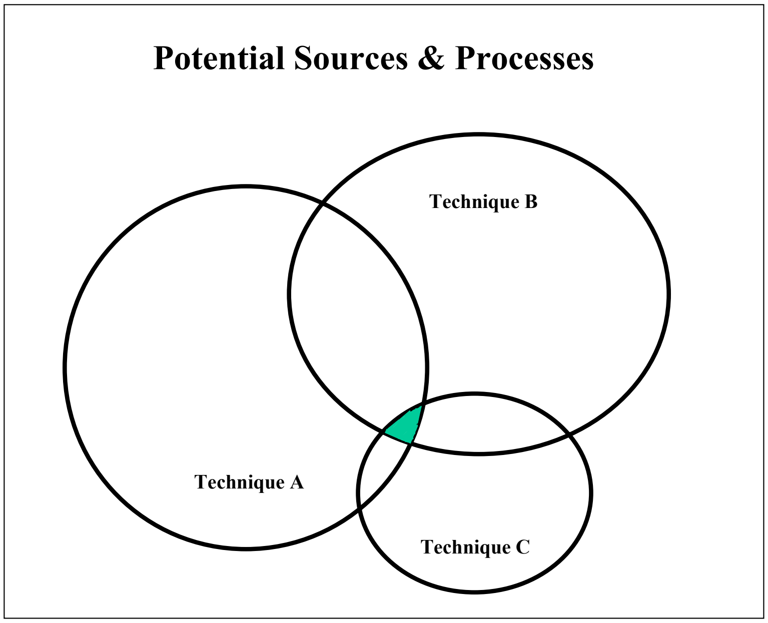



Figure 4 The Effect of Multiple Types of Analyses on the Quality of Nuclear Forensics Conclusions



### *Sensitivity*

The sensitivity of the methods of analysis will be particularly important when the amount of evidence is small. In some cases, illicit traffickers may initially deliver only a tiny sample, which is purportedly representative of a much larger batch of material, to their customer. Even for interdictions of large amounts of material, the analytical techniques should be as sensitive as possible, because trace species are often significant components of a signature. However, as the sensitivity of the analysis increases, so does the susceptibility to contamination and other interferences. For example, the analyst might have to decide whether the Fe and Cr detected in the analysis is the signature of a certain manufacturing process or merely contamination from a stainless steel spatula used to collect the evidence.

### *Communication of Results*

All results and assessments must be communicated in the form of a technical report. Reports may be issued periodically during and after the conclusion of an interdiction event to keep decision makers apprised of recent data and insights from the investigation. For example, the laboratory could issue reports to coincide with the availability of results from the sequence of techniques and methods in Table 1 (24 hours, one week, two months). However, a final report must also be issued after the conclusion of the event. The nuclear forensics laboratory should identify all data and other information used in the assessment and include the rationale for the conclusion. The laboratory should also identify any information that conflicts with the assessment and why they are choosing to disregard or discount that information.

Ideally, there should be an unambiguous method of specifying the confidence in the conclusions to decision-makers. The international nuclear forensics community has not yet reached a consensus on such a method. It is difficult to summarize a vast body of evidence, each with its own uncertainty, with a single categorization. However, such a categorization must be made to communicate the strength of the evidence to decision makers who might not have the requisite technical background to rigorously evaluate all stages of data acquisition and analysis. Therefore, nuclear forensic researchers are seeking to develop and demonstrate methods to articulate confidence in nuclear forensics interpretations that are based on combining disparate data and information. The articulation of confidence when formulating conclusions based on disparate datasets is at the heart of enabling credible interpretations of nuclear forensics data.

# MAXIMIZING U.S.-RUSSIAN NUCLEAR SECURITY COOPERATION IN 2015: LEGAL OBSTACLES AND OPPORTUNITIES*

Orde F. Kittrie,
*Arizona State University's Sandra Day O'Connor College of Law and University of Maryland Law School*[277]

Maximizing U.S.-Russian nuclear security cooperation in 2015 is dependent on the two countries successfully managing several critical legal issues over the next seven years. Much attention has been paid in recent months to the pending U.S.-Russian agreement designed to meet the legal requirements for peaceful nuclear cooperation set forth in Section 123 of the U.S. Atomic Energy Act of 1954 as amended (the agreement is commonly referred to as the U.S.-Russian 123 Agreement).[278] However, several other legal issues are equally if not more important to the future of U.S.-Russian nuclear security cooperation.

The first part of this paper will focus on the pending U.S.-Russian 123 Agreement. It will describe the U.S. legal requirements the agreement is designed to meet, summarize the agreement's current status, and provide an overview of the types of cooperative projects that would be made possible by entry into force of such an agreement. The second part of this paper will discuss other critical legal issues relevant to the future of U.S.-Russian cooperation on international nuclear security. These include legal issues related to nuclear material security and arms control. Key legal issues related to nuclear material security include access, sustainability, the expiration in 2013 of the Cooperative Threat Reduction Agreement,[279] and the expiration in 2013 of the highly enriched uranium (HEU) Purchase Agreement (also known as the "Megatons to Megawatts Agreement").[280] Key legal issues related to arms control include the expiration on

* Orde F. Kittrie was unable to attend the workshop in November.

277 Prior to joining the Arizona State University law faculty in 2004, Orde F. Kittrie served for 11 years at the U.S. Department of State, including for three years as the Department's senior attorney for nuclear affairs.

278 The U.S. Atomic Energy Act of 1954 can be found at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf; accessed April 8, 2008.

279 The Bob Stump National Defense Authorization Act of 2003 mandates that a sustainable materials protection, control, and accounting system be transferred to sole Russian Federation support no later than January 1, 2013. For further information regarding the Bob Stump Act, see http://www.army.mil/armybtkc/docs/PL%20107-314.pdf; accessed May 1, 2008.

280 For further information regarding the HEU Agreement, see http://www.nti.org/db/nisprofs/russia/fissmat/heudeal/heudeal.htm; accessed April 6, 2008.

December 5, 2009, of the Strategic Arms Reduction Treaty (START I)[281] and on December 31, 2012 of the Strategic Offensive Reductions Treaty (SORT).[282]

## THE PROPOSED 123 AGREEMENT

In a joint statement issued on July 3, 2007, Presidents George W. Bush and Vladimir V. Putin announced the initialing of a U.S.-Russia agreement designed to meet the legal requirements for transnational cooperation in the peaceful use of nuclear energy which are set forth at Section 123 of the U.S. Atomic Energy Act of 1954 as amended.[283] "We share the view," said the joint statement, "that this Agreement will provide an essential basis for the expansion of Russian-U.S. cooperation in the field of peaceful use of nuclear energy and expect this document to be signed and brought into force in accordance with existing legal requirements."[284] The U.S.-Russian 123 Agreement was signed on May 6, 2008[285] and transmitted to Congress on May 12, 2008[286] for the requisite statutory review period. The following sections will describe the requirements of section 123, summarize the agreement's current status, and provide an overview of the types of cooperative projects that would be made possible by entry into force of such an agreement.

### 123 Agreement Requirements Under U.S. Law

Section 123 of the U.S. Atomic Energy Act of 1954 as amended, 42 U.S.C. § 2153, requires that significant nuclear exports from the United States take place only pursuant to an agreement for peaceful nuclear cooperation with the recipient. Significant nuclear exports include power reactors, research reactors, nuclear source material (including reactor fuel), and four major components of reactors (pressure vessels, fuel charging and discharging machines, complete control rod drive units, and primary coolant pumps).[287] As is typical with agreements

---

281 To read the text of the START I Treaty, see http://www.fas.org/nuke/control/start1/text/index.html; accessed April 6, 2008. START I entered into force on December 5, 1994. Article XVII of the START I Treaty provides that the Treaty shall remain in force for 15 years. START II was signed in January 1993 but never entered into force.

282 The text of the Treaty on Strategic Offensive Reductions can be found at http://www.whitehouse.gov/news/releases/2002/05/20020524-3.html; accessed April 6, 2008.

283 The text of the pending 123 Agreement between the United States and the Russian Federation can be found in Appendix E.

284 The text of this Joint Statement, which was titled Declaration of Nuclear Energy and Nonproliferation: Joint Actions, can be found at http://www.whitehouse.gov/news/releases/2007/07/20070703.html; accessed April 8, 2008.

285 The text of the White House announcement of the signing can be found at http://www.whitehouse.gov/news/releases/2008/05/print/20080506-5.html; accessed May 30, 2008.

286 The text of the President's transmittal letter can be found at http://www.whitehouse .gov/news/releases/2008/05/20080513-1.html; accessed May 30, 2008.

287 Some types of peaceful nuclear cooperation, including a broad range of technical assistance in such areas as nuclear safety, are possible outside the framework of an agreement for cooperation. Examples include imports of nuclear material and equipment into the United States; exports from the United States of nuclear components (other than the four major reactor components noted above) under licenses issued by the Nuclear Regulatory Commission; nuclear technology (as information) approved for export by the U.S. Department of Energy pursuant to 10 CFR Part 810; and exports of nuclear-related dual-use items such as simulators, detectors, analytic equipment, and many types of pipes, valves and other parts licensed by the U.S. Department of Commerce. Consistent with this, a limited amount of peaceful nuclear cooperation between the United States and Russia has for many years taken place under

for peaceful nuclear cooperation, the proposed U.S.-Russian agreement does not commit the United States to any specific exports or other cooperative activities, but rather establishes a framework of conditions and controls to govern subsequent transactions, if any. The proposed U.S.-Russia agreement also continues the practice, which is not required by U.S. law, of applying nonproliferation conditions, assurances and controls in a reciprocal manner (i.e. obligation that section 123 requirements be applied with respect to U.S. nuclear exports in Russia are also applied with respect to Russian nuclear exports in the U.S.).

The proposed U.S.-Russian 123 Agreement includes the following key conditions and controls:[288]

- a guarantee that safeguards as set forth in the agreement will be maintained in perpetuity on items transferred pursuant to the agreement and on nuclear material produced through their use
- a peaceful use guarantee (i.e., that items subject to the agreement will never be used for any nuclear explosive device, for research on or development of such a device, or for any other military purpose)
- a guarantee that adequate physical protection will be maintained in perpetuity with respect to items subject to the agreement
- a transferring state right in perpetuity of prior consent to re-transfers by the recipient state of items transferred pursuant to the agreement and of any special nuclear material produced through their use
- a transferring state right in perpetuity of prior consent to alteration in form or content of nuclear material transferred pursuant to the agreement or used in or produced through the use of material or equipment so transferred (the proposed U.S.-Russia agreement provides prior consent to certain types of alteration, including enrichment to less than twenty percent in the isotope U235)
- a transferring state right to approve in advance storage facilities for plutonium, uranium 233, and highly enriched uranium subject to the agreement

The proposed U.S.-Russian agreement will permit transfers of sensitive nuclear facilities, sensitive nuclear technology, and major critical components only if it is subsequently amended.

Section 123 provides that an agreement for peaceful nuclear cooperation must be approved by the Secretary of Energy and the Secretary of State, following consultation with the Nuclear Regulatory Commission, and must thereafter be approved by the President, who must make certain statutory determinations and authorize execution of the agreement.

The President must submit an agreement for cooperation to Congress for a statutory review period of 90 days continuous session, as specially defined for this purpose at section 130(g)(2) of the Atomic Energy Act of 1954 as amended, 42 U.S.C. § 2159 (g)(2). Depending on the Congressional schedule, the review period can take four to six calendar months, and

---

agreements including the U.S.-Soviet Agreement on Scientific and Technical Cooperation in the Field of Peaceful Uses of Atomic Energy, which was signed by Presidents George H.W. Bush and Mikhail S. Gorbachev in Washington, D.C. on June 1, 1990.

[288] It is worth noting that 123 agreements typically have applied non-proliferation conditions, assurances and controls in a reciprocal manner. If this practice, which is not required by U.S. law, is continued in the U.S.-Russia 123 Agreement, the United States would assume all the obligations contained in the agreement with respect to any nuclear materials or equipment that it might import from Russia pursuant to the agreement.

sometimes longer. An agreement, such as the proposed U.S.-Russian agreement, which is fully consistent with the relevant conditions and controls contained in section 123 of the Act does not require specific Congressional approval before it may be brought into effect but rather, so long as Congress does not enact legislation to disapprove the agreement, the agreement may be brought into force following the close of the Congressional review period. However, even if Congress does not adopt a resolution of disapproval, it may adopt a resolution attaching conditions to the agreement as it did with the U.S.-China 123 Agreement in 1985.[289]

Exports made pursuant to an agreement for cooperation require a license from the U.S. Nuclear Regulatory Commission and must satisfy the U.S. nuclear export criteria set forth in sections 127 and 128 of the Atomic Energy Act (these criteria generally track the conditions and controls required in agreements for cooperation by section 123 of the Act.)

## Current Status of the U.S.-Russia 123 Agreement

The U.S. and Russian governments commenced negotiation of a 123 Agreement in 2006. The text was initialed in Moscow on June 29, 2007, by William Burns, the U.S. Ambassador to Russia, and Nikolai Spassky, the Deputy Director of Russia's Federal Atomic Energy Agency (Rosatom). The U.S.-Russian 123 Agreement was signed on May 6, 2008, and transmitted to Congress on May 12, 2008, for the requisite statutory review period. In addition, Russian officials have said that they plan to submit the 123 Agreement to the Duma for approval.[290]

Congress has already passed legislation expressing concern regarding a U.S.-Russian 123 Agreement, and stronger legislation targeting the agreement is currently pending. In September 2006, Congress passed, and on September 30, 2006, the President signed into law, the Iran Freedom Support Act, Public Law 109-293, which in relevant part expresses the non-binding "sense of Congress" that "it should be the policy of the United States not to bring into force an agreement for cooperation with the government of any country that is assisting the nuclear program of Iran or transferring advanced conventional weapons or missiles to Iran" unless the President has determined that: 1) "Iran has suspended" and "has committed to verifiably refrain permanently" from "all enrichment-related and reprocessing-related activity" (except uranium conversion exclusively for export to foreign nuclear production facilities pursuant to

---

[289] The United States currently has 123 agreements in force with 19 individual countries plus Taiwan and two international organizations, the International Atomic Energy Agency and EURATOM (which includes 27 individual countries). The United States has 123 agreements with each of its fellow nuclear weapon states parties to the Treaty on the Non-proliferation of Nuclear Weapons (NPT) other than Russia, namely France and the United Kingdom (both via the U.S.-Euratom Agreement) and China. It is worth noting, however, that the U.S.-China 123 Agreement took a tortuous path to entry into force. The U.S.-China 123 Agreement was submitted to Congress by President Ronald Reagan on July 24, 1985. In response, Congress passed Public Law 99-183, the Joint Resolution Relating to the Approval and Implementation of the Proposed Agreement for Nuclear Cooperation Between the United States and the People's Republic of China, enacted on December 16, 1985, which required a Presidential certification and a report followed by an additional waiting period before the agreement could be implemented. After the 1989 Tiananmen crackdown, Congress imposed sanctions in Public Law 101-246, the Foreign Relations Authorization Act for Fiscal Years 1990 and 1991, enacted on February 16, 1990, which suspended nuclear cooperation with China and required an additional Presidential certification on the People's Republic of China nuclear non-proliferation assurances. The certifications required by Public Laws 99-183 and 101-246 were not made until President Bill Clinton did so on January 12, 1998. The additional congressional review period ended on March 18, 1998, and the Agreement was thereafter implemented, thirteen years after President Ronald Reagan submitted it to Congress.

[290] For further information about the passing of the 123 Agreement in Russia, see the paper by Alexander Pikaev in this document.

internationally agreed arrangements); or 2) such other country has "suspended all nuclear assistance to Iran and all transfers of advanced conventional weapons and missiles to Iran," and "is committed to maintaining that suspension until Iran has implemented measures that would permit the President to make such determination."[291]

On September 25, 2007, almost a year later, the U.S. House of Representatives passed by a vote of 397 to 16 the Iran Counter-Proliferation Act of 2007, H.R. 1400, which would impose legally binding linkage between a 123 Agreement and a country's assistance to the Iranian nuclear program. H.R. 1400 specifies in relevant part that "no agreement for cooperation between the United States and the government of any country that is assisting the nuclear program of Iran or transferring conventional weapons or missiles to Iran may be submitted to the President or to Congress pursuant to section 123 of the Atomic Energy Act of 1954," no such agreement may enter into force, and no nuclear trade may be licensed under such an agreement, until the President determines and reports to Congress that "(A) Iran has ceased its efforts to design, develop, or acquire a nuclear explosive device or related materials or technology; or (B) the government of the country that is assisting the nuclear program of Iran or transferring advanced conventional weapons or missiles to Iran – (i) has suspended all nuclear assistance to Iran and all transfers of advanced conventional weapons and missiles to Iran; and (ii) is committed to maintaining that suspension until Iran has implemented measures that would permit the President to make the determination described in subparagraph (A)."[292]

H.R. 1400 defines the term "country that is assisting the nuclear program of Iran or transferring advanced conventional weapons or missiles to Iran" as meaning "(A) the Russian Federation; and (b) any other country determined by the President to be assisting the nuclear program of Iran or transferring advanced conventional weapons or missiles to Iran." H.R. 1400 contains no provision for an executive branch waiver relating to this agreement for cooperation requirement. As of May 30, 2008, H.R. 1400 and a similar Senate bill, S. 970 (which had 71 cosponsors as of May 30, 2008), were pending before the Senate committees to which they had been referred.

## Cooperative Projects that would be Made Possible by a U.S.-Russian 123 Agreement

As is typical with agreements for peaceful nuclear cooperation, the proposed U.S.-Russian agreement would not commit the United States or Russia to any specific exports or other cooperative activities, but rather would create a legal framework under which such activities can take place. The entry into force of such a framework agreement would make possible a variety of exports and other cooperative activities that are prohibited by U.S. law in the absence of a 123 Agreement. Various sources, including the December 2006 ***Report of the U.S.-Russian Civil Nuclear Energy Working Group***,[293] have suggested the following cooperative projects that could be facilitated by a U.S.-Russian 123 Agreement.

***Joint Development of Advanced Nuclear Technologies.*** A 123 Agreement could

[291] The text of the Iran Freedom Support Act can be found at http://bulk.resource.org/gpo.gov/laws/109/publ293.109.txt; accessed April 8, 2008.

[292] The Iran Counter-Proliferation Act of 2007, H.R. 1400, can be found at http://www.govtrack.us/congress/billtext.xpd?bill=h110-1400; accessed April 8, 2008.

[293] *Report of the U.S.-Russian Civil Nuclear Energy Working Group: A Bilateral Action Plan to Enhance Global and Bilateral Nuclear Energy Cooperation*. The report was signed by U.S. Assistant Secretary of Energy Dennis Spurgeon and Nikolay Spasskiy, Deputy Director of the Russian Federal Atomic Energy Agency, in December 2006.

facilitate joint development of proliferation-resistant and other advanced nuclear technologies including those envisioned by the U.S. Department of Energy's (DOE) Global Nuclear Energy Partnership (GNEP).[294]

***Storage and Possible Reprocessing of U.S.-Origin Spent Nuclear Fuel in Russia.*** It has been estimated that Russian provision of spent fuel management services could generate up to $20 billion in storage fees from South Korea, Taiwan and other possible customers lacking their own permanent nuclear waste repositories. However, most spent fuel in the possession of potential customers is of U.S. origin and thus cannot be sent to a country that does not have a 123 Agreement with the United States. A U.S.-Russian 123 Agreement is therefore necessary to open up this market for Russia. Fees from spent fuel management services could provide Russia's nuclear administration with additional funds for nuclear security upgrades and maintenance. The shipping of U.S.-origin fuel to Russia could also serve as an early and high-profile demonstration of the possibilities embodied in the system envisioned by GNEP and President Putin's proposal to establish an International Uranium Enrichment Center, under which nations with established nuclear energy capabilities provide nuclear fuel supply and disposal services to nations which agree to forego nuclear fuel enrichment and recycling technologies, which give rise to nuclear non-proliferation concerns.

***Increasing the Efficiency and Safety of Current and Future Russian-made Nuclear Power Plants.*** According to Anton Khlopkov, in his article entitled *What Will a Nuclear Agreement with the United States Bring Russia?*,[295] U.S.-Russian cooperation pursuant to a 123 Agreement could help increase the capacity factor and safety of Russian nuclear power plants, extend their operating life, and decrease their maintenance costs. This could benefit Russian consumers. In addition, the participation of U.S. companies in manufacturing equipment for Russian nuclear power plants, including the use of U.S. components in such plants, could enhance the attractiveness of Russian nuclear equipment exports to third countries.

## OTHER LEGAL ISSUES RELEVANT TO FUTURE U.S.-RUSSIAN COOPERATION ON INTERNATIONAL NUCLEAR SECURITY

As of mid-2008 there are, in addition to the proposed 123 Agreement, a number of other potential legal agreements and other key looming legal issues relevant to future U.S.-Russian cooperation on international nuclear security. In October 2007, Senator Richard Lugar called for a new "package of agreements designed to make progress on the non-proliferation, nuclear energy, arms control and missile defense fronts."[296] The following, derived from various sources, is a compendium of potential legal agreements and other key legal issues, in addition to the pending 123 Agreement, which are relevant to future U.S.-Russian cooperation on international nuclear security.

---

[294] For further information about the U.S. Global Nuclear Energy Partnership, see http://nuclear.inl.gov/gnep/index.shtml; accessed April 6, 2008.

[295] Anton Khlopkov, "What Will a Nuclear Agreement with the United States Bring Russia?," *13 Security Index,* N. 2, 82; available at http://pircenter.org/data/ib/sieng2/khlopkov_eng.pdf.

[296] For further information regarding the Cooperative Threat Reduction programs, see http://www.nti.org/db/nisprofs/russia/forasst/nunn_lug/overview.htm; accessed April 8, 2008. See also http://www.lugar.senate.gov/press/record.cfm?id=285095; accessed July 14, 2008.

## Legal Issues Related to the Security of Nuclear Material

***Cooperative Threat Reduction Umbrella Agreement Expiration in 2013***. On June 19, 2006, the United States and Russia signed a protocol to extend for another seven-year period the U.S.-Russian Cooperative Threat Reduction (CTR) umbrella agreement, which entered into force in 1992 and was first extended in 1999. As a result of protracted negotiations over the agreement's liability protections, the 2006 protocol was signed just days before the agreement was due to expire. The CTR agreement's taxation exemption and access provisions have also at times been the subject of contention. Disputes over one or more of these issues could again threaten the umbrella agreement's extension when the 2006 protocol expires in 2013.

***Continuing Disputes Over Access.*** Agreements under which the U.S. government supplies cooperative threat reduction and analogous assistance grant the U.S. government the right to examine the use of materials or services provided by it as part of the assistance process. However, the Russian government, at least in part because of the sensitive nature of this own work at some sites which receive assistance, has been loath to grant such access to the U.S. government. A February 2007 report by the U.S. Government Accountability Office (GAO) warned of continuing restrictions on U.S. access to facilities that store, manufacture, or dismantle Russian nuclear weapons.[297] The GAO report noted that "access difficulties at some Russian nuclear warhead sites may . . . prohibit DOE and Department of Defense (DOD) from ensuring that U.S.-funded security upgrades are being properly sustained."[298] For example, "Russia has denied DOE access at some sites after the completion of security upgrades, making it difficult for the department to ensure that funds intended for sustainability of U.S.-funded upgrades are being properly spent."[299] Specifically, neither DOE nor DOD has "reached an agreement with the Russian Ministry of Defense on access procedures for sustainability visits to 44 permanent warhead storage sites where the agencies are installing security upgrades."[300] Absent such agreement, DOE and DOD "will be unable to determine if U.S.-funded security upgrades are being properly sustained and may not be able to spend funds allotted for these efforts."[301] Such limitations could impede compliance with U.S. laws requiring verification of the proper use of U.S. government funds.

Perhaps the best-known standoff over access involves the DOD-funded Fissile Material Storage Facility at Mayak. The United States and Russia, from the outset of the project, agreed in principle that the United States would have the right to some form of monitoring of this site, to ensure that it is being used for its intended purpose. However, as of December 2007, four years after the site was commissioned and ten years after transparency negotiations began, negotiations were continuing over the parameters of such a transparency agreement.

***Sustainability of U.S.-Funded Security Upgrades.*** The February 2007 GAO report stated that "during our visit to Russia, officials at three of the four civilian nuclear research institutes we visited told us that they are concerned about their sites' financial ability to maintain

---

[297] Government Accountability Office, *Progress Made in Improving Security at Russian Nuclear Sites, but the Long-term Sustainability of U.S.-Funded Security Upgrades is Uncertain* (2007), available at http://www.gao.gov/new.items/d07404.pdf.
[298] Ibid, p. 22.
[299] Ibid, p. 26.
[300] Ibid, p. 29.
[301] Ibid.

U.S.-funded security upgrades after . . . DOE financial support ends in 2013."[302] DOD plans to halt funding for analogous activities in 2011. In April 2007, the DOE's National Nuclear Security Administration (NNSA) announced that it had reached a non-binding agreement with Russia's Federal Atomic Energy Agency (Rosatom) on a plan for sustaining U.S.-funded security upgrades at nuclear material sites after DOE ceases its financial support.[303] Separate discussions were reportedly underway with regard to sustaining work performed at sites with nuclear warheads and at nuclear material sites controlled by other agencies. Additional, legally-binding arrangements may have a useful role to play in ensuring that operation and maintenance of U.S.-funded security upgrades continues to receive the requisite levels of Russian funding after 2011 and 2013. Consideration should also be given as to whether and how to address similar sustainability challenges with respect to U.S. and other international efforts to engage former Soviet weapons of mass destruction (WMD) scientists in non-WMD-related employment. One mechanism for increasing confidence that security upgrades will be sustained after U.S. funding ends could be publication of the specific lines which are dedicated to security for nuclear sites in the long-term budgets of the relevant Russian agencies. However, U.S. officials have been told that such publication is forbidden under Russian law. If this is correct, Russian law should be amended to permit such publication.

***Low Penalties for Nuclear Material Trafficking***. Nuclear material security depends both on physical barriers to theft and deterrence of potential thieves. Nuclear smuggling networks can include principals, corrupt officials, and middlemen who transport nuclear material, forge export licenses and customs slips, and engage in other black market activities. For individuals and businesses that engage in or facilitate illicit smuggling of fissile material and related nuclear components for financial reasons, the choice to do so will depend in part on the magnitude of the penalty if caught. Russian law's currently low criminal penalties for nuclear material trafficking[304] could more effectively deter nuclear material trafficking if they were increased. For example, Article 188 of Russia's Criminal Code imposes penalties of no more than ten years' imprisonment for smuggling weapons of mass destruction.[305] Of even greater concern from a deterrence perspective are the extraordinarily low sentences, often entirely suspended, actually imposed by Russian authorities on those convicted of nuclear smuggling.[306] The Duma should consider amending the relevant Russian laws so as to impose mandatory minimum sentences for nuclear smuggling.

***Need for Improved Material Protection, Control, and Accounting (MPC&A) Regulations.*** Although Russia has developed a considerable body of laws and regulations governing nuclear safety and security, there is still considerable room for improvement. A

---

[302] Ibid, pp. 26-7. In section 3156(b)1 of the Bob Stump National Defense Authorization Act of 2003, Congress directed as follows: "The Secretary of Energy shall work cooperatively with the Russian Federation to develop, as soon as practicable but no later than January 1, 2013, a sustainable nuclear materials protection, control, and accounting system for the nuclear materials of the Russian Federation that is supported solely by the Russian Federation."

[303] National Nuclear Security Administration, *U.S. & Russia Agree to Sustain Security Upgrades at Nuclear Material Facilities: Agreement Helps to Ensure that U.S. Investments Will be Maintained*, March 29, 2007; available at http://www.nnsa.doe.gov/docs/newsreleases/2007/PR_2007-04-11_NA-07-11.htm; accessed May 1, 2008.

[304] Igor Khripunov and James Holmes, eds., "Enforcement as Deterrent," *Nuclear Security Culture: The Case of Russia*, (University of Georgia Center for International Trade and Security: December 2004), available at http://www.uga.edu/cits/documents/pdf/Security%20Culture%20Report%2020041118.pdf.

[305] Ibid.

[306] Ibid.

detailed analysis by the University of Georgia's Center for International Trade and Security found that Russia's nuclear regulations are too often obsolete and in urgent need of updating, frequently contradictory, sometimes ambiguous (thus leaving unacceptably wide discretion for interpretation), pervaded by unnecessary technical jargon that makes them difficult to understand, and too often lack specific and detailed practical instructions for handling critical tasks.[307] Russian Federation MPC&A regulations also fail to preclude the most high-risk categories of nuclear material from being accessed or handled by single individuals. In contrast, the U.S. nuclear complex requires application of the prophylactic two-person rule with respect to all access to or handling of the highest-risk categories of nuclear material. Various Russian government agencies are currently working, with assistance from DOE/NNSA, to enhance Russia's MPC&A regulations. This is an important project that ought to be completed expeditiously.

***Material Consolidation and Conversion Agreement Negotiation.*** The DOE-run Material Consolidation and Conversion project has operated on a "pilot" basis since 1999. During that time, the project has supported the transfer of HEU from various sites where it is no longer needed to fewer and more secure locations. The project has also supported the conversion of almost ten metric tons of HEU to low-enriched uranium (LEU). For example, it has supported the secure storage and conversion of Russian-origin HEU that has been returned to Russia from countries such as Bulgaria, the Czech Republic, Latvia, Serbia and Uzbekistan.[308] Both consolidation and conversion reduce security requirements and long-term costs associated with protecting highly sensitive nuclear material. However, Russia has rejected DOE's proposal to cover the conversion aspect of this cooperation under the existing MPC&A agreement, and the resultant lack of an agreed legal framework has limited the extent of material consolidation and conversion cooperation. As a result, negotiations have begun on a standalone, government-to-government Material Consolidation and Conversion Agreement. Three negotiating sessions have been held and a fourth was scheduled for March 2008.

***Plutonium Management and Disposition.*** Several legal issues currently stand as obstacles to implementation of the U.S.-Russian Agreement Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation (PMDA), signed in September 2000, which provides for cooperation between the two countries to convert 34 metric tons each of excess weapon-grade plutonium into forms unusable for weapons.[309] The PMDA does not contain liability protections but rather provides that the parties "shall continue negotiations on liability provisions to apply to all claims that may arise from activities undertaken pursuant to the Agreement and shall seek to conclude an agreement in writing containing such provisions at the earliest practicable date."[310] On September 15, 2006, the two countries signed a protocol designed to provide a framework for resolving liability issues.[311] However, while the PMDA is currently being provisionally applied by the Russian government pending ratification by the Duma, the Russian Foreign Ministry has advised that the liability protocol has neither been ratified by the Duma nor can it be provisionally applied.

---

[307] Ibid, "MPC&A Legal and Regulatory Framework," Chapter 6.
[308] For further information, see the paper by Philipp Bleek and Laura Holgate in this volume.
[309] For further information regarding this agreement, please see http://www.energy.gov/print/5742.htm; accessed April 8, 2008.
[310] Ibid, at Annex on Assistance, Section II-Liability.
[311] Further information regarding the liability protocol is available at http://nnsa.energy.gov/news/1013.htm; accessed July 14, 2008.

In addition, the PMDA's Annex on Monitoring and Inspections provides that the parties "shall seek to complete by December 2002 an agreed set of detailed measures, procedures and administrative arrangements . . . for monitoring and inspections of disposition plutonium, blend stock, spent plutonium fuel, immobilized forms, and disposition facilities."[312] The Annex specifies that this "set of detailed measures, procedures, and administrative arrangements shall be completed in writing prior to beginning construction of industrial-scale disposition facilities in the Russian Federation."[313] As of February 2008, the parties had yet to reach agreements on such a set of measures, procedures and arrangement.

In November 2007, U.S. Secretary of Energy Samuel W. Bodman and Russian Federal Atomic Energy Agency Director Sergei Kirienko signed a joint statement outlining a revised plan to dispose of 34 metric tons of surplus plutonium from Russia's weapons program.[314] The revisions have been characterized as designed to maximize technical and financial viability and more closely align Russian plutonium disposition with Russia's national energy strategy. The joint statement commits the two sides to negotiating amendment of the PMDA to reflect the revised plan.[315] As of March 2008, the U.S. had submitted to Russia a draft protocol amending the PMDA but it seemed likely that the next stage of negotiations would be delayed several months by the pending reorganization of Rosatom.

Russia is to provide a significant portion of funding for the revised plutonium disposition plan. In addition, the U.S. has pledged $400 million to support the Russian program. The November 2007 joint statement also commits the U.S. and Russia to seek contributions from other international donor countries and institutions. DOE plans to ask Congress to pass legislation that would facilitate DOE accepting, and then disbursing to Russia, funds from international donors for this purpose.

***Expiration of HEU Purchase Agreement.*** The HEU Purchase Agreement (also known as the "Megatons to Megawatts Agreement"), which was signed in 1993, is currently due to expire in 2013. Under the agreement, the United States is purchasing what will amount to 500 metric tons of HEU from dismantled Russian nuclear warheads. The HEU is converted into LEU for use in U.S. commercial reactors. These purchases currently supply the fuel for approximately half of the commercial nuclear power production in the U.S. (meaning that about ten percent of U.S. electricity needs are met thanks to these purchases) and have already resulted in the elimination of weapons-grade uranium sufficient for the manufacture of more than 10,000 nuclear weapons.

Recent developments have significantly altered the prospects for the continued flow to the U.S. of HEU from dismantled Russian nuclear warheads after the scheduled expiration date of the HEU Purchase Agreement. On February 1, 2008, U.S. Commerce Secretary Carlos M. Gutierrez and Russian Federal Atomic Energy Agency Director Sergei Kirienko signed an amendment to the 1992 Agreement Suspending the Antidumping Investigation on Uranium from the Russian Federation.[316] Prior to this amendment, the only Russian uranium product entering

---

312 The text of the agreement, including this annex, is available at http://www.nti.org/db/nisprofs/russia/fulltext/plutdisp/pudispft.pdf; accessed July 14, 2008.

313 Ibid.

314 The text of the joint statement is available at http://www.energy.gov/print/5742.htm; accessed July 14, 2008.

315 Ibid.

316 The text of a February 11, 2008, Federal Register announcement containing the amendment is available at http://frwebgate4.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=82779314129+0+0+0&WAISaction=retrieve. The amendment came in the wake of a September 26, 2007, decision by the United States Court of International Trade, available at http://www.cit.uscourts.gov/slip_op/Slip_op07/07-143.pdf, that called into question the

the United States for consumption in nuclear reactors was low-enriched uranium down-blended from bomb-grade material and sold to U.S. utilities through the United States Enrichment Corporation pursuant to the HEU Purchase Agreement. The amendment allows Russia to make direct sales of commercial Russian uranium products to U.S. utilities, beginning in 2011. Russia will be permitted to export relatively small quantities of such uranium during the years 2011 to 2013, and relatively larger quantities from 2014 to 2020,[317] at the end of which Russia is scheduled to gain full access to this U.S. market.

## Legal Issues Related to Arms Control

***Strategic Offensive Reductions Treaty Expiration in 2012.*** The Strategic Offensive Reductions Treaty (SORT) expires on December 31, 2012. After signing SORT in May 2002, the United States and Russia committed to negotiate transparency measures to accompany the treaty. Such measures have yet to be concluded. In addition, it is not too soon to begin thinking about a follow-on to SORT.

***Strategic Arms Reduction Treaty Expiration in 2009.*** The Strategic Arms Reduction Treaty (START) expires on December 5, 2009. Both sides fulfilled their START reductions several years ago, but they continue to employ the treaty's verification regime to conduct inspections and exchange data on their deployed strategic nuclear forces. Indeed, SORT, which still does not include substantive verification provisions of its own, has been buttressed by START's verification procedures. During 2007, the United States and Russia exchanged post-START proposals while some U.S. lawmakers and others urged the two sides to consider exercising START's five-year extension option.

---

applicability of anti-dumping measures to sales in the United States of Russian LEU obtained pursuant to enrichment services contracts.

[317] Russian uranium imported for U.S. initial cores (the LEU necessary to start a U.S. nuclear reactor that is entering service for the first time) is exempted from the annual export quotas set forth in the amendment.

# NUCLEAR SECURITY AND NON-PROLIFERATION FOR THE COMING DECADES: COOPERATION IN A GLOBAL CONTEXT

# NUCLEAR NON-PROLIFERATION AND NUCLEAR ARMS CONTROL

Viktor S. Koltunov, Vitali L. Kotyuzhansky, Yuri F. Zabaluyev,
*Rosatom Institute for Strategic Stability*

The twentieth century entered history as a century of confrontation between two social and political systems. It was also an era when humanity's great scientific and technical achievements – the mastery of nuclear and thermonuclear energy – were directed above all at developing nuclear weapons. The development of nuclear weapons brought with it the new threat of spreading nuclear military technology and an increasing number of countries with the bomb. The increasing number of countries with nuclear weapons gave rise in turn to greater risk that these weapons would be used, with all the disastrous consequences this would have for the international community. The prospect of such a turn of events necessitated a radical change of policy in the nuclear weapon states and the creation of reliable barriers to the proliferation of nuclear weapons.

At the foundation of the international legal non-proliferation regime is the Treaty on the Non-Proliferation of Nuclear Weapons (NPT),[318] which was signed on July 1, 1968, and came into force on March 5, 1970. This Treaty is the broadest international agreement to date with 189 signatories. They include non-nuclear states – countries that did not have nuclear weapons before January 1, 1967, and that committed themselves to maintaining their non-nuclear status – and nuclear weapons states, which committed themselves to not transferring nuclear weapons, other nuclear explosive devices, or the control over such weapons and devices directly or indirectly to any other countries and not helping, encouraging or inciting in any way any country that does not have nuclear weapons to acquire by whatever means nuclear weapons, other nuclear explosive devices or the control over such weapons and devices.

One of the most important elements of the non-proliferation regime was the obligation by the Treaty's signatories to hold negotiations on ending the nuclear arms race in the near future and concluding a treaty on full and comprehensive disarmament under strict and effective international control. Another important element was the right of all of the non-nuclear states to carry out research, produce and use nuclear energy for peaceful purposes without discrimination.

Despite the colossal efforts made over the NPT's lifetime to end the nuclear arms race, and despite the radical geopolitical changes in the world over the last 15 years – changes that have ended the global military confrontation between the two political systems – the situation regarding preserving and strengthening the non-proliferation regime remains tense. This is reflected in particular in: the gradual nuclear proliferation that has taken place (nuclear tests in India and Pakistan, a de-facto nuclear Israel, the situation with the North Korean and Iranian nuclear programs); differences of opinion between the nuclear weapons states and most of the

[318] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.

non-nuclear states on the ways and pace of nuclear disarmament; problems with bringing the Comprehensive Test Ban Treaty (CTBT)[319] into force; the deadlock at the Disarmament Conference on concluding a convention to end the production of fissile materials; the U.S. withdrawal from the Anti-Ballistic Missile Treaty (ABM)[320]; the standstill in establishing new nuclear-weapons free zones; and the United States' increasing inclination to use force in resolving international problems and the resulting incentive this gives to a number of non-nuclear countries to obtain nuclear weapons (modern knowledge and technology makes this easier to do, and nuclear weapons are seen as a way for a country to raise its political status and give itself added protection against external pressure).

In this context, the issue of countering proliferation of nuclear weapons and the means of their delivery remains very relevant. At the same time, it has become clear that the efforts of individual countries (or even groups of countries) to prevent nuclear weapons proliferation are not effective. Proliferation is a global problem and this makes international cooperation all the more important.

In his Address to the Russian Federation Federal Assembly in 2006, President Vladimir Putin spoke of the need to adopt comprehensive nuclear non-proliferation measures as "one of the most important issues in today's world."[321] Non-proliferation of weapons of mass destruction is almost always on the agenda and reflected in the documents of G8 summits (see Appendix D).

The non-nuclear NPT signatories consistently express their dissatisfaction with the pace of nuclear disarmament. They quite fairly view nuclear disarmament not as some kind of alternative, but as a strict obligation taken on by the nuclear states under the NPT's provisions in which progress has virtually come to a halt. Despite the NPT's positive achievements, it has not become a universal treaty and its lifetime has seen the emergence of de-facto nuclear states – India, Israel, and Pakistan – which symbolize the serious crisis facing the nuclear non-proliferation regime. Moreover, other countries still continue their attempts to join the 'nuclear club.'

All of the unresolved issues affecting the non-proliferation regime's effectiveness traditionally emerge in most concentrated form during the NPT review conferences. A program adopted by the conference in 2000, *13 Steps Towards Nuclear Disarmament and Non-Proliferation*, has still not been implemented.[322] The most recent conference in New York in 2005, failed to produce a single document containing concrete recommendations for strengthening the NPT.[323] The deep-running contradictions that have built up between nuclear states and developing countries over many years have led to a situation where these conferences become bogged down in discussing organizational issues instead of concentrating on matters of substance, namely the NPT signatories' commitment to the Treaty's three main principles: non-proliferation, disarmament, and the use of nuclear energy for peaceful purposes.

The most active position on nuclear disarmament during the conference was taken by countries that are part of the Coalition for a New Agenda: Brazil, Egypt, Ireland, Mexico, New Zealand, South Africa, and Sweden. These countries highlighted the issue of the nuclear states'

---

[319] The text of the Comprehensive Test Ban Treaty can be found at http://www.ctbto.org/; accessed April 6, 2008.
[320] To read the text of the AMB Treaty, see http://www.state.gov/www/global/arms/treaties/abm/abm2.html; accessed, April 8, 2008.
[321] The text of this document can be found at http://www.kremlin.ru/text/appears/2006/05/105546.shtml.
[322] For further information, see http://disarmament2.un.org/speech/29apr2001.htm; accessed April 8, 2008.
[323] For further information, see http://www.un.org/events/npt2005/; accessed April 8, 2008.

observance of Article VI of the NPT. Along with the question of cutting back strategic offensive nuclear weapons, these countries also focused attention on reducing non-strategic nuclear weapons, bringing the CTBC into force, and reaching an agreement on the Fissile Material Cut-off Treaty.[324] The developing countries have focused primarily on the issue of negative security guarantees for the non-nuclear states with respect to both the threat and the actual use of nuclear weapons.

The developing countries and many European nations link progress on non-proliferation efforts to nuclear disarmament and arms control and therefore expect concrete and practical steps from the five nuclear powers. But at the same time, new threats and challenges to security, regional conflicts, the increased role of force as a factor in resolving global problems, the increased danger of outside intervention in sovereign states' domestic affairs under the pretext of preventing weapons of mass destruction (WMD) proliferation, the U.S. withdrawal from the ABM Treaty and its plans to develop a global missile defense system (including plans to deploy components of this system in Europe), the new U.S. space strategy giving it the right to deploy weapons in space, and the George W. Bush Administration's highly negative attitude toward drawing up binding legal instruments in the area of arms control and non-proliferation have all stalled the disarmament process and make the prospect of reaching new nuclear arms control and arms reduction agreements very uncertain at the present time. The U.S. position on this issue is contradictory: on the one hand, the United States resolutely opposes nuclear weapons proliferation, but on the other hand it shows a clear lack of interest in further arms reductions – the aspect of non-proliferation policy that is a determining factor in shaping relations between the leading world powers and the developing countries.

The Russian position is that considerable progress in nuclear disarmament has been achieved over the last 10-15 years, and it supports continued development of this process. Russian President Vladimir Putin said on November 13, 2000, that, "We see no reason why further strategic offensive arms reductions should not be carried out. We have proposed to the United States, including at the highest levels, setting the goal of radically cutting back our countries' nuclear stockpiles to 1,500 warheads each (it would be entirely realistic to do this by 2008). But this is not the limit and we are ready to consider even lower levels in the future."[325] The two countries signed the bilateral Strategic Offensive Reductions (SORT) Treaty in May 2002, under which deployed nuclear warheads are to be cut back to 1,700-2,200 units in each country, but no further reductions followed and the disarmament process came to a halt.[326]

The questions today then are: Is there a future for further cooperation in nuclear arms control? What are the problems involved? What solutions can be found? The answer to the first question is very much in the affirmative, for, so long as we do not lose sight of reality, nuclear arms control remains one of the most important aspects of U.S.-Russian relations, and both countries now need to find common ground in new conditions. As we see it, the following elements could serve as the basis for a new treaty:

---

[324] For further information regarding the Fissile Material Cutoff Treaty, see http://www.fas.org/nuke/control/fmct/index.html; accessed April 6, 2008.

[325] The text of Vladimir Putin's statement on the antiballistic missile defense issue can be found in Russian at http://president.kremlin.ru/text/news/2000/11/129411.shtml; accessed July 14, 2008.

[326] The text of the Treaty on Strategic Offensive Reductions can be found at http://www.whitehouse.gov/news/releases/2002/05/20020524-3.html; accessed April 6, 2008.

- Lowered levels (as compared to the SORT) set for the number of warheads and limits on the overall number of means of their delivery, but without sub-limits for intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs) and heavy bombers, and without restrictions set on the structure of strategic nuclear forces. Russia has already stated its willingness to reduce strategic offensive arms to a total of 1,500 warheads or even less, but the United States is not yet ready for such a step. A compromise solution could be to set a level of 1,500-2,000 warheads and 850-1,000 means of their delivery. Conditions could also be agreed for the deployment of non-nuclear armed ICBMs and SLBMs.
- A ban on the development of new types of strategic offensive weapons and their transfer (sale) to third countries. This would require conditions to be made concerning the current cooperation between the United States and the United Kingdom on SLBMs.
- Development of clear accounting rules that exclude the possibility of building up 'return potential' (the existence of such rules is one of the key factors for reaching a new agreement).
- Bolstering confidence-building measures, transparency and predictability in the area of nuclear arms.
- Development of control measures that are reliable but at the same time cheaper and simpler than those set out in the Strategic Arms Limitation Treaty (START-I Treaty).[327]
- Making the agreement legally binding.

The drafting of a new agreement is directly or indirectly linked to a number of problems that have an influence on the future treaty's content. The most important among them (though this is not an exhaustive list) include the following.

- Restrictions need to apply to all types of strategic offensive weapons, including **long-range sea-based cruise missiles**. Long-range sea-based cruise missiles are considered to be a separate class of strategic offensive arms. These missiles are equipped with quite powerful nuclear devices (up to 200 kilotons), have high precision (the use of an optical correlation targeting system and satellite navigation equipment gives them probable circular deviation of just 8-10 meters), and a flight range of 2,600 km or more. The fact that they fly at low altitude (only several dozen meters above ground) and have a low effective dispersal surface enables them to approach their targets undetected and carry out an effective strike.
- The current situation with cruise missiles is as follows: they are not subject to restrictions under existing agreements and the United States opposes the introduction of any restrictions on them, citing the difficulties or even impossibility of carrying out control as the main reason.

The problem is that if restrictions and reductions are imposed on some types of strategic offensive weapons, but others – long-range sea-based cruise missiles – are not subject to any

[327] To read the text of the START I Treaty, see http://www.fas.org/nuke/control/start1/text/index.html; accessed April 6, 2008.

restrictions and the possibility for their unlimited increase remains open, this arms control system in general ends up making no sense.

The decision not to include long-range sea-based cruise missiles in arms limitations was to some extent acceptable when the situation was one of reducing strategic offensive weapons to a total of several thousand warheads, but it is quite a different matter if further serious reductions are made to the numbers of strategic offensive weapons while at the same time the number of sea-based cruise missiles increases dramatically.

There are problems with long-range sea-based cruise missiles including the fact that they can be equipped with nuclear or conventional devices, and accounting procedures used. Their control does present certain difficulties. But in principle, all of these issues, including the control question, can be resolved. It would be possible, for example, to set a limit on the total number of long-range sea-based cruise missiles and let the parties themselves decide the numbers of nuclear and conventional-armed missiles within this limit. Alternatively, a sub-limit could be set for the number of nuclear-armed cruise missiles. Control measures could include restrictions on deploying cruise missiles on particular types and classes of vessels, distinguishing signs for nuclear and non-nuclear cruise missiles, on-site inspections, the use of radiation control apparatus, the implementation of confidence-building measures, in which the parties already have considerable experience, and the organization of demonstrations of arms. The most important issue is to demonstrate political will and organize cooperation between the parties. All of these issues could become the subject of joint discussions.

One of the main issues for the future prospects of a new agreement is controlling the parties' compliance with their obligations. There can be no doubt that control must guarantee confidence that the parties are indeed complying with their obligations. The experience with the Intermediate-Range Nuclear Forces[328] and START-I Treaties shows that future treaties should provide for effective but less costly and unwieldy control measures. The START-1 Treaty, for example, stipulated 13 different types of inspection. The parties conduct several dozen inspections every year and each inspection costs several thousand dollars. At the same time, magnetic tape recordings of telemetric data transmitted from on board launched missiles are exchanged, deployed mobile ICBM launchers are placed in the open air in compliance with highly complicated procedures, and constant monitoring of mobile ICBM production sites is conducted.

Analysis shows that it is possible to considerably simplify the control mechanisms. It would be possible to renounce some control measures without reducing the overall effectiveness of control. Instead of 13 different types of inspection it would be possible to have just two: inspections to check initial data and annual inspections to check updated data. The first type of inspection could be conducted once (immediately after the treaty comes into force), and the second could be set as an annual quota of, say, 5-10 inspections, with each side deciding as it sees fit how to use this quota for the agreed inspection purposes.

Strengthening and developing confidence-building measures, transparency and predictability in the area of nuclear weapons is also very important. It would make sense in this respect to keep the information mechanism that has already been tried and tested through the START-I Treaty and complement it with the exchange of information on plans and programs in the areas of offensive (including sea-based cruise missiles) and defensive strategic arms.

[328] To read the text of the INF Treaty, see http://www.state.gov/www/global/arms/treaties/inf2.html; accessed April 6, 2008.

The **ABM issue** needs to be jointly examined. U.S. plans to deploy a global missile defense system and its withdrawal from the ABM Treaty cannot fail to have an impact on nuclear arms reductions and limitations. This arises from the objective interrelationship between offensive and defensive arms. The extent of this impact can vary depending on a number of factors, but that there is an impact of one kind or another is indisputable.

Although the ABM Treaty has ceased to function, the ABM problem has not disappeared. The reality is such that the parties will have to address this issue sooner or later, because if the United States does go ahead with its missile defense system plans, it will ultimately set off (and is already setting off) an insidiously developing arms race, the threat of weapons being deployed in space, which will call the whole future of continued confidence-building efforts into question.

Increased ABM potential will lead to the domination of a strategy based on preventive nuclear strikes in the event of international crises. Rather than holding back the spread of missiles and missile technology, this situation will give their proliferation an added boost. The interrelationship between strategic offensive arms and missile defense systems will create a situation that considerably complicates any further nuclear arms reductions. In order to stop the world from sliding toward a situation the international community thought had become a thing of the past, it must be clear that the ABM issue has to remain on the bilateral relations agenda.

Steps to reduce the negative impact of the above-mentioned factors could begin with the agreement of ABM-related confidence-building measures. Taking a sober look at the current situation with regard to missile defense, the aim today is not one of trying to achieve a far-reaching agreement, but rather of adopting a gradual approach and beginning with the more modest objective of agreeing to carry out confidence-building and transparency measures in this area.

The possibilities for this exist. The positive experience already built up by the parties and reflected in the Agreement on Confidence-Building Measures Related to Systems to Counter Ballistic Missiles Other Than Strategic Ballistic Missiles, signed on September 26, 1997, in New York, could serve as a concrete base upon which to build in this area.[329] Under this agreement, the parties inform each other of test grounds, other test sites and launches of interceptor missiles, organize voluntary demonstrations of their missile defense systems and components and the observation of their tests, and provide information on the parameters of the missile defense systems and components. Settling on confidence-building and transparency measures that would be then drawn up as an agreement would help to assuage the concerns arising from the deployment of missile defense systems as part of efforts to counter the strategic ballistic missile threat.

An agreement of this kind would put in place the conditions for gradually expanding the range of issues the parties could then examine and resolve. In this respect, they would be better informed on the actual state of affairs and each other's intentions in the area of missile defense. One proposal in this area is to establish a joint information system for collective use. The information provision system is the central, most complex, labor-intensive component of the missile defense system, and also the component that raises the greatest concerns. If, as the United States declares, the planned missile defense system is not directed at intercepting Russian ballistic missiles, and if Russia and America really are partners, then it would be possible to unite the two countries' efforts in developing this component of the system under the understanding

---

[329] The text of this agreement can be found at http//www.fas.org/nuke/control/abmt/text/abm_cbm.htm; accessed July 14, 2008.

that both countries would use the information it provides. In this respect, the Russian proposal for joint use of the Gabala radar station should be given consideration.

The idea of a common European missile defense system offers great potential for bilateral and multilateral cooperation. Joint evaluation of the nature and scale of missile proliferation and the potential threats of these weapons' use could provide the initial base on which to build. It is extremely important that work on this kind of system not lead to increased tension in relations with countries that for whatever reason will not be taking part in the work or that are considered as potential dangers to the European region. In order to achieve this objective, a European missile defense system, if the need for its development really does arise, should be based on the principle of 'rapid reaction missile defenses.' In other words, directing the system from the outset against this or that specific country (or group of countries) would not be the right approach.

Cooperation could extend to a wide range of areas, including the formation of a common database on potential means of attack, the development of the European missile defense system's concept, definition of the procedures, scale and deadlines for potential deployment of the system's formations, creation of its information field and pool of weapons resources, organization of command-headquarters exercises, and so on.

**The problem of outer space**. There is reason today to believe that conditions are emerging for the potential deployment of weapons in outer space. The gaps in international law in this area, the development of new strategic military doctrines as well as scientific and technical advances all lend weight to this conclusion.

A number of international agreements concerned to a greater or lesser extent with preventing the militarization of outer space already exist, but this does not mean that there are no gaps in the law that cannot be exploited. Military activities in outer space not covered by international agreements can be divided into two categories:

1) activities to create and use so-called space support systems
2) activities related to space weapons systems

The first type of systems (support systems) encompasses systems designed for the following tasks:

- timely detection of signs of preparation and launch of an attack, rapid warning of attack threats (vision-based, radio and radio-technical intelligence systems, missile attack warning systems, control of air space and outer space)
- systems to support state management and command of armed forces (space communications and data transmission systems)
- systems to monitor compliance with international treaties and agreements (space observation systems, systems for detecting missile launches and nuclear explosions)
- systems providing navigation, meteorological, topographical, surveying and cartographical support to armed forces units, systems for controlling the location of various objects (space-based systems for corresponding purposes)
- systems for detecting and assessing the consequences of emergency situations and natural disasters (space-based observation systems)

Current provisions of international law do not place any restrictions on the development and deployment of such systems, and the space powers sought precisely to avoid the imposition of such restrictions. Military systems of this kind considerably reduce the surprise factor in other countries' behavior, make it easier to forecast developments in the international situation, help prevent dangerous incidents related to the everyday activities of armed forces, and contribute overall to increasing national and international security and strengthening strategic stability.

Space systems of the second type (weapons systems) include space-based attack systems, anti-satellite systems, and radio-electronic and optical-electronic suppression systems. Activities related to these systems can have several objectives.

- Development and testing of objects with different types of WMD, which could be intended for deployment in outer space.
- Development, testing and deployment in outer space of weapons that are not WMD (missile defense systems, for example, or weapons systems designed for selective destructive of targets in the air, on land or at sea). The cessation of the ABM Treaty means that one of its most important aspects related to legal regulation of military activity in outer space, namely, the ban on the creation, testing and deployment of space-based missile defense systems and components, is no longer covered by legal provisions.
- Development, testing and deployment of anti-satellite weapons in outer space.
- Development, testing and deployment of various types of radio-electronic and optical-electronic suppression systems in outer space.

An analysis of these different objectives leads us to the conclusion that, in legal terms, outer space is not entirely protected from the possibility of becoming an arena for the deployment of weapons under certain conditions, and even a potential theater for military operations. Time will tell whether or not anyone will actually make use of the gaps in the international law on outer space, but the conditions for such developments are already emerging.

What are the possible consequences of deploying weapons in outer space? The one issue that is without doubt is that it would have a serious destabilizing effect on the international situation. The global reach of space-based weapons, the surprise factor in their use, the possibilities for covertly acting against and debilitating other countries' space objects, and monopoly possession of these weapons would place the international community in a situation where it feels like it has a 'sword of Damocles' hanging permanently over its head, all the more so as, unlike WMD, space-based weapons can be used selectively and are thus weapons that could actually be used in practice.

All of this leads to the conclusion that it is urgent to address this issue and prevent the deployment of weapons in outer space. It is not hard to realize that it is easier to keep outer space free of weapons when there are not actually any weapons there yet than to try to clear outer space of weapons after they have already been deployed.

Based on this position, Russia has consistently supported immediate agreement of measures aimed at preventing the deployment of weapons in outer space. These measures could include:

- the use of outer space in accordance with international law that is, in the interests of peace and security

- a commitment to not put any object equipped with weapons of any type into orbit, nor to deploy such weapons on celestial bodies or deploy them in outer space through any other means
- a commitment not to use force or the threat of force against objects in outer space

These provisions could form the basis for negotiating an agreement that would provide full protection against the deployment of weapons in outer space.

One of the biggest problems today with regard to possible future agreements on strategic offensive arms is the **entry into force of the Comprehensive Test Ban Treaty (CTBT)**. This process has already continued for more than 10 years and the treaty's future still remains unclear.

The main argument for not bringing the treaty into force advanced by its opponents in the nuclear powers is that without nuclear tests it will be impossible to guarantee the safety and reliability of existing nuclear weapons. Opponents to the treaty from countries not officially in the 'nuclear club' try to advance their own arguments, obviously hoping to ensure they have the opportunity to carry out nuclear tests in the event that their country manages to acquire nuclear weapons. But there is a clear need for the CTBT to come into force as soon as possible. The importance of this treaty is reflected in its place and role in the system of international nuclear arms control and nuclear non-proliferation agreements.

When drafting the CTBT, the participants in the negotiation process were aware that if all countries are involved, the treaty can provide reliable barriers not only to the efforts of 'threshold states' to develop nuclear weapons, but would also make it more difficult to improve existing nuclear arsenals. In this sense, the aim of the CTBT was not only the general goal of saving humanity from the possible environmental consequences of nuclear tests, but it would also make an important and in some ways unique contribution to non-proliferation efforts and would create favorable conditions for further nuclear arms reductions.

Influential arms experts assert that the safety and reliability of nuclear weapons can be guaranteed without conducting nuclear tests. All that is needed in this respect is to make use of the intellectual, technological and financial resources required to create the relevant diagnostic and control systems. The technological progress that is inherent to the development of science and technology in the world today will help in this work.

Are the conditions in place today for the CTBT to come into force? The answer is more affirmative than negative. First, the nuclear powers have observed a moratorium on nuclear tests during the last 10 years (Russia and the United States have observed a moratorium for more than 15 years now) and, according to the relevant authorities in these countries, the safety and reliability of their nuclear arsenals measure up to the stipulated demands. Second, the vast majority of countries have already made their choice in favor of the treaty. The treaty has already been signed by 177 countries and ratified by 140 (including 34 countries on the list of 44 countries whose participation is an essential condition for the treaty to come into force). Third, considerable sums of money, around $1 billion, have already been spent on technical preparations for the treaty to be able to function, establishing a verification mechanism (an international monitoring system, international data center, the infrastructure for a global communication system, and the technical secretariat), and also on the work of the CTBT Preparation Committee. It would be unjustified to have carried out this work and spent this money in vain.

Finally, in the opinion of experts, the verification system put in place by the CTBT would have sufficient possibilities for effectively controlling the ban on nuclear tests in all environments. This is confirmed by the results already achieved in the system's development. This system would be unprecedented in its global reach.

All of these facts indicate positive prospects for the CTBT to come into force and begin functioning in full. Speeding up this process could help to reinvigorate the spirit of cooperation between countries that was reflected in work on planning and drafting the CTBT (the work of an international group of seismology experts, the joint Russian-U.S. nuclear explosion control experiments and so on). Problems that could arise and dissuade a country from joining the CTBT could be resolved together by developing scientific and technical cooperation, exchanging experience, technology and knowledge; searching for confidence-building measures; and encouraging comprehensive and concrete dialogue on all unresolved issues.

The problem of **reduced combat readiness of strategic nuclear forces** – an issue that remains the subject of much discussion at various levels in the United States and is presented as one of the main directions for maintaining strategic stability – deserves separate analysis. The following arguments are commonly advanced with regard to this problem:

- Russian-U.S. relations have undergone radical change. Russia and the United States are now building relations based on partnership and it would not be in keeping with these new relations to maintain strategic nuclear forces at a high level of combat readiness and continue targeting them at each other.
- A high level of combat readiness of strategic nuclear forces combined with the concept of retaliatory strike increases the risk of accidental nuclear war (as a result of mistakes in the information processing and military command systems, inadequate evaluation of the situation, mistaken decisions, unauthorized action by service personnel or terrorists, and provocation by third countries, etc.).
- Missile attack warning systems could possibly send out a false alert, especially given the current state of Russian warning systems.

Analysis of these arguments reveals that there is no real evidence to support them. The high level of combat readiness of strategic nuclear forces achieved by the two sides earlier is not a hindrance to developing partnership relations today. The possibility of an accidental nuclear war is purely theoretical (the two sides have adopted constructive organizational and technical measures that practically rule out the possibility of a missile being launched through unauthorized action by service personnel or terrorists).

At the same time, lowering the combat readiness level of strategic nuclear forces would deprive nuclear weapons of their main function – the deterrent function – and this could negatively affect strategic stability.

Various possibilities for lowering the combat readiness level of strategic nuclear forces are being examined. The main options are removing warheads from missiles and storing them at a considerable distance from the missile systems' launch sites (other methods are not very effective and cannot be controlled). But removing the warheads from missiles creates new demands: the missiles need to be fitted with electronic equivalents to replace the warheads removed, additional storage facilities need to be prepared and additional service personnel needs to be brought in, all of which are quite costly undertakings.

Nor should it be forgotten that these measures to reduce the combat readiness of strategic nuclear forces concern Russia and the United States but do not address the question of similar steps being taken in the UK and France. Also, the measures primarily concern ICBMs, which constitute the backbone of Russia's strategic nuclear forces. Finally, there can be no ruling out a situation in which the two sides are forced to start raising the combat readiness level of their strategic nuclear forces once again but do not do so simultaneously. The country that first restores its strategic nuclear forces to full combat readiness could be tempted to make use of the opportunity for a first strike, and this could create an extremely unstable and dangerous situation.

Objectively speaking, proposals for reducing the combat readiness level of strategic nuclear forces are not in the interests of strengthening strategic stability and preventing the proliferation of nuclear weapons.

Based on all of the above, we can draw the following overall conclusion: there is no doubt as to the need to activate the arms control process. A breakdown in the disarmament process in not in the interests of Russia, the United States, or the international community in general. Disarmament has been an important part of international politics for several decades now. Russia and the United States have both made a significant contribution to maintaining strategic stability in the world and it would be completely irrational now to take disarmament issues off the global agenda. Only joint, open, concrete and unbiased discussion of the existing problems and divergences in approach and close cooperation can bring positive results in the form of legally binding agreements that are in keeping with national interests and the interests of the entire international community. The current attempts to reduce the disarmament process to unilateral steps cannot achieve these objectives because in the absence of legally binding agreements each side will have a less clear picture of the other side's real forces and will think them greater than they are in reality. Suspicions could arise that the other side is concealing the true scale of its forces. The absence of legally binding control measures makes it impossible to verify whether such concealment is actually taking place. Unilateral steps do not make for a more predictable future because they are implemented without mutual legal obligations and can be reversed with greater ease and rapidity. The problem of the irreversibility of arms reductions is becoming more acute; (this is an especially sensitive issue for Russia, given NATO's eastward expansion, the U.S. plans to deploy components of a missile defense system close to Russia's borders, and the prospect that weapons will be deployed in outer space.

The increasing importance of WMD proliferation issues and the growing problem of international terrorism, including nuclear terrorism, should also be kept in mind. If extremists get their hands on weapons of mass destruction the results would be catastrophic. There is thus a clear need for the international community to coordinate efforts to prevent further erosion of the non-proliferation regime.

There can be no doubt that success in this important area will facilitate more rapid progress in resolving other important international issues.

# APPROACHES TO REDUCING THE RISK OF NUCLEAR MULTI-POLARITY

Major-General Pavel S. Zolotarev,
*Russian Academy of Sciences' Institute for USA and Canada Studies,*
*Academy of Military Sciences*

Nuclear weapons non-proliferation has become one of the most important international security issues facing the world since the end of the Cold War. The nuclear arms control system inherited from the Cold War era has turned out to be less adaptable than many other components of the international political system. The overall rules in this crucial area for international security remain virtually unchanged, both at a global and regional level.

The nuclear non-proliferation regime is under threat. Some countries seeking to free themselves from the obligations of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)[330] have withdrawn from it or threaten to do so. It now appears that we are approaching the point at which this erosion of the nuclear non-proliferation regime has become irreversible, setting off a potential avalanche of nuclear weapons proliferation.

Without calling into question the current nuclear arms control system as a whole, there is a need to complement it with new elements that take into account changes in the world. Many experts call for the development of a new nuclear arms control concept in general.

Recent works that have attracted attention include the Carnegie Endowment for International Peace's *Universal Compliance: A Strategy for Nuclear Security*.[331] This work's value lies not only in the practical recommendations it contains but also in that it states clearly that the United States cannot resolve these problems alone. In today's conditions, only a multilateral nuclear arms control system that unites coordinated international efforts can produce effective results.

The United States has always been one of the main initiators of efforts to prevent nuclear weapons proliferation, but these initiatives have always stemmed more from the United States' own priorities and interests rather than from the nuclear weapons proliferation problem itself. When it first developed nuclear weapons, Washington's initial nuclear policy goal was to maintain its monopoly over these arms. In July 1946, the U.S. Congress passed the U.S. Atomic Energy Act, which prohibited the transfer of nuclear technology to other countries, including even to the United Kingdom, whose scientists had made an important contribution to the

[330] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.
[331] George Perkovich, Jessica T. Matthews, Joseph Cirincione, Rose Goettemoeller, and Jon Wolsthal. *Universal Compliance* (Washington, D.C.: Carnegie Endowment for International Peace, 2005). Available at http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=16593; accessed April 8, 2008.

Manhattan Project that developed the nuclear bomb. Amendments to the law lifting the barriers to U.S. nuclear cooperation with its NATO allies were made only in the mid-1950s.[332]

When the Soviet Union carried out its first nuclear test on August 29, 1949, ending the U.S. nuclear monopoly, the focus of U.S. nuclear policy shifted to maintaining supremacy over the Soviet Union. The confrontation between the two systems had an impact on nuclear non-proliferation policy, as reflected in double standards on both sides and an indulgent attitude toward other countries' nuclear ambitions when it suited the goals of nuclear rivalry.

Overall, however, the nuclear non-proliferation regime that took shape during this period was relatively effective. China, France, and the United Kingdom all developed their own nuclear deterrent during this period, but none of them could or tried to match the United States and the Soviet Union in numbers and variety of nuclear arms, limiting themselves to ensuring relative autonomy for themselves within a bipolar system of international relations. Other countries found a sense of relative security under the protection of either the Soviet or U.S. nuclear umbrella.

The end of the Cold War has not made the task of preventing nuclear weapons proliferation any simpler. Indeed, new problems have arisen. Part of the Soviet strategic nuclear arsenal ended up on the territories of newly independent states (Belarus, Kazakhstan and Ukraine), and not all of these countries were willing to renounce the possibility of obtaining nuclear power status. At the same time, some countries decided to use nuclear weapons as a means of establishing themselves as regional leaders, becoming nuclear powers in fact, although not officially recognised as such (India and Pakistan). Prompted by the sole remaining superpower's use of brute military force, some countries began to consider the expediency of developing nuclear weapons as a means of guaranteeing their security. Iraq had nuclear ambitions, and a complex situation has now arisen regarding the North Korean and Iranian nuclear programs.

Through the Cooperative Threat Reduction Program,[333] the United States has made an important contribution to ensuring safe and reliable transport, storage, and destruction of Soviet nuclear weapons in the interests of non-proliferation of these weapons following the collapse of the Soviet Union. U.S. aid has stopped these weapons from proliferating, maintained them in safe storage, and has ensured the safe destruction of surplus nuclear arsenals. In the end, Belarus, Kazakhstan and Ukraine gave up the nuclear weapons they inherited from the Soviet Union and joined the NPT as non-nuclear states.

Efforts to resolve the North Korean and Iranian nuclear issues have seen new approaches emerge. In each case, a group of countries, including Russia and the United States, regional nuclear powers (France and the United Kingdom are in one group and China is in the other) and influential regional powers (Germany is in one group and Japan is in the other) have formed. But this format has proven productive only when the United States stopped letting ideological aims (regime change) guide it and concentrated specifically on nuclear non-proliferation objectives.

Although the nuclear arms control system has undergone a certain amount of adaptation to the new situation in the world, not only does nuclear proliferation remain a real threat but there is also real potential for a new nuclear arms race.

---

[332] The U.S. Atomic Energy Act of 1954 can be found at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf; accessed April 8, 2008.

[333] For further information regarding the Cooperative Threat Reduction programs, see http://www.nti.org/db/nisprofs/russia/forasst/nunn_lug/overview.htm; accessed April 8, 2008.

Today's situation is one of nuclear multi-polarity. It is characterised by the existence of several groups of countries:

- officially recognised nuclear powers: China, France, Russia, the United Kingdom, the United States
- nuclear states not officially recognised as such but that openly declare their possession of nuclear weapons: India and Pakistan
- Israel: a country that does not admit to possessing nuclear weapons
- countries with nuclear ambitions and the necessary scientific and technological potential to develop nuclear arms: North Korea and Iran
- so-called 'latent' nuclear powers: countries that have the ability to develop nuclear weapons but that refrain from doing so for reasons of political or military inexpediency: Argentina, Brazil, South Korea and others

This situation of nuclear multi-polarity creates the following main threats and challenges:

- perpetuation of the motivations for possessing nuclear weapons
- possibilities for carrying out ambitions to acquire nuclear weapons
- the risk that nuclear weapons will be used

In this situation, **guaranteeing international security requires the creation of a comprehensive system for nuclear arms control and nuclear non-proliferation**.

Several main objectives emerge in reducing the risks posed by nuclear multi-polarity:

1) reducing the motivations for non-nuclear states to acquire nuclear weapons
2) preventing efforts by countries overtly or tacitly seeking to obtain nuclear weapons to manufacture or acquire such weapons
3) reducing the likelihood that countries possessing nuclear weapons will use them

The current nuclear arms control system is focused primarily on only one of these objectives – preventing non-nuclear countries from developing nuclear weapons. This is the objective pursued by the NPT, and so it is entirely natural that **most proposals for improving the nuclear control regime remain with the nuclear non-proliferation framework set out by the NPT**.

Some aspects that have emerged in the nuclear non-proliferation situation today provide a basis for proposals regarding the other two objectives for reducing the risks of nuclear multi-polarity, namely, reducing non-nuclear countries' motivations for developing nuclear weapons and reducing the likelihood of such weapons actually being used. Coming up with ways to reach these objectives requires first identifying the means for reaching each goal separately.

Two main tasks need to be accomplished in order to reduce the motivations of countries to obtain nuclear weapons:

- non-nuclear states need to be given security guarantees against the possible use of force by countries with overwhelmingly superior military power
- regional disputes and conflicts need to be settled in such a way as to exclude the need to possess nuclear weapons

Work on each of these objectives can be limited to political and diplomatic measures or be complemented with a series of military-technical measures. Examining two examples from the current situation in the world, we can see that military-technical measures are not always needed.

North Korea, for example, has used its nuclear program to blackmail the international community with the aim of retaining control by the ruling regime as it undertakes gradual social and political change with economic assistance from other countries. North Korea has no claims to world or regional leadership and does not have aggressive designs that require the possession of nuclear weapons. It appears that guarantees against the use of force to bring about regime change (as in Iraq), combined with economic aid, would be enough to remove the country's motivations for obtaining nuclear weapons. The positive shift in North Korea's position since mid-2006 seems to support this argument. As soon as the United States, having learned, perhaps, from the lessons of Iraq, put aside its rhetoric about the need for regime change in North Korea and focused instead on the nuclear non-proliferation issue, North Korea responded immediately by changing its position. Conditions and fulfilment of economic aid commitments became the determining factors in the negotiations. The situation looks today as if real policy with regard to North Korea could remain within political and diplomatic limits and not need be backed by military-technical measures.

The situation is different in the case of countries seeking to develop nuclear weapons in order to consolidate regional leadership, restore the balance of power with a hostile state that already has nuclear weapons, or both. Countries driven by these motivations could act by any means, including in violation of international law, International Atomic Energy Agency control, or international sanctions etc., to acquire nuclear weapons or develop their own nuclear fuel cycle technology to a level that would enable them to rapidly manufacture a nuclear weapon if the political situation called for it (thus putting themselves in the group of 'latent' nuclear powers). Efforts to reduce these countries' motivations for obtaining nuclear weapons could require military-technical measures.

Of course, the list of possible military-technical measures, including preventive measures, would be different for each specific case, but it is nonetheless expedient to draw up a basic 'menu' of these measures and the legal conditions for their use in advance.

First of all, the general vector of these measures needs to be defined. The measures concerned should clearly complement political efforts to reduce countries' motivations for obtaining nuclear weapons. If, for example, there is a nuclear power in the region, any country in the region that is not an ally or partner of the nuclear power should have the following security provisions:

- full and complete information on the nuclear power's arsenal and its nuclear weapons use policy
- timely information on the opponent's preparations of its nuclear weapons for use
- the possibility of carrying out a preventive strike using conventional weapons against its opponent's nuclear weapons
- the ability to counter a strike using nuclear weapons

It is clear that countries face significant difficulty in trying to ensure these security guarantees on their own. In reality, such guarantees can be achieved only if other countries help by offering military-technical possibilities. In this situation, there is a need not only for military-technical measures as a complement to political measures, but also for political measures to complement military-technical measures.

At first glance, these discussions appear far removed from reality. It makes sense therefore to look at how they could be applied in practice to a concrete situation.

Work is currently underway to examine the prospects for developing a regional missile defense system, in particular in Europe. There are no official agreements as yet, but the system's general outlines are already emerging. First of all, we need to examine a number of specific points:

- the increase in the number of 'latent' nuclear states continues; missile technology has become more accessible for many countries and, depending on the changing political situation, **potential missile and nuclear threats can arise in different parts of the world**
- missile defense systems are **effective only if they have the possibility of destroying their targets at various stages of the missiles' and warheads' flight trajectories** (the active, passive, and final stages of the trajectory)
- **an effective missile defense system cannot be built within just one country** because of the unpredictability of potential missile threats and the need to be able to destroy the targets at various stages of the flight trajectory
- **establishing components of a missile defense system outside a country's own territory requires joint efforts by countries to build the system**; failure to ensure cooperation would lead to concern among neighbors of the countries where missile defense components are to be installed that the system could be directed against them
- building a missile defense system on an international basis **requires a command and operation system that would give countries joint use of national information and weapons systems**; the system's command structure would have to enable military units from the participating states to take part in the system's operation.

With regard to existing missile defense and systems, a collective missile defense system would have to include:

- national missile attack warning systems
- national missile defense systems such as the S-400, Patriot, and IGIS systems to destroy targets during the active phase of the trajectory
- ground-based missile defense systems, including radar facilities, to destroy the warheads during the passive phase of the trajectory
- command facilities enabling the system to function as a collective whole and pool together national information and weapons systems

There is probably no sense in including weapons systems to destroy warheads during the final phase of the trajectory in the collective missile defense system, but information coordination between the national and collective missile defense systems will be essential. Only with knowledge of how the collective missile defense system functions can the objective of destroying remaining warheads be reached effectively.

Unfortunately, the topic of current discussions and official consultations remain primarily on the radar facilities in the Czech Republic, Gabala, and Armavir, and also on the plans to install missile defense system components in Poland. In reality, it is the Russian president's proposal to open information exchange centers on national missile attack warning systems in Moscow and Brussels that is of key importance.

The Russian-U.S. memorandum on opening a Joint Data Exchange Center in Moscow, signed almost 10 years ago, serves as a basis for highlighting several important points. First, the work of the Center is to be open to participation by other countries. Second, the Center's participants must provide timely warning of upcoming missile and rocket launches (test launches, launches as part of military exercises, for scientific purposes or the launch of satellites etc.). Third, in its initial stage of work, the Center will be equipped with national technical means for displaying information from the missile attack warning systems, but later these national systems will be interlinked.

Due to technical specificities, the weapons components of the missile defense systems are effective only when functioning in automatic mode. The shortage of time makes it not possible for human intervention in tracking the target, distributing the means for the target's destruction, carrying out the launch, and targeting them. Given this, the regional missile defense command point will probably have the following functions:

- collecting and monitoring information on the state of national weapons systems part of the unified regional missile defense system
- placing weapons systems in various states of readiness depending on the information coming in from various sources, including from the national missile attack warning systems
- collection and analysis of information on the status of missions to destroy targets at various stages of the trajectory (for optimum use of all means at the system's disposal)

The weapons systems themselves, so long as they are placed in the appropriate state of readiness in sufficient time, will function in automatic mode.

Overall, **carrying out the Russian president's proposal to open data exchange centers in Moscow and Brussels would open the way to creating joint command centers for a European missile defense system**.

The declared objective of establishing a European missile defense system is to counter a possible missile threat from Iran. The main motivations driving Iran seem to be aspirations for regional leadership and the fact that Israel possesses nuclear weapons. The fact that Israel does not officially admit to possessing nuclear weapons creates a situation in which it offers no negative guarantees to non-nuclear states and this acts as an added incentive for other countries to obtain nuclear weapons.

The world's major powers have made active efforts to prevent Iran from developing nuclear weapons. The Iranian nuclear program seems most probably aimed at turning the country into a 'latent' nuclear power. It is hard to say how successful the international community's attempts to prevent Iran from acquiring the technology needed to develop nuclear weapons will be. The possibility of a solution using force cannot be excluded. History shows that this could be an effective option. It is enough to recall the Israeli strike against a nuclear facility in Baghdad, which stalled Iraqi plans to develop a nuclear weapon for many years. But in the case of Iran, such action is fraught with serious consequences not only for the United

States but also for regional and global security in general. In this situation, the wisest course of action would be to avoid the use of force.

In Iran's case, the following military-technical measures could be possible:

- supplying Iran with modern missile and air defense systems
- offering for Iran to take part in the work of one of the data exchange centers (in Brussels or Moscow)

The benefits of helping Iran develop an effective air and missile defense system are clear. For a country planning a military operation, the prospect of high casualties can be enough to dissuade it from carrying out its plans. But there is another clear aspect. Assistance in helping to develop an air and missile defense system should not come without conditions. It should be linked to concrete non-proliferation obligations. Furthermore, in taking on a share of the responsibility for Iran's security, the international community has the right to assume that this reduces the motivations for Iran to acquire nuclear weapons.

As for Iran's potential participation in the work of the data exchange center, this would give it the chance to receive full information on the missile situation within the framework of the existing missile attack warning systems and the agreed procedures for informing on all kinds of upcoming missile launches. Participation in the center's work would also oblige Iran to provide information on its own planned missile launches.

One area in which the data exchange centers' work can expand in the future is through each of the nuclear weapon states providing information on the main indicators of their nuclear missile potential. This, combined with the eventual transformation of the data exchange centers into command centers for a European missile defense system, would create a predictable situation for all participants in the centers' work. The resulting ability to more accurately assess the situation would in turn create guarantees against inadequate responses.

Participating countries should have the right to withdraw from the centers' work. But if they do so, their subsequent actions will be scrutinized much more closely and they will be deprived of the information they received through participation in the centers. Such actions cannot be ruled out in the case of escalating conflict between two nuclear states over a desire not to disclose information on the state of their nuclear and missile potential. But a series of measures to prevent the opposed nuclear states from using nuclear weapons should be in place for such cases.

Measures aimed at preventing the use of nuclear weapons should take into account some of the specificities of the use of nuclear weapons.

- The greater the deterrent role of nuclear weapons the more unclear the conditions for their use.
- In order to prevent conflict from escalating during a period of growing crisis or war fought with conventional weapons, military and political authorities must demonstrate their resolve to use nuclear weapons, but actual preparations for using nuclear weapons need to be carried out covertly.
- In order to prevent an advance attack by the opponent, a nuclear strike must be sudden and reduce to a minimum the opponent's ability to carry out a counter strike.

If the nuclear state has no possibilities for ensuring these conditions, the likelihood of its using nuclear weapons will be greatly reduced.

Of course, any situation of increasing crisis between countries that include at least one nuclear weapons state will come in for close scrutiny by other countries' intelligence services. The information gathered can be used to give timely warning to the state against whom a nuclear strike is being prepared that a sudden strike is already impossible. At the same time, other countries' air and missile defense forces can be concentrated in the area around the conflict zone in order to prevent attempts to launch an attack using nuclear weapons against any of the parties.

These measures can all be quite effective so long as the legal base and appropriate agreements are already in place and the structures needed for their implementation have been established. These structures should include:

- **A center for collecting, summarizing and analyzing intelligence information** from countries taking part in the measures to prevent the use of nuclear weapons. This center would need to have the authorization to inform the parties to the conflict of plans by one of the parties to launch a sudden advance nuclear strike, in the interests of disrupting such plans.
- **An air and missile defense system based on pooling the resources of national air and missile defense systems** of the countries taking part in the efforts to prevent the conflicting parties from using nuclear weapons.
- **Command centers for comprehensive use of all the available methods** of destroying the means of delivery of nuclear weapons and nuclear warheads in the event of their use.

All of this shows that carrying out military-technical measures aimed at reducing countries' motivations for obtaining nuclear weapons, and the measures aimed at preventing the use of nuclear weapons, require practically the same kind of command structure and military resources. The conclusion, therefore, is that during their consultations on establishing a European missile defense system, Russia, the United States, and NATO should focus not on neutralizing potential threats to Russia from the American system, but on designing the system for the priority missions of preventing nuclear weapons proliferation and preventing the use of nuclear weapons.

Traditionally, the United States has never been inclined to share command with anyone else, and this is true also of the elements of the proposed European missile defense system in Europe. But the examples of cases when the United States has laid aside other interests and shown initiative and resolution in addressing nuclear non-proliferation issues give hope for full cooperation on the ultimate goal.

As was said, the problem of nuclear arms control in today's world goes beyond the NPT framework and no matter how great the United States' efforts to resolve the nuclear non-proliferation issue on its own terms, only a multilateral approach that combines the efforts of different countries will work. We cannot achieve nuclear security unless we address the reasons that incite countries to obtain nuclear weapons and take measures to prevent such weapons from being used.

This does not claim to be an exhaustive list of possible approaches, but the proposals it outlines could be of interest for more detailed examination and drawing up concrete proposals and recommendations that could become the subject of talks and negotiations.

# NUCLEAR SECURITY IN 2015: THE CASE OF NORTH KOREA

Joel S. Wit,
*Columbia University*

Looking seven years into the future of any country is a difficult exercise but it is particularly difficult when talking about the Democratic People's Republic of Korea (DPRK) and its nuclear weapons program. There is a high level of uncertainty, largely because it is unclear whether the Six Party Talks in Beijing will achieve their objective of denuclearizing North Korea. Moreover, Pyongyang's political stability also is unclear.

## THE SCOPE OF THE CHALLENGE

What is the scope of the potential challenge? What do we know about North Korea's nuclear weapons program? The short answer is that there is more we do not know than we do know, but the general outlines of its effort are fairly clear.

U.S. intelligence estimates are that North Korea may have produced anywhere from 35-60 kg of plutonium, enough for a maximum of 15 weapons.[334] Pyongyang's first nuclear test in late 2006, may not have been entirely a success but nevertheless, most experts believe that the North can and has produced nuclear weapons. Whether those weapons can be mounted on the North's existing inventory of ballistic missiles, particularly its medium-range Nodong missiles, also remains unclear.

The center of the nuclear program is the Yongbyon installation, which has a number of facilities including an operating reactor and reprocessing plant. There may also be other locations related to nuclear weapons development, assembly, storage and even deployment. In my meetings with North Korean nuclear scientists, they state that they do not know where the nuclear material goes once it leaves their installation. There are likely other facilities that continue the weapons production process to completion.

Various intelligence agencies estimate that there are about 5,000 nuclear personnel at the Yongbyon facility. As for the total number of scientists, engineers and technicians working on the North Korean program, a best guess is 20,000, of whom about 5,000 participants are central to the weapons program.

[334] Peter Crall, "NK Delivers Plutonium Documentation," *Arms Control Today*, June 2008, available at www.armscontrol.org/act/2008_06/NKPlutonium.asp; accessed July 31, 2008.

If left unconstrained, by 2015 the size of North Korea's nuclear arsenal would grow, albeit slowly. How much is unclear. Key uncertainties would be the age of North Korea's sole reactor and the availability of fresh fuel. Most experts believe the North does not have any additional fuel loads beyond the rods that are currently in the reactor, although it could modify other rods produced for a different model. If that is true, it would certainly severely limit Pyongyang's ability to produce additional plutonium.

North Korea's suspected uranium enrichment program seems to be much less advanced than the George W. Bush Administration claimed in 2002, when it discovered that effort. It is highly unlikely that the North can produce highly enriched uranium (HEU) for weapons. Indeed, its program may not have advanced beyond the research and development phase. As a result, North Korea would probably be unable to produce HEU for additional weapons over the next seven years.

There is no information about the security measures surrounding Pyongyang's stockpile or its nuclear technology but presumably they are extremely tight. Knowledge of its true capabilities is certainly compartmented, confined to a very small number of the top leadership, Kim Jong Il, the military, and the head of the defense-industrial organization responsible for the program.

## FACTORS SHAPING NUCLEAR SECURITY

What about the future? Projecting to 2015 is particularly difficult in the case of North Korea because of uncertainties about the future of the negotiations in Beijing designed to achieve its denuclearization.

Those talks have made some progress over the past six months by shutting down Pyongyang's operating reactor, beginning a process of disabling its known plutonium production facilities and, hopefully, producing declarations by the North Koreans containing information about their nuclear program. (Eventually, we should be able to paint a more complete picture of its program as a result of these declarations.)

However, the bulk of difficult work remains to be done. Key issues remaining include: convincing North Korea to disclose whether it has an HEU program, to dismantle its nuclear weapons, ship its spent fuel and weapons-grade plutonium out of the country, and put in place extensive verification measures.

Moreover, if there is a price to be paid, it will be high and may include the provision of light-water reactors (LWRs) to Pyongyang. That issue is still a difficult one for the United States to address since LWRs were a centerpiece of the unsuccessful 1994 U.S.-DPRK Agreed Framework. Even if all of this was agreed tomorrow, the process of denuclearization would continue for years—certainly until 2015 if not beyond—and may cost billions of dollars.

A second factor complicating attempts to project to 2015, is that there have been and will continue to be uncertainties about the future of the North Korean political system. Just how brittle that system is has been the subject of periodic debate ever since the collapse of the Soviet Union. However, predictions of Pyongyang's demise so far have been, in the words of Mark Twain, "greatly exaggerated."

Nevertheless, the sudden end of the North Korean political system can not be ruled out. Its demise might be triggered by events such as the death of Kim Jong Il before a firm process of leadership transition is in place, humanitarian disasters, social instability caused by economic reform, or economic collapse.

Demise may never happen but if it does over the next seven years before North Korea is denuclearized, it may be sudden, unexpected and have real implications for nuclear security. In the context of a messy collapse, which might entail an internal power struggle that could degenerate into fighting and even civil war, a key question will be the fate of North Korea's nuclear material and small nuclear arsenal, not to mention its other weapons of mass destruction (WMD) materials and stockpiles. Another important issue might be the fate of North Korean nuclear weapons scientists who could flee the country, including to states that Pyongyang has maintained close ties with over the years, such as Iran and Syria, that also present proliferation concerns.

All of this speculation lends itself to a matrix, which combines different outcomes for the denuclearization process and the political evolution of North Korea. The worst case scenario would be that the negotiations in Beijing fail, the North's arsenal gradually expands, and central control in Pyongyang collapses in chaos. The best case scenario is that denuclearization proceeds and central control continues.

## THE WORST CASE SCENARIO

Considering the worst case scenario first, what are the prospects for international cooperation, and specifically U.S.-Russian cooperation, in dealing with the nuclear consequences of North Korea's demise? In the worst case scenario, locating, safeguarding and disposing of materials and stockpiles of weapons would be the highest priority for the United States, which presumably would be working closely with South Korea, and any of its forces that might intervene in the North. This task would not only include nuclear weapons but also chemical and any biological weapon stockpiles.

Successfully completing such a task would be enormously difficult, not only because of the possibly chaotic situation on the ground, but also because Pyongyang's WMD may be dispersed at both suspected and unknown sites, many of which could be underground. Securing materials, facilities and related personnel could require as many as 10,000 troops (assuming some estimates of 100 known sites are correct), many hundreds more to search for unknown facilities, and perhaps thousands more to secure them once they are located. Planners will also need to consider the long-term disposition of the weapons, materials, and personnel, including a transition plan for people and international monitoring of the destruction of weapons and materials.

While the United States and South Korea have given a great deal of thought to how to deal with this possible scenario, it is likely that other countries would also be greatly concerned. For example, in recent conversations with American experts, the Chinese military has stated that it has contingency plans for dealing with the demise of North Korea and, specifically with its inventory of WMD if central control collapses. The Chinese are concerned that such materials might find their way into their country and into the wrong hands.

Presumably, Russia would also be concerned about the disposition of North Korean WMD stockpiles, materials, and personnel in the event of demise not only because of its political, security, and economic interests in the Korean peninsula, but also because of the proximity of the Russian Far East to North Korea (including a common border). Of particular interest might be preventing any WMD materials or personnel from slipping across the border in the chaos that might follow collapse.

All of these considerations argue for joint contingency planning in dealing with North Korea's WMD in the event of Pyongyang's demise, since leakage would have an adverse impact on the security of bordering countries as well as the international community. Such planning might include information sharing on current contingency planning as well as discussions of a possible division of labor in case of collapse. While official cooperation seems unlikely, since any leaks would provoke a harsh North Korean reaction given the ever-present reality of demise, private consultations might be conducted through unofficial channels, intelligence services or even in academic meetings.

## A BETTER CASE SCENARIO

A better case scenario is that the denuclearization process proceeds, and the North Korean central government continues to function. In that context, given North Korea's limited financial and technical capabilities and the abundant resources of the other Six Party Talks participants, international cooperation in achieving a nuclear-free North is inevitable. Moreover, the international community can bring to bear its extensive experience cooperating in many of the areas necessary for denuclearization: dismantling nuclear weapons, shipping spent fuel and weapons-grade plutonium, dismantling nuclear facilities, conducting environmental remediation, redirecting nuclear scientists, and verification.

A number of experts have argued that conducting such cooperative activities with North Korea will be impossible since, among other reasons, it has not made a final definitive decision to give up its nuclear weapons. No doubt working cooperatively inside the North will be difficult for this and other reasons, but if historical experience is any guide, on-the-ground cooperation is possible. This conclusion is based on the experience of governments, international organizations, and non-governmental organizations operating inside North Korea in the 1990s, including the U.S.-North Korean joint spent fuel storage project, the KEDO reactor effort, and assistance programs run by non-governmental organizations.

Such cooperation has already been evident in the disabling of North Korea's main nuclear installations at Yongbyon, which is being conducted by American experts working closely with North Korean technicians at the site. Moreover, a key task of disablement will be unloading spent fuel from the North's nuclear reactor and storing it until the rods can be shipped out of the country. Following the conclusion of the 1994 U.S.-North Korea Agreed Framework, experts from both countries worked together on a similar project.

All of the necessary denuclearization activities will require extensive international cooperation as well as financing if the task of making sure the peninsula is free of nuclear weapons is to be successfully completed. Each of the potential participants has both strengths and weaknesses. South Korea, for example, has the political will, the financial resources and the technical skills but its experience in working cooperatively in the nuclear field is limited. China has the technical skills but its financial resources are likely to be limited.

Russia would seem to have the most to offer in conducting cooperative programs in North Korea. Moscow has a political interest in successfully achieving denuclearization, has maintained close ties with the North Korean nuclear and scientific community, has the technical resources and know-how required for denuclearization, and has extensive experience in working with the United States and the international community on threat reduction efforts in its own territory and in other countries.

Implementing a cooperative process of denuclearization will serve as something of an insurance program over the next seven years and beyond if North Korea's demise does take place. First, the participants will gain a much greater understanding of North Korea's nuclear weapons program—its materials, weapons, installations, and personnel—as that process advances, and that knowledge will serve all of the participants well in case of collapse. Second, in the context of cooperation, inter-organizational and personal ties hopefully will be established inside North Korea. Those ties could make the job of securing materials and weapons in the event of Pyongyang's demise much easier. Finally, as a process of cooperative denuclearization takes place, the nuclear dangers posed by the central government's demise, particularly leakage, will diminish.

## U.S.-RUSSIAN COOPERATION

Looking at the range of tasks required by denuclearization—removal of North Korea spent fuel and plutonium, dismantlement of nuclear weapons, environmental remediation, redirection of North Korean nuclear weapons scientists, and establishment of an effective verification regime—it is clear that Moscow and Washington could cooperate on a number of denuclearization tasks.

For example, the redirection of North Korean nuclear weapons scientists will become an important priority as denuclearization proceeds. As was mentioned earlier, a redirection program may deal with up to 20,000 scientists, engineers, and technicians, many of whom are the most highly-trained individuals in North Korea. Pyongyang will want to put these individuals to work in contributing to economic development. For the other five parties, a successful scientist redirection program will help provide assurance that they will not have to address the problem of a nuclear North Korea again. Moreover, such a program will serve as another tool of verifying that resources are being devoted to peaceful purposes.

The United States and Russia obviously have the most extensive experience in redirection of WMD scientists among participants in the Six Party Talks and can lead a concerted program in North Korea. Such a program might also serve as the foundation for future efforts to deal with the thousands of scientists from Pyongyang's chemical and biological weapons programs. South Korea will also likely play an important role given its political interests, technical know-how, and financial resources. Moreover, there may be a role for private South Korean companies in helping to commercialize any redirection effort. Another potential participant currently not part of the Six Party Talks may be the European Union, which has past threat reduction experience as well as an interest in peace on the Korean peninsula.

A redirection program led by Washington and Moscow could consist of a number of initiatives including:

- an international science center, based in Pyongyang that would provide North Korean weapons experts with the opportunity to

  - contribute to the solution of national and international science and technology problems
  - reinforce Pyongyang's economic modernization program
  - support basic and applied research
  - promote integration of North Korean scientists into the global scientific community

- multilateral cooperation designed to reinvigorate North Korea's peaceful nuclear activities, focusing on the production of radioactive isotopes for medical, industrial, and agricultural uses. An important component of such a program would be the conversion of North Korea's standard Russian designed IRT research reactor from HEU to low-enriched uranium (LEU). The North Korean reactor, which began operation in 1965, currently operates intermittently and probably uses 36 percent enriched fuel. There are approximately 40 kg of 80 percent enriched spent fuel on site. According to technical experts, there is no barrier to using the same conversion process and LEU fuel developed for the Libyan reactor, which was converted in 2006, in the North Korean IRT. The Libyan reactor conversion was carried out under the auspices of the U.S.-Russian Reduced Enrichment for Research and Test Reactors Program and included the repatriation of 17 kg of HEU and the provision of new LEU fuel by Russia.[335]
- reestablishing international ties with North Korean nuclear institutes, such as the Institute for Atomic Energy, which has a number of units and 600 scientists and technicians focusing on cyclotron operations, radio isotopic production, radiation detection, nuclear fusion research, and nuclear electronic engineering.[336]

Russia, working closely with the United States and other participants in the Six Party Talks, might make other significant contributions to the denuclearization process. Such activities might include participating in:

1) the dismantlement of North Korea's nuclear weapons and the destruction of non-nuclear components
2) the removal of spent fuel and plutonium from North Korea to Russia, possibly as the destination for such shipments
3) the decommissioning of North Korea's graphite–moderated plutonium production reactor, an area where Russia has extensive experience planning such activities
4) environmental remediation, particularly in planning for dealing with seriously contaminated sites like the Yongbyon nuclear facility where U.S experience is more limited

U.S.-Russian cooperation may also extend beyond the conduct of threat reduction programs to the provision of important incentives to North Korea in order to secure its agreement

[335] Nuclear Threat Initiative, "Past and Current Efforts to Reduce Civilian HEU Use," available at www.nti.org/db/heu/pastpresent.html; accessed July 31, 2008.
[336] I visited the IAE in January 2007, and met with the Deputy Director, who is very anxious to resume contacts with the international scientific community.

to denuclearize. One issue which has yet to be seriously addressed is Pyongyang's persistent demand for LWRs. Whether that demand will continue is the subject of much speculation. Certainly, from a technical viewpoint, North Korea's energy needs would be much better served by conventional energy sources such as coal-fired plants. Nevertheless, it is worth understanding that the North Korean's have had a consistent and continuing interest in LWRs since the 1980's. Chances are that this interest will continue into the future.

Whether Russia would play a role in any new project is unclear. Certainly Moscow has wanted to participate in a reactor project for some time now. A persistent barrier to such a role has been the lack of financing available to pay for a Russian-led project and the opposition of South Korea and Japan. Any new project would have to overcome these political and financial hurdles.

## CONCLUSION

While significant uncertainties about the nuclear future of North Korea remain, U.S.-Russian cooperation could play an important role in dealing with potential problems. Much will depend on the overall state of political relations between the two countries. But both countries share a common interest in ensuring that any future demise of North Korea does not result in the leakage of WMD stockpiles, materials or scientists. Moreover, if denuclearization proceeds as a result of the Beijing Six Party Talks, close bilateral cooperation on key issues where each could bring to bear extensive technical and historical experience would seem to serve the interests of both Washington and Moscow as well as the other parties to those discussions.

# BUILDING PARTNERSHIP ON THE STRENGTH OF EXPERIENCE: TRENDS, PRIORITIES, AND TOOLS FOR CONTINUED RUSSIAN-U.S. COOPERATION

# BUILDING PARTNERSHIP ON THE STRENGTH OF EXPERIENCE: TRENDS, PRIORITIES, TOOLS FOR CONTINUED RUSSIAN-U.S. COOPERATION[337]

Rose Gottemoeller,
*Carnegie Moscow Center/Carnegie Endowment for International Peace* and
Ashot A. Sarkisov,
*Russian Academy of Sciences*

*U.S. National Academies' (NAS) and Russian Academy of Sciences' (RAS)*
*Co-Chairs of Joint Committees on the Future of the Nuclear Security Environment in 2015*

Many countries and international organizations, including the World Bank and the European Bank for Reconstruction and Development, are currently considering how best to provide assistance to other countries on questions of global importance. Russia is no exception. Since 2007, Russia has been expressing a new aspiration to provide assistance "as an indispensable element of the modern collective security system." This policy trend is clearly laid out in a Ministry of Foreign Affairs concept paper that was approved by the Russian President on June 14, 2007.[338] The Russians state that until recently, the scope and types of Russian assistance had to be quite limited "for objective reasons"—in other words, due to Russia's dire economic crisis during the 1990s. However, they stress, since Russia's economic situation has improved dramatically, the country can now resume a significant effort in this area.

Now, therefore, is a good time for Russia and the United States to examine the experience gained over fifteen years of joint work in the nuclear security environment. Although Russia was not able to work much in the broader area of development assistance during this period, U.S.-Russian cooperation in non-proliferation programs was extensive and fruitful. This joint experience thus provides clues about how Russia and the United States can move forward at the current stage to address new challenges. This workshop, *The Future of the Nuclear Security Environment in 2015*, has focused on the nuclear security agenda, but nevertheless the workshop papers and discussions have provided many good examples of how the U.S. and Russia can work effectively together across a range of serious issues. Indeed, further U.S.-Russian cooperation may unfold not only in the bilateral relationship, but also in other countries and regions around the world.

The workshop was designed to better understand how cooperation might develop in the future, looking at trends in the relationship, priorities for cooperation, and tools that could be

[337] This paper combines the presentation provided during the workshop and the final summary of the workshop.
[338] "Russia's Participation in International Development Assistance: Concept Paper," approved by the President of the Russian Federation, June 14, 2007, p. 3.

used directly either to continue or expand joint U.S.-Russian cooperation. The primary focus, once again, was the nuclear security environment, but with recognition that the results of the discussion may apply to other aspects of the relationship. The workshop has pursued these goals by reflecting on U.S.-Russian experiences with the Cooperative Threat Reduction[339] programs and considering how best to use the lessons learned, both positive and negative, to facilitate joint cooperation in the future. The workshop has not focused on the long-term future, but rather on the period to 2015, when major milestones will have been reached in nuclear non-proliferation cooperation—for example, the conclusion of the current U.S.-Russian cooperation on nuclear material protection, control, and accounting.[340]

This workshop was not designed or intended to produce consensus recommendations for future joint work involving U.S. and Russian specialists. However, workshop participants, Russians and Americans, have shown a significant amount of agreement on many issues discussed during the workshop, including specific approaches and activities that the United States and Russia could jointly undertake in the coming years. Several of these approaches and activities are mentioned here, although the co-chairs cannot do justice to the wealth of sound ideas that have been developed in the workshop presentations and discussions.

## TRENDS

In our view, the major trend discussed was the transition begun by Russia and the United States from assistance, prevalent in the 1990s, **to partnership.** A partnership relationship implies that the two countries are willing to share in establishing priorities for cooperation, managing projects, and paying costs. However, the process of moving to such a partnership relationship has not been fully accomplished. One Russian participant commented that actual partnership activities have thus far been *malovato* (slight).

Threat analyses can differ in Moscow and Washington, which makes it difficult at times to agree on tactics and timing in pursuing joint policies. Such differences have been evident, for example, in the approaches that the two countries have taken regarding Iran and its nuclear program. Moreover, political tensions between Washington and Moscow have been high recently, and this trend is likely to continue in certain aspects of the relationship, complicating efforts to cooperate.

Nevertheless, many workshop participants appear to agree that U.S. and Russian interests do converge in key areas, particularly in tackling the threats of terrorism and nuclear proliferation. These two threats have provided a significant underpinning for U.S. and Russian

---

[339] Cooperative Threat Reduction (CTR) programs are frequently defined as those programs residing in the Department of Defense under the so-called Nunn-Lugar "Umbrella Agreement." In this project, however, they were defined more widely to include the cooperative nonproliferation programs organized and implemented by the U.S. Department of Energy. For further information regarding the CTR Umbrella Agreement, see Richard Lugar, "Trust Needs Verification," *The Washington Times*, July 18, 2008, found at http://www.washingtontimes.com/news/2008/jul/18/trust-still-needs-verification/.

[340] The Bob Stump National Defense Authorization Act of 2003 mandates that a sustainable materials protection, control, and accounting system be transferred to sole Russian Federation support no later than January 1, 2013. For further information regarding the Bob Stump Act, see http://www.army.mil/armybtkc/docs/PL%20107-314.pdf; accessed May 1, 2008.

cooperation in recent years, with a number of bilateral initiatives agreed at the highest level.[341] Decision-makers and experts in both countries agree that these threats are urgent and must be cooperatively addressed in the relationship.

The workshop sessions that have highlighted the nuclear non-proliferation and terrorism issues began with overview discussions led by Ambassador Linton Brooks and Dr. Lev Ryabev. Both authors emphasized that the relationship between the United States and Russia, and the willingness of both countries to further reduce nuclear arms, would go a long way toward strengthening the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) regime as it approaches its next Review Conference in 2010.[342] Both also stressed nuclear terrorism as a dominant threat—or as Lev Ryabev put it, "a most tangible military threat."[343] They emphasized the importance of broad technical collaboration to counter terrorism, pointing to ways in which the United States and Russia could renew cooperative ties in this important area.

Linton Brooks, for example, called for more streamlined procedures to share sensitive information, which would be necessary, among other things, in order for Russia and the United States to take the lead in creating an international system of nuclear attribution based on a technical nuclear forensics capability. This idea led to a wide discussion and expressions of significant interest when Michael Kristo's paper on nuclear forensics cooperation was presented.

Lev Ryabev voiced disappointment that collaboration between U.S. and Russian national laboratories has waned in recent years, and he argued that these organizations could contribute much to non-proliferation cooperation, including efforts to combat nuclear terrorism. He provided an interesting list of projects that could be used to renew the cooperation, including development of means to detect undeclared nuclear activities, highly sensitive devices for monitoring small quantities of nuclear explosives, and instruments for remote monitoring of nuclear fuel cycle facilities.

A number of workshop participants, both Russian and American, have commented that renewing cooperation between U.S. and Russian laboratories is a worthy goal, and have expressed interest in finding ways to do so. Indeed, as a general matter, participants viewed positive cooperation between Russia and the United States on nuclear non-proliferation and counter-terrorism as a way to effect improved and strengthened relations between the two countries.

## PRIORITIES

Many Russian and American workshop participants commented on priorities for further cooperation. We provide several examples here, without assigning any order of importance to these items.

Both Russian and U.S. participants have examined nuclear weapons reduction issues and non-proliferation problems and identified both as important. They have especially emphasized the need to further reduce nuclear weapons and pursue other steps to express U.S. and Russian commitments to fulfilling Article VI of the NPT. Ambassador Brooks stressed the necessity of

[341] See Appendix D.
[342] To read the text of the Treaty on the Non-Proliferation of Nuclear Weapons, see http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf; accessed April 6, 2008.
[343] See the paper by Lev Ryabev in this volume.

thinking forward to 2015 as a time when the United States and Russia could strive for a more ideal relationship, when both would be working closely together, for example, to reduce nuclear arsenals, develop nuclear power, and combat nuclear terrorism. Dr. Ryabev also stressed the possibility of a more intensive relationship in the future, to accomplish further nuclear arms reductions. However, in addition, he underscored the possibility of continuing tensions, for example over the deployment of U.S. missile defenses in Europe.

Although they differed in their threat perceptions, both Brooks and Ryabev pointed to extensive joint work that the United States and Russia have done to cooperate in solving country-specific proliferation problems, particularly in Iran and North Korea. These themes—differing threat perceptions but a clear aspiration for further cooperation—were also quite clearly expressed in the papers by Viktor Koltunov, et al., and Pavel Zolotarev. Indeed, even on controversial topics such as missile defense, where threat perceptions have differed enormously, these authors were willing to offer new ideas for cooperation. Zolotarev, for example, described in detail the concept of a regional missile defense system in Europe that would include Russian as well as European and American participants.

The importance of bilateral cooperation on nuclear energy technologies, especially on fast reactors, nuclear fuels, and spent fuel disposition, has also been a topic of broad discussion. A number of participants have mentioned new possibilities for cooperation in assuring supplies of nuclear fuel, which are already under intensive discussion at the International Atomic Energy Agency (IAEA). Tariq Rauf's paper highlighted the agency's work, and particularly the initiative of the Director General to provide a new framework for nuclear fuel cycle development that would provide for broad assurances of fuel supply as well as assurances regarding spent fuel storage and disposition. Rauf noted that thirteen complimentary proposals regarding fuel assurances currently exist on the IAEA website, and stressed that analysis of them continues.

Workshop participants have had the benefit of a detailed briefing by Sergei Ruchkin on a particular mechanism for assuring fuel supply, the Russian international nuclear fuel service center established at Angarsk in Siberia. Most agreed that this concept could provide some interesting opportunities for U.S.-Russian cooperation, as was foreseen and encouraged by President George W. Bush and President Vladimir V. Putin in their St. Petersburg (2006) and Kennebunkport (2007) summit statements.[344]

The other area of nuclear power cooperation that has received particular focus is fast reactors, although a whole range of nuclear fuel cycle topics have been considered to be fruitful areas for possible joint work. For example, Evgeny Avrorin presented a list in his paper that included projects that would focus on the back end of the fuel cycle—transmutation methods for long-lived radioactive products, for example, and radioactive waste immobilization and disposal. He also focused on projects for enhancing nuclear safety and security, and for assessing risks. Although none of these ideas was discussed in detail, the participants have generally agreed that nuclear energy cooperation is an important topic for the future. One area that did receive further attention is the possible role of fast reactors in the development of future civilian nuclear power options. Vladimir Orlov's historical analysis of fast reactor concepts was intended to engage workshop participants in a reconsideration of many of the stereotypes surrounding these complex efforts and to encourage serious research on these options for the future.

Many workshop participants have voiced their belief that cooperation on nuclear technologies will be greatly accelerated by the ratification of the 123 Agreement between the

[344] See Appendix D, for the full text of these statements.

United States and Russia.[345] This agreement, as outlined in detail by Orde Kittrie, would create a legal framework under which such activities can take place. Kittrie explained that the "framework agreement would make possible a variety of exports and other cooperative activities that are prohibited by U.S. law in the absence of a 123 Agreement." These potential areas of new and expanded cooperation include: joint development of proliferation-resistant and other advanced nuclear technologies, storage and possible reprocessing of U.S.-origin spent nuclear fuel in Russia, and increasing the capacity factor and safety of Russian nuclear power plants, extending their operating life, and decreasing their maintenance costs. These potential cooperative efforts cannot be launched, however, until the 123 Agreement has entered into force. Significant legal and political challenges to the full entry into force remain in both Russia and the United States, however, as Alexander Pikaev and Kittrie detailed in their workshop papers.

Joint work to address nuclear terrorism threats has been a particular focal point of discussion, with a number of priorities emphasized as being worthy of development as new areas of partnership. The idea of working together to develop nuclear forensics capabilities has already been discussed above. Michael Kristo's paper, however, sparked a lively exchange and a number of questions from the Russian participants about the overall concept.

Cristina Hansell emphasized in her paper the threat of improvised nuclear devices and the necessity therefore of minimizing fissile material production no matter what the source. The spectrum of measures she envisioned ranged from international law to national policy to technical measures such as proliferation-resistant reactor design, a point also stressed by Evgeny Avrorin. Minimizing fissile material production was also the focal point of Philipp Bleek and Laura Holgate's paper, wherein they proposed some forward-looking ideas for U.S.-Russian cooperation on minimizing civil highly enriched uranium stocks.

One particular idea that participants have discussed involved the United States and Russia taking the lead to establish both bilateral and multilateral programs to help countries implement United Nations Security Council Resolution 1540 (UNSCR 1540), which calls on countries to develop new laws and policies to combat proliferation of weapons of mass destruction.[346] Such an effort would apply U.S. and Russian experience acquired as nuclear weapon states that have been responsible for ensuring the safety and security of large and diverse nuclear arsenals.

In our view, the workshop discussions have identified two notions. The first would build on already existing cooperation, such as finding ways to minimize the use of highly enriched uranium, or applying U.S. and Russian experience to helping other states to implement UNSCR 1540. The other notion would involve developing completely new directions for cooperation, such as analyzing nuclear forensics problems. On this topic Russian participants have had some questions about the scope and definition of the problem, and both sides recognize that new work would have to be done to develop the modes of such cooperation, for example in areas related to sharing sensitive information.

[345] See Appendix E for the text of the 123 Agreement.

[346] To read the text of United Nations Security Council Resolution 1540, see http://daccessdds.un.org/doc/UNDOC/GEN/N04/328/43/PDF/N0432843.pdf?OpenElement; accessed April 6, 2008.

# TOOLS

To round out the discussion, workshop participants have examined various tools that have been developed in U.S. and Russian cooperative threat reduction projects over the past fifteen years, including possibilities for using or adapting such tools in the future, in the context of the bilateral partnership or broader regional or global contexts. Many U.S. and Russian participants have noted that the U.S.-Russian experience will not be exactly applicable to nuclear security environments in other countries and regions. But the experience gained and lessons learned could be useful in tackling nuclear security problems elsewhere.

Sustainability has been a clear leitmotif of the discussion on tools for cooperation, as many participants from both countries recognize that, with joint projects and programs coming to an end in 2013, attention will have to be focused on ways and means to continue—never mind expand—the relationship. The Dori Ellis, et al. and Sergei Antipov et al. papers especially focused the discussion, providing many sound ideas for developing tools that would enhance sustainability of project results.

For example, the Antipov et al. papers introduced the idea of using remote monitoring technology to increase the workplace discipline of staff, ensuring that they follow rules for handling nuclear material, and to ensure that material protection, control, and accounting systems are functioning properly. Antipov's focus on remote monitoring technology as a sustainability tool further developed the theme established earlier by Ryabev in his discussion of remote monitoring as an advanced means to combat nuclear proliferation and terrorism threats—and as a potentially productive arena for U.S.-Russian joint research.

Among a very rich menu of ideas, Ellis et al. emphasized the necessity of human resource management and continued training. They introduced the example of the Kola Technical Training Center, which was designed explicitly to support the significant number of nuclear sites on the Kola peninsula that had received material, protection, control, and accounting upgrades over the years of U.S.-Russian cooperation in this region. The training center not only provides continuing training for personnel, but also maintenance and testing support for equipment, and a spare parts inventory. A second Russian paper by Antipov et al. affirmed this U.S. analysis of the importance of the Kola Center as a vital resource to ensure sustainability.

Beyond the focus on sustainability, the workshop discussions have also zeroed in on particular concepts that have already proven their worth in ensuring effective cooperation. Ashot Sarkisov, for example, recalled that the concept of a "strategic master plan" had been vital for ensuring that general purpose submarine dismantlement in the Northern Fleet area went forward according to the requirements of the project funders, the European Bank for Reconstruction and Development. It had also proven important, however, for ensuring that all entities—including international partners—were "on the same page" throughout the dismantlement process.

The Strategic Master Plan discussion emphasized the utility of considering different constellations of project partners, both for the effectiveness of project implementation, but also for sustainability reasons. Participants agreed that government-to-government projects, although very important, are not the only way to pursue such cooperation. At times non-governmental approaches, or public-private partnerships, are more appropriate to achieving priority goals on a timely basis.

Cost sharing between the U.S. and Russian governments, or between government and private entities, has also been identified as an important phenomenon of future nuclear security cooperation and partnership. Eric Novotny described in his paper the important progress that the Civilian Research and Development Foundation (CRDF) has made in developing this concept of science collaboration involving Russian universities and institutes. The notion of "in-kind" cost sharing—for example, providing laboratory facilities for a joint project—is well established and has been a relatively easy way for Russian entities to help pay for projects. This held true even during the period of dire economic crisis in the 1990s.

According to Novotny, CRDF has noticed, however, a significant increase in the willingness of Russian educational institutions to share costs through cash payments, backed by significant funding from the Ministry of Education and Science and other Russian government entities. This sign of Russian government commitment to the sustainability of projects is also an important indicator that Russia appears ready to take on more financing of future projects, including those outside Russia's borders. If the trend continues to develop, then it will be yet another piece of evidence that Russia has emerged from the crisis of the 1990s and is now ready to embrace the broader responsibilities of partnership.

As Vyacheslav Apanasenko raised in his paper and workshop presentation, a broader partnership between the United States and Russia would be enhanced by creative approaches to including both private as well as public partners in cooperative activities. As the experience with the Strategic Master Plan development and the resolution of the North Korean funds transfer through the Bank of Macau have demonstrated, the involvement of private banks and other private institutions often provide alternative methods of addressing specific challenges when they arise. Apansenko identified other examples of effective cooperation involving private partners, e.g., the fruitful NAS-RAS inter-academy projects, such as this effort, that have spawned a host of joint workshops, joint reports, and joint recommendations. Looking forward to 2015, workshop participants have noted the need to continue to think creatively about new opportunities and new means of including a wider range of partners, particularly if formal government channels face particular challenges in their interactions.

To facilitate such cost sharing, and otherwise to enhance and accelerate the implementation of U.S.-Russian cooperation, some new legal and procedural mechanisms have been proposed. As an example, several participants have referred to the ongoing process of completing an "Agreement for Peaceful Nuclear Cooperation" (123 Agreement) between the United States and Russia. They believe that once the 123 Agreement is in place between Moscow and Washington, it will provide a basic foundation for U.S.-Russian cooperation on nuclear energy technologies, but it will also allow the United States to fully benefit from the international fuel services center at Angarsk—including potentially the take-back and storage of U.S.-origin spent fuel.

Several concepts and methodologies, many participants stressed, have already proven successful in implementing joint cooperation, and should be further developed and improved in the future. Joel Wit has recounted in his paper, for example, how the North Korean denuclearization process had begun to accelerate, leading to some expressions of interest by North Korean officials in the experience of scientist redirection in Russia and the former Soviet states. Of the estimated 20,000 scientists, engineers and technicians working on the North Korean nuclear program, about 5,000 are central to the weapons program. Wit suggested that the United States and Russia could work together on projects to redirect these scientists and promote their integration into the global scientific community.

One of Wit's ideas would be to establish an international science center in Pyongyang on the model of the International Science and Technology Center in Moscow, but other programs could also be applied to this problem. Wit noted, for example, that the Reduced Enrichment for Research and Test Reactors program had been used to convert the Libyan research reactor to low-enriched uranium fuel. The same type of approach could be used, in cooperation with Moscow, to convert the North Korean Russian-designed research reactor.

## SUMMARY REFLECTIONS OF CO-CHAIRS

The workshop has demonstrated once again the effectiveness of the scientific cooperation between the Russian Academy of Sciences and the U.S. National Academies. The framework for such work is provided by joint committees formed to review and study the complex scientific and political problems that both our countries must address today.

This framework is unique in that the authors and experts participating can put forward independent points of view and provide knowledge and experience in a variety of areas, combining expertise in management and administration, political science, science and technology, and finance and economics. When such highly qualified individuals participate in a complex review with unequalled open discussion, they shed light on key problems that must be solved to strengthen international security over the coming years. Lack of explicit consensus for some of the questions covered is more an advantage than a disadvantage of such discussions, as critical priorities can thus be identified along a wide spectrum of problems.

The other advantage of such cooperation is the strict schedule that is maintained to complete the work. This strict format for NAS-RAS cooperation was earlier applied to the joint projects *Overcoming Impediments to U.S.-Russian Cooperation on Nuclear Non-proliferation* (2004)[347] and *Strengthening U.S.-Russian Cooperation on Nuclear Non-proliferation* (2005).[348] The present work is a logical continuation of these two projects and may serve as a model for continuing the fruitful work begun at this workshop.

In particular, as happened following the successful joint workshop in 2004, this workshop may provide a foundation upon which to develop recommendations for Moscow and Washington on how, in concrete terms, Russia and the United States may proceed in successfully transitioning to a relationship of full partnership. In this partnership, both the countries can serve as leaders, whether bilaterally and or on the international scene, responding to the difficult nuclear security challenges that will face us all in the coming decades.

[347] Joint National Academies' – Russian Academy of Sciences' Committees on U.S.-Russian Cooperation on Nuclear Non-Proliferation, *Overcoming Impediments to U.S.-Russian Cooperation on Nuclear Non-Proliferation* (Washington, D.C.: The National Academies' Press, 2004). The full text of this report can be found at http://www.nap.edu/catalog.php?record_id=10928; accessed April 8, 2008.

[348] Joint National Academies'-Russian Academy of Sciences' Committees on Strengthening U.S.-Russian Cooperation on Nuclear Non-Proliferation, *Strengthening U.S.-Russian Cooperation on Nuclear Non-proliferation,* (Washington, D.C.: The National Academies' Press, 2005). The full text of this report can be found at http://books.nap.edu/catalog.php?record_id=11302; accessed April 8, 2008.

# LIST OF ACRONYMS

| | |
|---|---|
| **ABM** | **Anti-ballistic Missiles** |
| **ANL** | **Argonne National Laboratory (U.S.)** |
| **BNG PS** | **British Nuclear Group Project Services** |
| **BOG** | **Board of Governors (IAEA)** |
| **BR** | **Breeding Rations** |
| **CDP** | **Complex Decommissioning Program** |
| **CIS** | **Commonwealth of Independent States** |
| **CMB** | **Coastal Maintenance Bases** |
| **CNIIKM** | **Central Scientific Research Institute of Structural Materials (Russia)** |
| **CPPNM** | **Convention on the Physical Protection of Nuclear Material** |
| **CRDF** | **U.S. Civilian Research & Development Foundation** |
| **CREST** | **Cooperation in Research and Education in Science and Technology** |
| **CSIS** | **Center for Strategic and International Studies (U.S.)** |
| **CTBT** | **Comprehensive Test Ban Treaty** |
| **CTR** | **Cooperative Threat Reduction** |
| **DG** | **Director General (IAEA)** |
| **DHS** | **U.S. Department of Homeland Security** |
| **DNDO** | **U.S. Domestic Nuclear Detection Office** |
| **DOD** | **U.S. Department of Defense** |
| **DOE** | **U.S. Department of Energy** |
| **DPRK** | **Democratic People's Republic of Korea** |
| **EBRD** | **European Bank for Reconstruction and Development** |
| **EU** | **European Union** |
| **FASI** | **Russian Federal Agency for Scientific Innovation** |
| **FR** | **Fast Reactor** |
| **FSUE** | **Federal State Unitary Enterprise (Russia)** |
| **GAO** | **U.S. General Accounting Office** |
| **GIF** | **Generation IV International Forum** |
| **GNEP** | **Global Nuclear Energy Partnership (U.S.)** |

| | |
|---|---|
| **GR** | **Government Relations** |
| **GSEC** | **Global Security Engagement and Cooperation** |
| **GTRI** | **Global Threat Reduction Initiative** |
| **HEU** | **Highly Enriched Uranium** |
| **HNMC** | **Heavy Nuclear Missile Cruisers** |
| **IAEA** | **International Atomic Energy Agency** |
| **IBRAE** | **Nuclear Safety Institute (Russia)** |
| **IC** | **International Consultant** |
| **ICBM** | **Intercontinental Ballistic Missiles** |
| **IND** | **Improvised Nuclear Device** |
| **INF** | **Treaty on Intermediate-Range Nuclear Forces** |
| **INFCC** | **International Fuel Cycle Centers** |
| **INPRO** | **International Project on Innovative Reactors and Fuel Cycles** |
| **IPFM** | **International Panel on Fissile Materials** |
| **IPPE** | **Institute of Physics and Power Engineering (Russia)** |
| **ISTC** | **International Science and Technology Center** |
| **ITDB** | **Illicit Trafficking Database** |
| **ITU** | **Institute of Transuranium Elements (EU)** |
| **ITWG** | **Nuclear Smuggling International Technical Working Group** |
| **IUEC** | **International Uranium Enrichment Center (Russia)** |
| **JCC** | **Joint Coordinating Committee** |
| **JCG** | **Joint Coordinating Group** |
| **KIMACS** | **Kurchatov Institute Materials Accounting and Control System (Russia)** |
| **KTTC** | **Kola Training and Technical Center (Russia)** |
| **LEU** | **Low-Enriched Uranium** |
| **LLNL** | **Lawrence Livermore National Laboratory (U.S.)** |
| **LMC** | **Liquid-Metal Coolant Reactors** |
| **LSF** | **Long-term Radioactive Waste Storage Facility** |
| **LWR** | **Light Water Reactors** |
| **MA** | **Minor Actinides** |
| **MES** | **Russian Ministry of Education and Science** |
| **MESU** | **Ukrainian Ministry of Education and Science** |
| **MFA** | **Ministry of Foreign Affairs (Russia)** |
| **MIT** | **Massachusetts Institute of Technology (U.S.)** |

| | |
|---|---|
| **MOD** | **Ministry of Defense (Russia)** |
| **MOM** | **Material Operation Monitoring System** |
| **MOX** | **Mixed Oxide Fuel** |
| **MP** | **Members of Parliament (Russia)** |
| **MPC&A** | **Material, Protection, Control, and Accounting** |
| **NAS** | **The U.S. National Academies** |
| **NDEP** | **Northern Dimension Environmental Partnership** |
| **NFC** | **Nuclear Fuel Cycle** |
| **NGO** | **Non-Governmental Organization** |
| **NIKIET** | **Research and Development Institute for Power Engineering (Russia)** |
| **NNSA** | **U.S. National Nuclear Security Agency** |
| **NMS** | **Nuclear Maintenance Service** |
| **NPP** | **Nuclear Power Plant** |
| **NPSS** | **Nuclear Powered Surface Ships** |
| **NPT** | **Treaty on the Non-Proliferation of Nuclear Weapons** |
| **NS** | **Nuclear Submarines** |
| **NSF** | **U.S. National Science Foundation** |
| **NTI** | **Nuclear Threat Initiative (U.S.)** |
| **NTNFC** | **National Technical Nuclear Forensics Center** |
| **OMB** | **U.S. Office of Management and Budget** |
| **ORNL** | **Oak Ridge National Laboratory (U.S.)** |
| **PMBOK** | **Project Management Body of Knowledge** |
| **PMDA** | **U.S.-Russian Agreement Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation** |
| **RANF** | **Reliable Access to Nuclear Fuel** |
| **RAS** | **Russian Academy of Sciences** |
| **RC** | **Reactor Compartment** |
| **RERTR** | **Reduced Enrichment for Research and Test Reactors Program** |
| **RR** | **Reactor Rooms** |
| **RU** | **Reactor Units** |
| **RW** | **Radiological Waste** |
| **SLBM** | **Submarine-Launched Ballistic Missiles** |
| **SMP** | **Strategic Master Plan** |
| **SNF** | **Spent Nuclear Fuel** |
| **SORT** | **Strategic Offensive Reduction Treaty** |
| **SRNL** | **Savannah River National Laboratory (U.S.)** |
| **START I** | **Strategic Arms Reduction Treaty** |
| **START II** | **Strategic Arms Reduction Treaty** |

| | |
|---|---|
| **SWU** | **Separative Work Unit** |
| **TOR** | **Terms of Reference** |
| **TR** | **Thorium Reactor** |
| **TSF** | **Temporary Storage Facility** |
| **UNSCR 1540** | **United Nations Security Council Resolution 1540** |
| **VLLW** | **Very Low Level Waste** |
| **VNIINM** | **Bochvar All-Russian Scientific Research Institute of Inorganic Materials (Russia)** |
| **VNIITF** | **All-Russia Scientific Research Institute of Technical Physics (Russia)** |
| **WBS** | **Work Breakdown Structure (SMP)** |
| **WMD** | **Weapons of Mass Destruction** |
| **WNA** | **World Nuclear Association** |

# APPENDICES

# APPENDIX A

## The Future of the Nuclear Security Environment in 2015

***An International Workshop Sponsored by the U.S. National Academies (NAS) and the Russian Academy of Sciences (RAS)***

**November 12–13, 2007**
**Hall L/M**
**Austria Center**

***Vienna, Austria***

### AGENDA

*November 12, 2007*

**9:00 – 9:30** **Opening Remarks**

**Welcome and Introductory Remarks from the U.S. National Academies' - the Russian Academy of Sciences' Joint Committee on the Future of the Nuclear Security Environment in 2015**

*Rose Gottemoeller*, NAS Committee Co-Chair, Director, Carnegie Moscow Center

*Ashot A. Sarkisov*, RAS Committee Co-Chair, Advisor, Russian Academy of Sciences

**9:30 – 10:45** **Session I: Overview of U.S.-Russian Partnership and Perceptions of the Threat Environment**

"Leadership Through Partnership: A Vision for the 2015 Nuclear Security Relationship between the U.S. and Russia," *Ambassador Linton Brooks,* Former Administrator of the U.S. National Nuclear Security Administration

"Fundamental Principles of Russian-U.S. Cooperation in the Nuclear Arena," *Lev D. Ryabev*, Advisor, Rosatom

Discussion

| | |
|---|---|
| **10:45 – 11:15** | **Break** |
| **11:15 – 12:30** | **Session II: Accumulated Experience through Long-Term Cooperation, Applying Lessons Learned from U.S.-Russian MPC&A Programs** |
| | "The Experience of MPC&A Partnership between Russia and the United States," *Sergei V. Antipov,* Kurchatov Institute |
| | "Material Protection, Control, and Accounting: Lessons Learned Applied to the United States and Russian Nuclear Security Cooperation in 2015," *Dori Ellis*, Director, Global Security Programs, Sandia National Laboratories |
| | "Kola Technical and Training Center of the Russian Naval Fleet," *Sergei V. Antipov,* Kurchatov Institute |
| | Discussion |
| **12:30 – 14:00** | **Lunch Buffet for All Workshop Participants, Lounge 5/6** |
| **14:00 – 14:15** | **Welcome from the International Atomic Energy Agency (IAEA)** |
| | *Tariq Rauf,* Head of the Verification and Security Policy Coordination Section, Office of External Relations and Policy Co–ordination, Office of the Director General, IAEA |
| **14:15 – 15:30** | **Session III: Full Partnership – Sharing Strategic, Management, and Financial Responsibilities** |
| | "Strategic Master Plan Development as an Example of Efficient International Cooperation in Addressing Large Problems in the Nuclear Arena," *Ashot A. Sarkisov*, RAS Committee Co-Chair, Advisor, Russian Academy of Sciences |
| | "Minimizing Civil Highly Enriched Uranium Stocks by 2015: A Forward-Looking Assessment of U.S.-Russian Cooperation," *Philipp Bleek*, Visiting Fellow, Center for Strategic and International Studies |
| | "Cost-Sharing Arrangements in International Science and Technology Cooperation: The CRDF Experience," *Eric Novotny*, Senior Vice President, Civilian Research and Development Foundation |
| | Discussion |
| **15:30 – 16:00** | **Break** |
| **16:00 – 17:15** | **Session IV: A Nuclear Renaissance – Expanding Nuclear Energy and Associated Security Challenges** |
| | "International Uranium Enrichment Centre in Angarsk: A Way to Ensure the Security of Supply and Non-Proliferation," *Sergei V. Ruchkin,* Russian Representative, World Nuclear Association |

"Nuclear Power of Fast Reactors: A New Start," *Viktor V. Orlov*, Professor, Research and Development Institute of Power Engineering

"Legal Aspects of Implementation and Fulfillment of U.S.-Russian Cooperative Agreements on the Peaceful Use of Nuclear Energy," *Alexander A. Pikaev*, Head of the Department, International and Inter-regional Conflicts Center for International Security

"Prospects of U.S.-Russian Cooperation in the Area of Nuclear Non-proliferation in the Context of Problems Arising from Nuclear Power Renaissance," *Evgeny N. Avrorin*, Scientific Director Emeritus, All-Russian Scientific Research Institute of Technical Physics

Discussion

**17:15 – 17:30** **Review of the Day's Discussion**

**17:30** **Adjourn**

**17:45** **Reception, Vienna Austria Centre, Lounge 5/6,** *All Welcome*

***November 13, 2007***

**9:00 – 9:30** **Reflections of the Co-Chairs**

*Ashot A. Sarkisov*, RAS Committee Co-Chair, Advisor, Russian Academy of Sciences

*Rose Gottemoeller*, NAS Committee Co-Chair, Director, Carnegie Moscow Center

**9:30 – 10:45** **Session V: Creative Solutions to Tomorrow's Challenges – Opportunities for Bi-lateral and Multi-lateral Cooperation**

"Nuclear Terrorism Threats and Responses," *Cristina Hansell*, Director, Newly-Independent States Non-proliferation Program, Monterey Institute

"Partnership Arrangements between the State and the Private Sector," *Vyacheslav M. Apanasenko*, Associate Member of the Russian Academy of Rocket and Artillery Sciences

"U.S. and Russian Collaboration in the Area of Nuclear Forensics," *Michael Kristo*, Nuclear Forensics Task Manager, Lawrence Livermore National Laboratory

Discussion

**10:45 – 11:15** **Break**

| | |
|---|---|
| **11:15 – 12:30** | **Session VI: Nuclear Security and Non-Proliferation for the Coming Decades – Cooperation in a Global Context** |
| | "Problems of Non-Proliferation and the Control of Nuclear Weapons," *Viktor S. Koltunov*, Senior Professor, Institute of Strategic Stability, Rosatom |
| | "Approaches to the Reduction of Risk Associated with Nuclear Multi-polarity," *Pavel S. Zolotarev*, Deputy Director, Institute of USA and Canada, RAS |
| | "Nuclear Security and North Korea: Is Threat Reduction Possible?" *Joel Wit*, Senior Research Fellow, Weatherhead Institute for East Asian Studies, Columbia University |
| | "Russian–U.S. Cooperation in the Area of Non-Proliferation: United Nations Security Council Resolution 1540," *Viktor S. Slipchenko,* United Nations Security Council Committee 1540, Expert, United Nations |
| | Discussion |
| **12:30 – 14:00** | **Lunch Buffet for All Workshop Participants, Lounge 5/6** |
| **14:00 – 15:30** | **A Path Forward: Suggestions and Proposals for the Next Decades of Cooperation,** *Open Discussion* |
| **15:30 – 16:00** | **Break** |
| **16:00 – 17:00** | **Summary of Discussion** |
| **17:00 – 17:30** | **Closing Remarks and Thanks** |
| **17:30** | **Adjourn** |

# APPENDIX B

## The Future of the Nuclear Security Environment in 2015

***An International Workshop Sponsored by the U.S. National Academies (NAS) and the Russian Academy of Sciences (RAS)***

**November 12–13, 2007**
**Hall L/M**
**Austria Center**

***Vienna, Austria***

### PARTICIPANTS LIST

| | |
|---|---|
| **Sergey Victorovich Antipov**<br>Head of Laboratory<br>Nuclear Safety Institute<br>Russian Academy of Sciences | **Ambassador Linton F. Brooks**<br>Independent Consultant |
| **Vlyacheslav Mikhailovich Apanasenko**<br>Former Chief of the Russian Navy Missiles and Artillery | **Cristina Hansell**<br>Director, Newly Independent States, Non-proliferation Program<br>James Martin Center for Non-proliferation Studies, Monterey Institute of International Studies |
| **Evgeny Nikolaevich Avrorin**<br>Scientific Manager<br>All-Russian Research and Development Institute of Theoretical Physics (VNIITF) | **Mona Dreicer**<br>Deputy, P-Division Leader<br>Lawrence Livermore National Laboratory |
| **Philipp Bleek**<br>Visiting Fellow<br>International Security Program<br>Center for Strategic and International Studies | **Christopher Eldridge**<br>Division of Safeguards Information Technology<br>Department of Safeguards<br>International Atomic Energy Agency |
| **Sergey Bocharov**<br>Executive Secretary<br>Contact Expert Group<br>International Atomic Energy Agency | **Dori Ellis**<br>Director Global Security Programs<br>Sandia National Laboratories |

| | |
|---|---|
| **James Fuller**<br>Affiliate Professor<br>Henry M. Jackson School of International Studies<br>University of Washington, Seattle | **Sergei Novikov**<br>First Secretary<br>Russian Permanent Mission to the International Organizations in Vienna |
| **Ira Goldman**<br>Nuclear Fuel Cycle and Materials Section<br>Division of Nuclear Fuel Cycle and Waste Technology<br>Department of Nuclear Energy<br>International Atomic Energy Agency | **Eric Novotny**<br>Senior Vice President<br>U.S. Civilian Research & Development Foundation |
| **Rose Gottemoeller**<br>Director<br>Carnegie Moscow Center | **Viktor Vladimirovich Orlov**<br>Research and Development Institute of Power Engineering |
| **Rita S. Guenther**<br>Senior Program Associate<br>Committee on International Security and Arms Control, The National Academies | **Alexander Alexeivich Pikaev**<br>Head of the Department of International and Inter-regional Conflicts<br>Center for International Security |
| **Anne M. Harrington**<br>Director<br>Committee on International Security and Arms Control, The National Academies | **Tatiana Stanislavovna Povetnikova**<br>Program Coordinator<br>Nuclear Safety Institute<br>Russian Academy of Sciences |
| **Lisa G. Hilliard**<br>Foreign Affairs Specialist<br>U.S. Mission in Vienna | **Tariq Rauf**<br>Head of Verification and Security Policy Co-ordination, Office of External Relations and Policy Co-ordination<br>International Atomic Energy Agency |
| **Andrey Karasev**<br>Counsellor<br>Russian Permanent Mission to the International Organizations in Vienna | **Sergey Vasilevich Ruchkin**<br>Rosatom/Tenex Representative at the World Nuclear Association in London |
| **Viktor Stephanovich Koltunov**<br>Senior Professor<br>Institute of Strategic Stability, Rosatom | **Lev Dmitrovich Ryabev**<br>Senior Advisor<br>Rosatom |
| **Michael Kristo**<br>Lawrence Livermore National Laboratory | **Vice Admiral Ashot Arakelovich Sarkisov**<br>Departmental Director<br>Nuclear Safety Institute |
| **Admiral Richard Mies**<br>Independent Consultant | **Ambassador Greg Schulte**<br>U.S. Mission in Vienna |
| **Cherry Murray**<br>Deputy Director for Science and Technology<br>Lawrence Livermore National Laboratory | **Yuri Konstantinovich Shiyan**<br>International Affairs Department<br>Russian Academy of Sciences |
| **Victor S. Slipchenko**<br>United Nations Security Council<br>1540 Committee Expert | **Pavel Semenovich Zolotarev**<br>Deputy Director<br>Institute of USA and Canada, RAS |
| **Joel Wit**<br>Senior Research Fellow<br>Weatherhead Institute for East Asian Studies<br>Columbia University | |

# APPENDIX C

## JOINT NATIONAL ACADEMIES'/RUSSIAN ACADEMY OF SCIENCES' COMMITTEE BIOGRAPHIES

### National Academies' Committee Members Bios

**Rose Gottemoeller**, *committee co-chair*, became Director of the Carnegie Moscow Center in January 2006. She was previously a Senior Associate at the Carnegie Endowment for International Peace, specializing in arms control, non-proliferation and nuclear security issues. From 1998 to 2000, she served in the Department of Energy (DOE) as Assistant Secretary for Non-proliferation and National Security and then as Deputy Under-secretary for Defense Nuclear Non-proliferation. From 1993 to 1994, she was Director for Russia, Ukraine, and Eurasia Affairs on the National Security Council in the White House.

**Linton F. Brooks** served until January 2007 as Administrator of DOE's National Nuclear Security Administration (NNSA), where he was responsible for the U.S. nuclear weapons program and for DOE's international nuclear non-proliferation programs. Ambassador Brooks has over four decades of experience in national security, including service as Assistant Director of the Arms Control and Disarmament Agency, Chief U.S. Negotiator for the Strategic Arms Reduction Treaty, Director of Arms Control on the National Security Council staff and a number of Navy and Defense Department assignments as a 30 year career naval officer.

**Mona Dreicer** has 30 years of experience in various nuclear related fields: international security, non-proliferation, and arms control (e.g. CTBT/IMS, TTBT, FMCT, AMEC, NPT/IAEA); radiation dose and dose reconstruction (e.g. U.S. I-131 doses from NTS weapons tests, the aftermath of Chernobyl, SRS tritium releases); health and environmental risk assessment for the nuclear fuel cycle in Europe; and environmental/nuclear safety. Dreicer has worked for the USG, International Atomic Energy Agency (IAEA), three different national laboratories, (Los Alamos National Laboratory, Livermore National Laboratory [LLNL] and the Environmental Measurements Laboratory), a French non-profit research organization, and as a private consultant. As Director of the Office of Nuclear Affairs at the U.S. Department of State, her office was responsible for assessing compliance of nuclear arms control treaties and worked to ensure effective verification of non-proliferation agreements and U.S.-Russia nuclear materials programs. Since 2003, she has been a Deputy Division Leader at LLNL overseeing non-proliferation and international global nuclear materials management programs.

**James Fuller** is an Affiliate Professor in the Henry M. Jackson School of International Studies at the University of Washington in Seattle. He is also a member of its Visiting Committee. For many years, until his retirement in 2003, he was the Director of Defense Nuclear Non-proliferation Programs at the Pacific Northwest National Laboratory in Richland, Washington; he remains a technical consultant for nuclear non-proliferation programs there and for other U.S. Government agencies. He holds a Ph.D. in nuclear science, specializing in plasma physics, from the University of Florida. He is credited with being a co-developer of the first nuclear driven laser. He has served in the U.S. Government as a national lab scientist in many capacities over the past 20-plus years in endeavors related to nuclear weapons material control and nuclear warhead dismantlement monitoring. Some relevant examples of this service include being the Executive Secretary in the George H.W. Bush Administration of the President's Committee on Fissile Material Control and Nuclear Warhead Monitoring, Scientific Peer Review Group Chairman of the NNSA Warhead Radiation Signatures Campaign, and Chairman of the NNSA Information Barrier Advisory Group – a group whose task was to develop minimally intrusive equipment to monitor sensitive nuclear materials and nuclear warheads on a bilateral or multilateral basis with other nuclear states. He currently remains heavily involved in the U.S.-Russian Warhead Safety and Security Exchange Agreement.

**Richard W. Mies** (Admiral United States Navy, retired) is the President and CEO of Hicks and Associates, Inc., a wholly owned subsidiary of Science Applications International Corporation (SAIC). Admiral Mies joined SAIC after retiring from the U.S. Navy in February 2002, at the rank of Admiral. During his military career, Admiral Mies served as Commander in Chief, United States Strategic Command, and in a number of staff positions. He is one of only a few flag officers to complete qualifications as both a submariner and naval aviation observer. His many service decorations include the Defense Distinguished Service Medal, Navy Distinguished Service Medal, Defense Superior Service Medal (two awards), Legion of Merit (four awards), and National Intelligence Distinguished Service Medal. Admiral Mies graduated from the U.S. Naval Academy with a B.S., majoring in mechanical engineering and mathematics, and completed post-graduate education at England's Oxford University, the Fletcher School of Law and Diplomacy, and Harvard University. He holds a Masters degree in government administration and international relations and an Honorary Doctorate of Law degree from the University of Nebraska.

**Cherry Murray** is deputy director for science and technology at LLNL. Prior to this appointment, she was physical sciences research senior vice president, Bell Laboratories, Lucent Technologies. Murray has been recognized for her work in surface physics, light scattering, and complex fluids; she is best known for her work on imaging in phase transitions of colloidal systems. After receiving a B.S. and Ph.D. in physics from the Massachusetts Institute of Technology, she joined Bell Laboratories as a member of the technical staff in 1978. She has numerous publications and two patents to her credit. She was chair of the New Jersey Nanotechnology Consortium, a wholly owned subsidiary of Lucent managed by Bell Laboratories to promote research in nanotechnology as part of the economic development of New Jersey. Murray is a member of the National Academy of Engineering, the National Academy of Sciences, and the American Academy of Arts and Sciences. She is a fellow of the American Physical Society and the American Association for the Advancement of Sciences and a member of numerous advisory committees and boards.

**M. Teresa Olascoaga** currently leads the Cooperative International Programs (CIP) Group, one of two International Security Center (ISC) groups at Sandia National Laboratory. She is also the former Deputy Director of the SC. She manages a broad spectrum of programs focused on nuclear and biological non-proliferation, nuclear materials management, regional security, and arms control, and leads the six CIP departments. Terri has 10 years experience managing and leading U.S. nuclear security programs and strategic initiatives, particularly those with Russia, including DOE/NNSA's material protection, control, and accounting (MPC&A) program. She also has over 15 years of domestic and international experience in managing and performing security system design, evaluation, technology/policy support and training for various applications including DOE, Department of Defense, National Regulatory Commission, IAEA and NATO nuclear security, and for commercial aviation security in the U.S. Terri holds a B.S. degree in mathematics from New Mexico State University, and an M.S. in industrial engineering from Columbia University.

### Russian Academy of Sciences' Committee Member Biographies

**Vice Admiral Ashot Arakelovich Sarkisov**, *Co-Chair*, Academician Ashot Arakelovich Sarkisov is an Advisor of the Russian Academy of Sciences (RAS). The scientific achievements of Academician Sarkisov relate to shipboard and stationary nuclear power safety, radioactive waste management and energy-related environmental problems. In the past 10 years, Academician Sarkisov has initiated and led large-scale studies on the problems related to decommissioning and environmental rehabilitation of the former Russian Navy facilities. His most recent major study focuses on the development of the Strategic Master Plan for Naval Decommissioning in the northwest region of the Russian Federation. He serves as Chair of the Expert Council on Naval and Shipbuilding Problems of the Higher Certification Commission of the Russian Federation, Chair of the Expert Council on the International Russian-American Scientific-Technical Program of the International Science and Technology Center, and Deputy Chair of the Scientific Council on Atomic Energy of the Russian Academy of Sciences. He is also the member of a number of other scientific councils and editorial boards of various scientific journals. Academician Sarkisov received his pregraduate education at the Leningrad Higher Naval Engineering College and Leningrad University. After years of military service he retired in the rank of vice-admiral. He has more than 200 scientific papers, including several monographs and many books. He participated in the Great Patriotic War from 1941 to 1945, he has been awarded nine Orders and many medals. In 2007, he was awarded the Aleksandrov Gold Medal of the RAS for nuclear science and engineering works.

**Vyacheslav Mikhailovich Apanasenko** is corresponding member of the Russian Navy Missiles and Artillery Academy and International Informatization Academy, Academician and Professor of the Academy of Safety, Defense and Law Problems. After 37-years of military service, he retired at the rank of rear admiral. During his military career, Apanasenko served in a number of positions, including Navy Chief of Staff. He took part in the implementation of the Strategic Arms Reduction and Limitation Treaty (START-I, START-II), Treaty on Conventional Forces in Europe and preparation of the Vienna Documents for the Negotiations on Confidence and Security-Building Measures as well as the Open Skies Treaty. Apanasenko has been a driving force and one of the authors of the comprehensive programs for arms reduction, on industry-scale decommissioning of weaponry and military equipment. He taught at the Brookings

Institute and at the Simpson Universities, the Russian Federation Military Academy of Armed Forces Central Command, and at institutions of higher education in Russia. He is author of more than 50 scientific papers and proceedings addressing the problems of Navy weapons development, strategic arms reduction, etc. His many service decorations include Legion of Merit (1999), Order Red Star (1984), Peter the Great Medal (2003), and the Admiral Kuznetsov Medal (2006, 2007).

**Evgeny Nikolaevich Avrorin**, full member of the Russian Academy of Sciences, is the honorary Scientific Supervisor of the Zababakhin Russian Federal Nuclear Center, Institute of Technical Physics (ZRFNC-VNIITF) in Snezhinsk. His primary research accomplishments involve the area of high energy density physics and include the developments of nuclear weapon and nuclear explosion devises for peaceful use, and basic investigation of nuclear explosion and laser fusion physics. During the nuclear test experiments (1956-1989), he participated in the fundamental and applied research performed at the Russian Federal Nuclear Center-VNIITF. In 1963, he was awarded the Lenin prize for achievements related to building the Soviet nuclear fusion shield. In 1966, he was awarded the Title of Hero of Socialist Labor for the development of nuclear explosion devises for peaceful application. Avrorin has also worked on applied problems of nuclear power engineering, non-proliferation and control of nuclear weapon technology, and environmental monitoring and remediation. He participated in the U.S.-Russian negotiations on nuclear test ban in international negotiations on the development of the Comprehensive Nuclear Test Ban Treaty; he was invited by the IAEA as an expert in non-proliferation safeguards improvement. For his contribution to the progress and improvement of nuclear weapons Avrorin was awarded the Red Banner of Labor (1956), Order of Lenin (1987), and the Order of Merit for the Country of the II Degree (2006).

**Leonid A. Bolshov** is the Director of Nuclear Safety Institute (IBRAE) of the Russian Academy of Sciences. He is a Doctor of Science in physics and mathematics. In 1997, he was elected as a corresponding member to the Energy Division of the Russian Academy of Sciences. He was awarded the State Prize in physics in 1988 for solid surfaces studies. Bolshov is a prominent scientist in the field of nuclear energy safety and thermal physics processes under high energy fluxes. His current activities include works on development of the Russian Strategy in the field of Nuclear Power, Spent Fuel, Waste Management and Emergency Planning, as well as modeling and system analysis of severe accident phenomena and their radioecological consequences, and risk assessment for both nuclear and non-nuclear technologies. He focuses on such issues as reduction of radiological terrorism threats and cooperation on development of counter-terrorism measures at the national and international levels. At present, he leads the activity on the development of a Strategic Master Plan for nuclear submarine decommissioning in the North-West of Russia. He is the Vice-Chairman of the Scientific Council on Nuclear Energy of the Russian Academy of Sciences; member of the Scientific Councils of EMERCOM and Rosatom; and member of the Board of Editors of the professional magazine *Atomic Energy*. Bolshov is a member of the Safety Review Group of the EBRD and the Scientific Secretary of the Russian committee of the joint NAS-RAS Committee on Countering Terrorism. Bolshov is the author/co-author of more than 300 scientific publications.

**Lev Dmitrievich Ryabev** is Senior Advisor to the Head of the Federal Atomic Energy Agency and Deputy Director of the Russian Federal Nuclear Center – the All-Russian Research Institute of Experimental Physics (RFNC-VNIIEF). His main activities are related to the development of the USSR and Russian nuclear weapons complex as well as the fuel and energy complex, including the nuclear power industry. He participated in the development of the CTBT and the Strategic Arms Reduction Treaty at the Disarmament Conference held in Geneva. Ryabev was the Director of the All-Russian Research Institute of Experimental Physics, U.S.S.R. Deputy Prime Minister and Head of the State Fuel and Energy Commission of the Cabinet of Ministers. He has more than 10 publications related to the nuclear weapons complex and the nuclear power industry. He was awarded Order of Lenin, two Orders of Badge of Honor, and a Medal of Honor. He received the U.S.S.R. State Prize, and Prize of the Government of the Russian Federation.

# APPENDIX D

## JOINT STATEMENTS BY PRESIDENTS VLADIMIR V. PUTIN AND GEORGE W. BUSH AND INTERNATIONAL STATEMENTS ON NUCLEAR SECURITY

### Joint Statement by President George W. Bush and President Vladimir V. Putin on Nuclear Security Cooperation

**U.S.-Russia Summit**
***February 23-24, 2005, Bratislava, Slovakia***

The United States and Russia will enhance cooperation to counter one of the gravest threats our two countries face, nuclear terrorism. We bear a special responsibility for the security of nuclear weapons and fissile material, in order to ensure that there is no possibility such weapons or materials would fall into terrorist hands. While the security of nuclear facilities in the U.S. and Russia meet current requirements, we stress that these requirements must be constantly enhanced to counter the evolving terrorist threats. Building on our earlier work, we announce today our intention to expand and deepen cooperation on nuclear security with the goal of enhancing the security of nuclear facilities in our two countries and, together with our friends and allies, around the globe.

To this end the United States and Russia will continue and expand their cooperation on emergency response capability to deal with the consequences of a nuclear/radiological incident, including the development of additional technical methods to detect nuclear and radioactive materials that are, or may be, involved in the incident.

We will work together to help ensure full implementation of UN Security Council Resolution 1540 and early adoption of an International Convention on Nuclear Terrorism and the amended Convention on Physical Protection of Nuclear Material.

U.S. and Russian experts will share "best practices" for the sake of improving security at nuclear facilities, and will jointly initiate security "best practices" consultations with other countries that have advanced nuclear programs. Our experts will convene in 2005 a senior-level bilateral nuclear security workshop to focus increased attention on the "security culture" in our countries including fostering disciplined, well-trained, and responsible custodians and protective forces, and fully utilized and well-maintained security systems.

The United States and Russia will continue to work jointly to develop low-enriched uranium fuel for use in any U.S. - and Russian-design research reactors in third countries now using high-enriched uranium fuel, and to return fresh and spent high-enriched uranium from U.S. - and Russian-design research reactors in third countries.

The United States and Russia will continue our cooperation on security upgrades of nuclear facilities and develop a plan of work through and beyond 2008 on joint projects. Recognizing that the terrorist threat is both long-term and constantly evolving, in 2008 our countries will assess the joint projects and identify avenues for future cooperation consistent with our increased attention to the security culture in both countries.

We have established a bilateral Senior Interagency Group chaired by Secretary of Energy Bodman and Rosatom Director Rumyantsev for cooperation on nuclear security to oversee implementation of these cooperative efforts. A progress report will be due on July 1, 2005, and thereafter on a regular basis.

# STATEMENT ON NON-PROLIFERATION

## *G8 Summit*
## July 6-8, 2005, Gleneagles, United Kingdom

1. We acknowledge, as we did at Evian and Sea Island, that the proliferation of weapons of mass destruction (WMD) and their delivery means, together with international terrorism, remain the pre-eminent threats to international peace and security. The threat of the use of WMD by terrorists calls for redoubled efforts.

2. All States have a role to play in meeting the challenge of WMD proliferation by upholding international arms control, disarmament and non-proliferation norms. All must meet their obligations in full, and ensure effective implementation. We reaffirm our commitments in this regard. And we emphasise our determination to meet proliferation challenges decisively, through both national efforts and effective multilateralism.

3. At Sea Island, we agreed an Action Plan on Non-Proliferation. During the past year, we have worked intensively with our international partners on all its aspects.

**Universalising and reinforcing the non-proliferation regime.**

4. Multilaterally agreed norms provide an essential basis for our non-proliferation efforts. We strongly support universal adherence to and compliance with these norms. We will work to strengthen them, including through improved verification and enforcement. We call on all States not party to the Nuclear Non-Proliferation Treaty, an IAEA Comprehensive Safeguards Agreement and Additional Protocol, the Chemical Weapons Convention, the Biological and Toxin Weapons Convention, the 1925 Geneva Protocol and the Hague Code of Conduct Against the Proliferation of Ballistic Missiles, to accede without delay. We remain ready to assist States to this end.

5. We welcome the agreement by the international community of the International Convention on the Suppression of Acts of Nuclear Terrorism, initiated by the Russian Federation. We look forward to its early entry into force.

**United Nations**

6. We acknowledge the role of the UN Security Council in addressing the challenges of proliferation. We welcome the fact that the majority of UN members have responded to UNSCR 1540 by submitting reports on their domestic non-proliferation provisions including export controls, and their contribution to international co-operation. We urge those who have not yet done so to submit reports without delay. It is essential that all states meet their obligations in full, by enacting and enforcing national legal and regulatory measures including appropriate criminal and civil penalties for violations, and by committing to international cooperation on non-proliferation. We stand ready to consider all requests from states seeking to develop their national procedures. We urge the 1540 Committee to work quickly and effectively, drawing on

the support of relevant international organisations. We also urge the Security Council to consider how best to ensure that the work of the committee makes an enduring contribution to non-proliferation.

7. We welcome the attention given to non-proliferation by the UN Secretary General in his report "In Larger Freedom". We stand ready to engage actively at the meeting of Heads of State and Government for the High Level Plenary Event of the General Assembly in September. We acknowledge the role of the Conference on Disarmament in advancing our non-proliferation and disarmament objectives and call on it to resume substantive work.

8. We look forward to strengthening the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA) by State Parties at the Diplomatic Conference in October.

**Proliferation Security Initiative**

9. We reaffirm our commitment to the Proliferation Security Initiative (PSI) and its Statement of Interdiction Principles, which is a global response to a global problem. We welcome the increasing international endorsement for the Initiative. We call on all States to commit themselves to deepen co-operation in order to counter trafficking in WMD, delivery means and related materials.

10. We also call for enhanced efforts to combat proliferation networks and illicit financial flows by developing, on an appropriate legal basis, co-operative procedures to identify, track and freeze relevant financial transactions and assets.

**Nuclear Non-Proliferation**

**Nuclear Non-Proliferation Treaty (NPT)**

11. We emphasise that the NPT remains the cornerstone of nuclear non-proliferation. We reaffirm our full commitment to all three pillars of the Treaty. While we note with regret that it was not possible to achieve consensus at the 2005 Review Conference, we welcome the fact that all States Parties reaffirmed the validity of the Treaty. We remain determined that threats and challenges to the nuclear non-proliferation regime be addressed on the basis of the NPT. For our part, we pledge ourselves to redouble our efforts to uphold and strengthen the Treaty.

**International Atomic Energy Agency (IAEA)**

12. Safeguards are an essential tool for the effective implementation of the NPT. We reaffirm our full support for the IAEA. We are working for the implementation of a Comprehensive Safeguards Agreement and the Additional Protocol to become the universally accepted norm for verifying compliance with NPT safeguards obligations. The Additional Protocol must become an essential new standard in the field of nuclear supply arrangements. We will continue to work together to strengthen NSG guidelines accordingly. We welcome the establishment of the Committee on Safeguards and Verification, which will review the IAEA's ability to ensure

compliance with NPT obligations and safeguards Agreements in the light of recent non-proliferation challenges.

**Enrichment and Reprocessing Technology**

13. Since Sea Island, we have worked to develop further measures to prevent the export of sensitive nuclear items with proliferation potential to states that may seek to use them for weapons purposes or allow them to fall into terrorist hands, while allowing the world to enjoy safely the benefits of peaceful nuclear technology. We agreed at Sea Island that the export of such items should occur only pursuant to criteria consistent with global non-proliferation norms and to states rigorously committed to these norms. Over the past year, we have made progress in the development of such criteria. We welcome the decision at the recent Plenary Session of the Nuclear Suppliers Group (NSG) to work actively with a view to reaching consensus on this issue. In aid of this process, we continue to agree, as we did at Sea Island, that it would be prudent in the next year not to inaugurate new initiatives involving transfer of enrichment and reprocessing technologies to additional states. We continue to call on all states to adopt this strategy of prudence. We also welcome the adoption by the NSG of important measures which restrict nuclear transfers to States which have violated their non-proliferation and safeguards obligations.

14. We believe that strengthened conditions on the supply of sensitive technology should be accompanied by new measures to ensure that those states which forgo the nuclear fuel cycle and meet all nuclear non-proliferation obligations enjoy assured access to the market for nuclear fuel and related services. We welcome the efforts of the Expert Group, established by the Director-General of the IAEA, which has recently reported on possible Multinational Approaches to the Fuel Cycle. We will work together with all interested partners for a way forward which provides genuine access while minimising the risks of proliferation.

**Proliferation Challenges**

15. The example of Libya's important renunciation of weapons of mass destruction demonstrates that the international community responds positively to States which desire to be a part of the global non-proliferation mainstream. In this spirit, we are working with determination to address current proliferation challenges.

16. We express profound concern over the threat posed by DPRK's nuclear weapons programme, particularly following its recent statements that it has manufactured nuclear weapons and in the light of its missile programmes and history of missile proliferation. The DPRK has violated its commitments under the NPT and its IAEA safeguards agreement. We reiterate the necessity for the DPRK promptly to return to full compliance with the NPT, and dismantle all its nuclear weaponsrelated programmes in a complete, verifiable and irreversible manner. It is also essential that the DPRK not contribute to missile proliferation elsewhere, and maintain indefinitely its moratorium on the launching of missiles. We reaffirm our full support for the Six-Party talks, which represent an important opportunity to achieve a comprehensive solution. It is essential that the DPRK return to the Six Party Talks immediately without preconditions, and participate constructively to this end.

17. We remain united in our determination to see the proliferation implications of Iran's advanced nuclear programme resolved. It is essential that Iran provide the international community with objective guarantees that its nuclear programme is exclusively for peaceful purposes in order to build international confidence. We welcome the initiative of France, Germany and the United Kingdom, and the High Representative of the European Union to reach agreement with Iran on long-term arrangements which would provide such objective guarantees as well as political and economic co-operation. We call upon Iran to maintain the suspension of all enrichment- related and reprocessing activities while negotiations on the long term arrangements proceed. We reiterate the need for Iran to co-operate fully with IAEA requests for information and access, to comply fully with all IAEA Board requirements, and to resolve all outstanding issues related to its nuclear programme. We also urge Iran to ratify the Additional Protocol without delay and, pending its ratification, to act fully in accordance with its provisions.

**Defending against biological threats**

18. We reaffirm our strong commitment to strengthening our defenses against biological threats. Over the last year, our efforts have focussed on enhancing protection of the food supply. We will continue efforts to address biological threats and support work in other relevant international groups.

19. This year marks the 30th anniversary of the entry into force of the Biological and Toxin Weapons Convention. New biological threats mean that full compliance with the Convention remains as relevant today as it was at its inception. We encourage States Party to take a full part in the ongoing programme of work which this year will discuss the content, promulgation and adoption of codes of conduct for scientists. Further, we look forward to a substantive and forward-looking Review Conference in 2006.

20. 2005 also marks the 80th anniversary of the opening for signature of the 1925 Geneva Protocol prohibiting the use in war of asphyxiating, poisonous or other gases and bacteriological methods of warfare. We emphasise the continuing vital relevance of this multilateral rejection of the use in war of chemical and biological weapons.

**Chemical Weapons Convention**

21. We continue to support full implementation of the Chemical Weapons Convention, including its non-proliferation aspects. While acknowledging the obligation to destroy chemical weapons within the time limits provided for by the chemical weapons convention and to destroy or convert chemical weapons production facilities, we recall that States Party agreed in 2003 to an Action Plan which requires all to have national implementing measures in place by the time of the Conference of States Party scheduled for this November. We urge those States Party who have not yet done so to take all necessary steps to ensure the deadline is met. We stand ready to provide appropriate assistance. We support the use of consultations and cooperation, as well as fact-finding, verification, and compliance measures, including, if necessary, challenge inspections, as provided in the CWC.

Global Partnership against Proliferation of Weapons and Materials of Mass Destruction

22. We reaffirm our commitment to the Global Partnership against the Proliferation of Weapons and materials of Mass Destruction, and to the Kananaskis Statement, Principles, and Guidelines. We will work to build on the considerable progress we have made to implement co-operative projects to which the G8 and thirteen other countries now contribute. We renew our pledge to raise up to $20 billion over ten years to 2012 for Global Partnership priorities, initially in Russia. In this context, we will embark on new projects according to these priorities. We welcome Ukraine's participation, and continue to discuss with a number of countries of the Former Soviet Union their interest in joining the Partnership. We reaffirm our openness in principle to a further expansion of the Partnership to donor and recipient partners which support the Kananaskis documents.

**Nuclear Safety and Security**

23. We welcome continued co-operation with the IAEA in the area of nuclear and radiological safety and security, including on strengthening regulatory infrastructures and the interface between safety and security. We support the establishment of the Global Threat Reduction Initiative and welcome the progress which has been made so far. We welcome the results of the IAEA's International Conference on Nuclear Security which was held in London in March. We have all signed the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management and urge others to join us.

24. Since the horrific accident in 1986, we have worked with Ukraine to improve the safety and security of the Chernobyl site. This year, together with the EU and 16 other countries, we have increased pledged funding for the construction of a new safe confinement over the remnants of the reactor to approximately $1 billion. We welcome Ukraine's political and financial commitment to this project, and urge Ukraine to ensure that the project can be completed safely by 2009.

# JOINT STATEMENT BY U.S. PRESIDENT GEORGE W. BUSH AND RUSSIAN FEDERATION PRESIDENT V.V. PUTIN ON COOPERATION IN THE PEACEFUL USES OF NUCLEAR ENERGY AND COUNTERING NUCLEAR PROLIFERATION

**U.S.-Russia Summit**
***July 15-17, 2006, St. Petersburg, Russia***

The United States and the Russian Federation believe that strengthening their cooperation in civil nuclear energy is in the strategic interests of both our countries. It will serve as an additional assurance of access for other nations to economical and environmentally safe peaceful nuclear energy.

The United States and the Russian Federation are working together to meet the challenges posed by the combination of proliferation of weapons of mass destruction and international terrorism. We recognize the devastation that could befall our peoples and the world community if nuclear weapons or materials or other weapons of mass destruction were to fall into the hands of terrorists. We are closely cooperating to lessen that unacceptable danger, including by strengthening the non-proliferation regime and ensuring the security of nuclear weapons and fissile materials.

## Cooperation in the Peaceful Uses of Nuclear Energy

The United States and the Russian Federation are convinced that reliable and sufficient energy supplies are the cornerstone of sustainable economic development and prosperity for all nations, and a necessary condition for maintaining international stability. Today nuclear energy is a proven technology for providing reliable electric power without emission of greenhouse gases, and is an essential part of any solution to meet growing energy demand.

We share the view that nuclear energy has an essential role in the promotion of energy security, which is an issue of special concern for the leaders of the G-8. Advancing nuclear energy will require further development of innovative technologies that reduce the risk of proliferation, provide for safe management of waste, are economically viable, and are environmentally safe.

Being consistent in our approach to assure access to the benefits of nuclear energy for all nations complying with their non-proliferation obligations, we have each proposed initiatives on the development of a global nuclear energy infrastructure, specifically the Russian proposal to establish a system of international centers to provide nuclear fuel services, including uranium enrichment, under IAEA safeguards, and the U.S. proposal for the Global Nuclear Energy Partnership to develop innovative nuclear reactor and fuel cycle technologies.

Following up on these initiatives, the United States and the Russian Federation intend to work together, actively involving the IAEA, to allow all nations to enjoy the benefits of nuclear energy without pursuing uranium enrichment and spent fuel reprocessing capabilities.

The United States and the Russian Federation together with four other nuclear fuel supplier states have also proposed a concept for reliable access to nuclear fuel for consideration and development at the IAEA.

We call upon other countries to join us to facilitate the safe and secure expansion of nuclear energy worldwide.

Proceeding from our national interests and common goals, and recognizing the benefits of civil commercial nuclear trade, we express our intent to develop bilateral cooperation in the peaceful use of nuclear energy.

We have directed our Governments to begin negotiations with the purpose of concluding an agreement between the United States and the Russian Federation on cooperation in the peaceful use of nuclear energy.

**Countering Nuclear Proliferation**

We recognize the vital role of the NPT in the prevention of nuclear proliferation and the importance of the IAEA in implementing safeguards required by the NPT. We are working with our G-8 partners to make the Additional Protocol an essential norm for verifying compliance with nuclear safeguards obligations. We welcome the establishment of the IAEA Committee on Safeguards and Verification. We are actively fulfilling our obligations under Article VI of the NPT by substantially reducing nuclear forces as we implement the Moscow Treaty of May 24, 2002.

We reiterate our support for effective measures to prevent transfers of sensitive nuclear equipment, materials and technologies to states that may seek to use them for weapons purposes, or allow them to fall into terrorists' hands, and will work together to this end.

We reiterate our commitments undertaken under the Bratislava Joint Statement on Nuclear Security Cooperation of February 24, 2005. We have made substantial progress in the implementation of those commitments and we reaffirm our goal of completing nuclear security upgrades by the end of 2008.

We welcome the continued cooperation and the recent extension of the Cooperative Threat Reduction Agreement to ensure full implementation of the ongoing projects launched earlier under this Agreement. In this context we take note of the start of operations of the Mayak Fissile Materials Storage Facility. We continue discussions on how best to implement our commitments to the disposition by each side of 34 metric tons of weapons grade plutonium.

We applaud the extension of UN Security Council Resolution 1540, the adoption by the UN General Assembly of the International Convention for the Suppression of Acts of Nuclear Terrorism, and the decision by the States Parties to strengthen the Convention on Physical Protection of Nuclear Material.

We will continue to advance the objectives of the Proliferation Security Initiative, which makes an important contribution to countering the trafficking in WMD, their delivery means, and related materials. We welcome increasing international endorsement for the initiative, as was demonstrated at the High Level Political Meeting in Warsaw. We take note of the discussion at that meeting on how PSI states can work cooperatively to prevent and disrupt proliferation finance, in furtherance of UNSCR 1540.

We look forward to reinforcing our partnership with India. We welcome the important non-proliferation commitments India has made, and India's closer alignment with the non-proliferation regime mainstream. We look forward to working with India on civil nuclear cooperation to address its energy requirements, and on further enhancing the global non-proliferation regime.

We will continue to work together to strengthen the global non-proliferation regime.

We are especially concerned by the failure of the Iranian government to engage seriously on the proposals made by the P-5 countries and Germany. In this context, we stand fully behind the decision by Foreign Ministers on July 12.

We are seriously concerned by North Korea's ballistic missile tests and urge it to return to a moratorium on such launches, to the Six-Party Talks, and to full implementation of the September 19, 2005 agreement.

The Russian Federation and the United States are actively working for the unity among the UN Security Council members on these sensitive issues. We will continue consultations with our G-8 partners to strengthen the global non-proliferation regime

Through our cooperation in the field of nuclear non-proliferation we seek to improve the security of our own peoples and of all others in the world community. In doing so, we are building on the unique historic roles and responsibilities of the United States and the Russian Federation in nuclear science and technology, both military and civilian. We are united in our determination to help make the benefits of nuclear energy securely available to all for peaceful purposes.

# JOINT STATEMENT BY U.S. PRESIDENT GEORGE W. BUSH AND RUSSIAN FEDERATION PRESIDENT V.V. PUTIN ANNOUNCING THE GLOBAL INITIATIVE TO COMBAT NUCLEAR TERRORISM

**U.S.-Russia Summit**
***July 15-17, 2006, St. Petersburg, Russia***

The United States of America and Russia are committed to combating the threat of nuclear terrorism, which is one of the most dangerous international security challenges we face.

Today we announce our decision to launch the Global Initiative to Combat Nuclear Terrorism. Building on our earlier work, the Global Initiative reflects our intention to pursue the necessary steps with all those who share our views to prevent the acquisition, transport, or use by terrorists of nuclear materials and radioactive substances or improvised explosive devices using such materials, as well as hostile actions against nuclear facilities. These objectives are reflected in the International Convention for the Suppression of Acts of Nuclear Terrorism, the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities as amended in 2005, the Protocol to the Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation, and other international legal frameworks relevant to combating nuclear terrorism.

The United States and Russia call upon like-minded nations to expand and accelerate efforts that develop partnership capacity to combat nuclear terrorism on a determined and systematic basis. Together with other participating countries and interacting closely with the IAEA, we will take steps to improve participants' capabilities to: ensure accounting, control, and physical protection of nuclear material and radioactive substances, as well as security of nuclear facilities; detect and suppress illicit trafficking or other illicit activities involving such materials, especially measures to prevent their acquisition and use by terrorists; respond to and mitigate the consequences of acts of nuclear terrorism; ensure cooperation in the development of technical means to combat nuclear terrorism; ensure that law enforcement takes all possible measures to deny safe haven to terrorists seeking to acquire or use nuclear materials; and to strengthen our respective national legal frameworks to ensure the effective prosecution of, and the certainty of punishment for, terrorists and those who facilitate such acts.

We stress that consolidated efforts and cooperation to combat the threat of nuclear terrorism will be carried out in accordance with international law and national legislation. This Global Initiative builds on the International Convention for the Suppression of Acts of Nuclear Terrorism, which the Russia and the United States were the first to sign on September 14, 2005. This unique international treaty provides for broad areas of cooperation between states for the purpose of detecting, preventing, suppressing, and investigating acts of nuclear terrorism.

One of our priority objectives remains full implementation by all countries of the provisions of UNSCR 1540, which was adopted in 2004 as a result of joint efforts by the United States and Russia. This resolution is an important non-proliferation instrument aimed at preventing weapons of mass destruction (WMD) from entering "black market" networks and, above all, keeping WMD and related material from falling into the hands of terrorists. The full implementation by all countries of UNSCR 1373, including the sharing of information pertaining to the suppression of acts of nuclear terrorism and their facilitation, also remains a priority.

We note the importance of IAEA activities in implementing the Convention on the Physical Protection of Nuclear Material and Facilities, as amended and its Plan entitled "Physical Nuclear Security - Measures to Protect Against Nuclear Terrorism," and we reaffirm our willingness to continue supporting and working with the IAEA in this area to enhance the effectiveness of national systems for accounting, control, physical protection of nuclear materials and radioactive substances and the security of civilian nuclear facilities, and, where necessary, to establish such systems.

We trust that, through their participation in this new Global Initiative to Combat Nuclear Terrorism, all countries that share our common goals of suppressing and mitigating the consequences of acts of nuclear terrorism will - on a voluntary basis and on the basis of independent responsibility of each country for the steps taken within its jurisdiction - reinforce the joint efforts to increase international cooperation in combating this threat.

The United States and the Russian Federation reaffirm that issues related to safeguarding nuclear weapons and other nuclear facilities, installations and materials used for military purposes remain strictly the national prerogative of the nuclear weapons state parties to the Non-Proliferation of Nuclear Weapons Treaty (NPT), for which they bear special responsibility. The Joint Statement on Nuclear Security, which we adopted in Bratislava, noted that while the security of nuclear facilities in the United States and Russian Federation meets current requirements, these requirements must be constantly enhanced to counter evolving terrorist threats. We trust that the other nuclear weapon state parties to the Non- Proliferation of Nuclear Weapons Treaty (NPT) will also ensure a proper level of protection for their nuclear facilities, while taking into account the constantly changing nature of the terrorist threat.

As part of this initiative, we intend to work with countries possessing sensitive nuclear technologies to reaffirm their commitment to take all necessary measures to ensure proper protection and safeguarding of nuclear facilities and relevant materials in their territory.

We will be prepared to work with all those who share our views to strengthen mechanisms for multilateral and bilateral cooperation to suppress acts of nuclear terrorism, with a view to practical implementation of the measures provided for in the International Convention for the Suppression of Acts of Nuclear Terrorism as well as in other relevant international legal frameworks.

# STATEMENT ON NON-PROLIFERATION

***G8 Summit***
**July 16, 2006, St. Petersburg, Russia**

The proliferation of weapons of mass destruction (WMD) and their means of delivery, together with international terrorism remain the pre-eminent threat to international peace and security. The international community must therefore boldly confront this challenge, and act decisively to tackle this threat. We reaffirm our determination and commitment to work together and with other states and institutions in the fight against the proliferation of WMD, including by preventing them from falling into hands of terrorists.

As an essential element of our efforts to confront proliferation, we are determined to fulfill arms control, disarmament and non-proliferation obligations and commitments under relevant international treaties, conventions and multilaterally agreed arrangements to which we are parties or in which we participate. We call on all other states to meet their obligations and commitments in full in this regard. We rededicate ourselves to the re-invigoration of relevant multilateral fora, beginning with the Conference on Disarmament. These efforts will contribute to the further reinforcement of the global non-proliferation regime.

We call on all states not Party to the Treaty on the Non-proliferation of Nuclear Weapons (NPT), the Chemical Weapons Convention (CWC), the Biological and Toxin Weapons Convention (BTWC) and the 1925 Geneva Protocol to accede to them without delay and those states that have not yet done so to subscribe to the Hague Code of Conduct Against Ballistic Missile Proliferation. We urge all states concerned to strictly observe a moratorium on nuclear weapon test explosions or any other nuclear explosions.

## Nuclear Non-Proliferation

### NPT

We reaffirm our full commitment to all three pillars of the NPT. We call on all states to comply with their NPT obligations, including IAEA safeguards as well as developing effective measures aimed at preventing trafficking in nuclear equipment, technology and materials.

### IAEA Safeguards

We stress the importance of the IAEA safeguards system. We are seeking universal adherence to IAEA comprehensive safeguards agreements for the effective implementation of Article III of the NPT and to the Additional Protocol. In this context we urge all states that have not yet done so, to sign, ratify and implement these instruments promptly. We are actively engaged in efforts toward this goal, with a view to make comprehensive safeguards agreements together with an Additional Protocol the universally accepted verification standard. We will also work together vigorously to establish the Additional Protocol as an essential new standard in the field of nuclear supply arrangements.

Peaceful use of nuclear energy

We recall that Article IV of the NPT stipulates that nothing in the Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of the Treaty. We are committed to facilitate the exchange of equipment, materials and information for the peaceful use of nuclear energy. Full compliance with NPT non-proliferation obligations, including safeguards agreements, is an essential condition for such exchange.

An expansion of the peaceful use of nuclear energy must be carried forward in a manner consistent with nuclear non-proliferation commitments and standards. In this regard, it is important to develop and implement mechanisms assuring access to nuclear fuel related services to states as an alternative to pursuing enrichment and reprocessing activities. In this respect we appreciate the recent potentially complementary Initiative of the President of the Russian Federation on multinational centres to provide nuclear fuel cycle services and the Initiative of the President of the United States on the Global Nuclear Energy Partnership as well as the recent initiative tabled at the IAEA by France, Germany, the Netherlands, the Russian Federation, the United Kingdom and the United States regarding a concept for a multilateral mechanism for reliable access to enrichment services for nuclear fuel. We will work to elaborate further these initiatives. To further strengthen this common approach we will:

- continue reviewing multinational approaches to the fuel cycle, including international centres to provide nuclear fuel cycle services, with the IAEA, as well as relevant practical, legal and organizational solutions;

- facilitate developing credible international assurances of access to nuclear fuel related services; while

- those of us who have or are considering plans relating to use and/or development of safe and secure nuclear energy will promote research and development for safer, more efficient, more environmentally friendly and more proliferation resistant nuclear energy systems, including relevant technologies of the nuclear fuel cycle. Until advanced systems are in place, appropriate interim solutions could be pursued to address back-end fuel cycle issues in accordance with national choices and non-proliferation objectives.

FMCT

We support the early commencement of negotiations on the Fissile Material Cut-Off Treaty in the Conference on Disarmament.

**Enrichment and Reprocessing**

In accordance with approaches agreed upon at the G8 summits at Sea Island and in Gleneagles, we support the development of measures to prevent transfers of sensitive nuclear equipment, materials and technologies to states that may seek to use them for weapons purposes, or allow them to fall into terrorists' hands.

We will exercise enhanced vigilance with respect to the transfers of nuclear technology, equipment and material, whether in the trigger list, in the dual-use list, or unlisted, which could contribute to enrichment-related and reprocessing activities, and will be particularly vigilant with respect to attempts to acquire such technology, equipment and material by covert and illicit means.

We agreed at Sea Island that the export of such items should occur only pursuant to criteria consistent with global non-proliferation norms and to those states rigorously committed to these norms. Over the last two years we have made significant progress in the development of such criteria. We welcome the progress noted by the Nuclear Suppliers Group and its commitment to work actively with a view to reaching consensus on this issue by 2007.

In aid of this process we continue to agree, as we did at Sea Island and Gleneagles, that it would be prudent in the next year not to inaugurate new initiatives involving transfer of enrichment and reprocessing technologies to additional states. We call upon all other states to adopt this strategy of prudence.

## India

We look forward to reinforcing our partnership with India. We note the commitments India has made, and encourage India to take further steps towards integration into the mainstream of strengthening the non-proliferation regime, so as to facilitate a more forthcoming approach towards nuclear cooperation to address its energy requirements, in a manner that enhances and reinforces the global non-proliferation regime.

## BTWC

We look forward to a successful 6th BTWC Review Conference dedicated to the effective review of the operation of the Convention. We will facilitate adoption by the Review Conference of decisions aimed at strengthening and enhancing the implementation of the BTWC.

We call upon all States Parties to take necessary measures, including as appropriate the adoption of and implementation of national legislation, including penal legislation, in the framework of the BTWC, in order to prohibit and prevent the proliferation of biological and toxin weapons and to ensure control over pathogenic micro organisms and toxins. We invite the States Parties that have not yet done so to take such measures at the earliest opportunity and stand ready to consider appropriate assistance. In this regard, we welcome initiatives such as the 2006 EU Joint Action in support of the BTWC.

## CWC

We continue to support full implementation of the CWC. We note the ongoing destruction of chemical weapons by the possessor states and are encouraged by the fact that the stockpiles of these deadly weapons are gradually decreasing. We acknowledge their obligations to destroy chemical weapons and to destroy or convert chemical weapons production facilities within the time limits provided for by the Chemical Weapons Convention.

We welcome the increasing number of States Parties to the Convention. We acknowledge the value of the Organization for the Prohibition of Chemical Weapons' Action Plan on national implementation measures and improvement of the situation with adoption of such measures. We urge States Parties to continue and intensify efforts in this direction. We stand ready to provide appropriate assistance.

**United Nations Security Council Resolution 1540**

We reaffirm the key role of the UN Security Council in addressing the challenges of proliferation. We urge all states to implement fully UNSC Resolution 1540, including reporting on their implementation of the Resolution.

We welcome the decision of UN Security Council Resolution 1673 to extend the mandate of the 1540 Committee in promoting the full implementation of the resolution. We intend to continue working actively at national and international levels to achieve this important aim, and stand ready to consider all requests for assistance in this regard.

**HCOC**

We reaffirm our commitment to work toward the, universalisation of the Hague Code of Conduct Against Ballistic Missile Proliferation, and the full implementation of its confidence-building measures.

**PSI**

We reaffirm our commitment to the Proliferation Security Initiative, which constitutes an important means to counter trafficking in WMD, their delivery means and related materials. We welcome the increasing international endorsement for the Initiative as it was demonstrated at the High Level Political Meeting in Warsaw. We take note of the discussion at that meeting on how PSI states can work cooperatively to prevent and disrupt proliferation finance, in furtherance of the objectives of UNSCR 1540.

**Libya**

The international community's positive response to Libya's renunciation of weapons of mass destruction demonstrates the benefits that follow a strategic decision to cooperate with the international community and be a part of the global non-proliferation mainstream.

**Iran**

We remain seriously concerned over the proliferation implications of Iran's advanced nuclear programme and we remain united in our commitment to see those implications resolved.

We stand fully behind the far reaching proposals presented to Iran on June 6, 2006 on behalf of China, France, Germany, Russia, the United Kingdom, the United States of America with the support of the High Representative of the European Union for a long-term comprehensive agreement with Iran based on cooperation and mutual respect.

We fully support the Statement of the Foreign Ministers of China, France, Germany, Russia, the United Kingdom, the United States of America issued on July 12, Paris, in which the Ministers and the High Representative of the European Union expressed their profound disappointment over the absence of any indication at all from the Iranians that Iran is ready to engage seriously on the substance of the above-mentioned proposals. Iran has failed to take the steps needed to allow negotiations to begin, specifically the suspension of all enrichment related and reprocessing activities, as required by the IAEA and supported in the United Nations Security Council Presidential Statement. The Ministers therefore decided to return the issue to the United Nations Security Council. We, the Leaders of the G-8, fully support this decision and the clear messages it sends to Iran about the choice it must make. We support the Paris appeal to Iran to respond positively to the substantive proposals made on June 6, 2006.

**DPRK**

We welcome the unanimously adopted UN Security Council Resolution 1695 which represents the clear and strong will of the international community.

We condemn the launching by the Democratic People's Republic of Korea (DPRK) of multiple ballistic missiles on July 5 local time and express serious concerns as this jeopardizes peace, stability and security in the region and beyond. This action violated the DPRK's pledge to maintain a moratorium on missile launches and is inconsistent with the purposes of the Six-Party Talks Joint Statement of September 19, 2005, in which all parties - including the DPRK - committed to joint efforts to lasting peace and stability in Northeast Asia. We also express our grave concern about the DPRK's indication of possible additional launches. We call on the DPRK to reestablish its preexisting commitments to a moratorium on missile launches and to refrain from contributing to missile proliferation. In accordance with the UN Security Council Resolution 1695 we will exercise vigilance in preventing any external cooperation with the DPRK's missile and WMD programmes.

These missile launches intensify our deep concern over the DPRK's nuclear weapons programmes. We reiterate the necessity for the DPRK promptly to return to full compliance with the NPT. We strongly urge the DPRK to abandon all nuclear weapons and existing nuclear programmes. We reaffirm our full support for the September 19, 2005 Joint Statement and the Six-Party talks. We urge the DPRK to expeditiously return to these talks without precondition and to cooperate to settle the outstanding issues of concern on the basis of this Statement, which reaffirms the common objective of Six Parties; all participants should intensify their efforts to achieve the verifiable denuclearization of the Korean Peninsula in a peaceful manner and to maintain peace and stability on the Korean Peninsula and in Northeast Asia.

## Global Partnership

The Global Partnership against the Spread of Weapons and Materials of Mass Destruction has continued its progress in the past year towards achieving the goals set out at Kananaskis. It has become a significant force to enhance international security and safety. Much has been accomplished in all areas but more has to be done to increase the efficiency of our cooperation.

We reaffirm our commitment to the full implementation of all G8 Global Partnership objectives. We also reaffirm our openness to examine the expansion of the Partnership to other recipient countries and donor states which support the Kananaskis documents and to embrace the goals and priorities of all Partnership members. We welcome the progress GP members have made working with Ukraine.

We appreciate the contribution of 13 non-G8 states who joined the Global Partnership.

We remain committed to our pledges in Kananaskis to raise up to $20 billion through 2012 for the Global Partnership, initially in Russia, to support projects to address priority areas identified in Kananaskis and to continue to turn these pledges into concrete actions.

# DECLARATION ON NUCLEAR ENERGY AND NON-PROLIFERATION: JOINT ACTIONS

***U.S.-Russia Summit***
**July 2-3, 2007, Kennebunkport, Maine**

We are determined to play an active role in making the advantages of the peaceful use of nuclear energy available to a wide range of interested States, in particular developing countries, provided the common goal of prevention of proliferation of nuclear weapons is achieved. To this end, we intend, together with others, to initiate a new format for enhanced cooperation.

Bearing this in mind, we acknowledge with satisfaction the initialing of the bilateral Agreement between the Government of the Russian Federation and the Government of the United States of America for cooperation in the field of peaceful use of nuclear energy. We share the view that this Agreement will provide an essential basis for the expansion of Russian-U.S. cooperation in the field of peaceful use of nuclear energy and expect this document to be signed and brought into force in accordance with existing legal requirements.

We share a common vision of growth in the use of nuclear energy, including in developing countries, to increase the supply of electricity, promote economic growth and development, and reduce reliance on fossil fuels, resulting in decreased pollution and greenhouse gasses.

This expansion of nuclear energy should be conducted in a way that strengthens the nuclear non-proliferation regime. We strongly support the Treaty on the Non-Proliferation of Nuclear Weapons, and are committed to its further strengthening. We support universal adherence to the IAEA Additional Protocol, and call on those who have not yet done so to sign and ratify it. We support the activities of the IAEA with respect to both safeguards and promotion of peaceful nuclear energy, and fully understand the need for growth of its capabilities, including its financial resources, commensurate with the expanded use of nuclear energy worldwide.

We are prepared to support expansion of nuclear energy in the following ways, consistent with national law and international legal frameworks. These efforts build on, reinforce, and complement a range of existing activities, including the work at the IAEA for reliable access to nuclear fuel, the initiative of the Russian Federation on developing Global Nuclear Infrastructure, including the nuclear fuel center in the Russian Federation, the initiative of the United States to establish the Global Nuclear Energy Partnership, the IAEA International Project on Innovative Nuclear Rectors and Fuel Cycles, and the Generation IV International Forum.

Facilitating the supply of a range of modern, safe, and more proliferation resistant nuclear power reactors and research reactors appropriate to meet the varying energy needs of developing and developed countries.

Arranging for participation in national and multinational programs to develop requirements for nuclear reactors for participating countries.

Facilitating and supporting financing to aid construction of nuclear power plants through public and private national and multinational mechanisms, including international financial institutions.

Providing assistance to states to develop the necessary infrastructure to support nuclear energy, including development of appropriate regulatory frameworks, safety and security programs to assist states in meeting international standards, and training of personnel.

Developing solutions to deal with the management of spent fuel and radioactive waste, including options for leasing of fuel, storage of spent fuel, and over time development of technology for recycling spent fuel.

Ensuring that the IAEA has the resources it needs to meet its safeguards responsibilities as nuclear power expands worldwide.

Supporting expanded IAEA Technical Cooperation to help states build the necessary infrastructure for safe, secure, and reliable operations of nuclear power plants.

Assisting development and expansion of regional electricity grids, to permit states without nuclear reactors to share in the benefits of nuclear power.

Providing nuclear fuel services, including taking steps to ensure that the commercial nuclear fuel market remains stable and that states are assured of reliable access to nuclear fuel and fuel services for the lifetime of reactors, including through establishment of international nuclear fuel cycle centers, to provide nuclear fuel cycle services, including uranium enrichment, under IAEA safeguards.

Supporting negotiation of long-term contracts for power reactors and research reactors, including assured supply of fuel and arrangements for management of spent fuel.

We are prepared to enter into discussions jointly and bilaterally to develop mutually beneficial approaches with states considering nuclear energy or considering expansion of existing nuclear energy programs in conformity with their rights and obligations under the NPT. The development of economical and reliable access to nuclear energy is designed to permit states to gain the benefits of nuclear energy and to create a viable alternative to the acquisition of sensitive fuel cycle technologies.

The energy and non-proliferation challenges we face today are greater than ever before. We are convinced that this approach will permit substantial expansion of nuclear energy and at the same time strengthen non-proliferation. We welcome the cooperation of states that share this common vision and are committed to jointly taking steps to make this vision a reality.

# HEILIGENDAMM STATEMENT ON NON-PROLIFERATION

***G8 Summit***
**June 6-8, 2007, Heiligendamm, Germany**

1. Preventing the proliferation of weapons of mass destruction and their means of delivery as well as effectively combating international terrorism are critical to international peace and security. We, the Leaders of the G8, remain resolute in our shared commitment to counter the global proliferation challenge and continue to support and implement all the statements on non-proliferation issued on the occasion of previous summits of the G8.

2. The global proliferation challenge requires determined action and international cooperation on the basis of a broad and multifaceted approach. To be successful we need to work jointly with other partners and through relevant international institutions, in particular those of the United Nations system, to strengthen all instruments available for combating the proliferation of weapons of mass destruction and their means of delivery.

3. We will also continue to promote a stable international and regional environment in order to address the underlying factors for proliferation activities.

4. We reaffirm our commitment to the multilateral treaty system which provides the normative basis for all non-proliferation efforts. The strengthening and universalisation of WMD related treaties, in particular the Treaty on the Non-Proliferation of Nuclear Weapons, the Chemical Weapons Convention and the Biological and Toxin Weapons Convention, are therefore a key priority. These three treaties continue to be essential instruments to maintain international peace and security and are the cornerstones of the international regime for non-proliferation and disarmament.

5. We will continue to encourage states to fulfill their obligations under the multilateral treaty regimes and to help states in effectively implementing those obligations at their national levels, inter alia by accounting for, securing and physically protecting sensitive materials. We place particular emphasis on urging the adoption of effective measures to combat illicit trafficking in WMD materials and their means of delivery, in particular through capacity building related to law enforcement and the establishment and enforcement of effective export controls, as well as through the Proliferation Security Initiative.

6. We reaffirm our commitment at Gleneagles to develop cooperative procedures to identify, track and freeze financial transactions and assets associated with WMD proliferation networks. We agree that the United Nations Security Council resolutions, including 1540, 1695, 1718, 1737, and 1747, require all states to take actions against WMD proliferation and call upon states to fulfill their obligations and responsibilities against WMD proliferation finance.

7. We reiterate the key role of the United Nations Security Council in addressing the challenge of proliferation. In this regard, we underline the importance of full implementation by all States of

the UNSC Resolution 1540 and we reiterate our support for the efforts of the 1540 Committee, including the sharing of best practices.

8. The Global Partnership against the Proliferation of Weapons and Materials of Mass Destruction, launched five years ago at Kananaskis, is a unique and successful joint effort. At the midpoint of its lifespan we have reviewed the progress made so far and assessed the state of the cooperative projects undertaken. We acknowledge the progress that has been made since the launch of the Partnership in 2002 but more has to be done to increase the efficiency of our cooperation. We remain firmly committed to completing the Kananaskis goals. We will discuss in due course whether the Partnership should be extended beyond 2012 and if so how to allocate the means for expanding its scope to address threat reduction and non-proliferation requirements worldwide, including those mandated by United Nations Security Council Resolution 1540. We will discuss how other states, both donors and recipients, could be included in an expanded Global Partnership.

9. We strongly support the endeavours underway to overcome the stalemate in the Conference on Disarmament. We reaffirm our support to the early commencement of negotiations on a Fissile Material Cut-Off Treaty.

10. We underline the crucial importance of ensuring compliance with the multilateral treaty system. To that end we need to strengthen verification and enforcement. We are committed to continue our efforts to make the IAEA Comprehensive Safeguards Agreement together with an Additional Protocol the universally accepted verification standard for the peaceful use undertakings of the NPT. We will also work towards rendering the implementation of the CWC and BTWC more effective, in particular by promoting full and effective national implementation by all States Parties and full compliance with their obligations with regard to both Conventions. We are also committed to enhancing the effectiveness of the UNSC in meeting the challenge of proliferation and effectively fulfilling its role as the final arbiter of the consequences of non-compliance.

11. We acknowledge that the nuclear non-proliferation regime faces serious challenges. We therefore reaffirm our full commitment to the objectives and obligations of all three pillars of the NPT and we will continue to work for its universalisation. We call on all states party to the NPT to make a constructive contribution to a balanced and structured review of the Treaty, which has successfully begun with the first meeting of the Preparatory Committee of the 2010 Review Conference. We will undertake all efforts to achieve a positive outcome of the review process with a view to maintaining and strengthening the authority, credibility and integrity of the treaty regime.

12. We urge all states concerned to observe a moratorium on nuclear weapon test explosions or any other nuclear explosions.

13. We reaffirm the inalienable right of all parties to the NPT to the use of nuclear energy for peaceful purposes as enshrined in Article IV in conformity with all their Treaty obligations. To reduce the proliferation risks associated with the spread of enrichment and reprocessing goods and technology, we welcome the continued discussion by the Nuclear Suppliers Group on

mechanisms to strengthen controls on transfers of enrichment and reprocessing equipment, facilities and technology. We regret that they did not reach consensus on this issue by 2007 as called for in St. Petersburg. We urge the NSG to accelerate its work and swiftly reach consensus. We agree to continue to undertake previously agreed actions on the understanding that should the NSG not reach consensus on appropriate criteria by 2008, we will seriously consider alternative strategies to reduce the proliferation risks associated with the transfer of enrichment and reprocessing goods and technologies. We also stress the importance of developing and implementing mechanisms of multilateral approaches to the nuclear fuel cycle as a possible alternative to pursuing national enrichment and reprocessing activities. Following the IAEA special event in September last year we are now looking forward to the suggestions that the IAEA Director General will be presenting to the IAEA Board of Governors later this month. In considering the suggestions we will be guided by the criteria of added value to the non-proliferation regime, confidence in the reliability of supply assurances, compatibility with Article IV of the NPT, and the need to avoid any unnecessary interference or disturbance with the functioning of existing commercial markets. In this context, we reaffirm our commitment to ensure that the highest possible non-proliferation, safety and security standards for the peaceful use of nuclear energy are observed. We appreciate suggested initiatives in the field of multilateral approaches to the nuclear fuel cycle, including the Russian initiative on multinational centres to provide nuclear fuel cycle services, the US initiative on the Global Nuclear Energy Partnership, the Six-Party proposal of a standing mechanism for reliable access to nuclear fuel, the Japanese initiative on an IAEA standby arrangements system for the assurance of nuclear fuel supply, the UK proposal for non-revocable advanced export approval and the German initiative to establish a special territory under the exclusive control of the IAEA where enrichment could take place on a commercial basis. We reiterate that participation in any mechanism dealing with multilateral approaches should be carried out on a voluntary basis and should not preclude any state from purchasing nuclear fuel cycle services on the existing market, beyond the frameworks of multilateral mechanisms.

14. We are committed to resolving regional proliferation challenges by diplomatic means. We remain united in our commitment to resolve the proliferation concerns posed by Iran's nuclear programme. We deplore the fact that Iran has so far failed to meet its obligations under UNSC Resolutions 1696, 1737 and 1747 and will support adopting further measures, should Iran refuse to comply with its obligations. We again urge Iran to take the steps required by the international community, and made mandatory by these resolutions, to suspend all its enrichment-related and reprocessing activities, including research and development, and allow negotiations to begin. International confidence in the exclusively peaceful nature of the Iranian nuclear programme would permit a completely new chapter to be opened in our relations with Iran not only in the nuclear but also more broadly in the political, economic and technological fields. In this regard, we support the action of the IAEA and call on Iran to fully cooperate with the Agency.

15. Regarding the Korean Peninsula we are continuing to support the Six-Party Talks and swift implementation of the initial actions agreed on 13 February, 2007 as a first step towards full implementation of the Joint Statement of 19 September, 2005, including the resolution of the outstanding issues of concern. At the same time, we condemn the DPRK's nuclear test which is a clear threat to international peace and security. We urge the DPRK to comply with the UNSC Resolutions 1695 and 1718, strictly to refrain from any further nuclear test or missile launch, and

to abandon all nuclear weapons and existing nuclear programmes as well as all other existing WMD and ballistic missile programmes in a complete, verifiable and irreversible manner. We urge the DPRK to return to full compliance with the NPT and IAEA safeguards. At the same time, we expect all states to fully implement the UNSC resolutions.

16. We look forward to reinforcing our partnership with India. We note the commitments India has made, and encourage India to take further steps towards integration into the mainstream of strengthening the non-proliferation regime so as to facilitate a more forthcoming approach towards nuclear cooperation to address its energy requirements, in a manner that enhances and reinforces the global non-proliferation regime.

17. The threat of nuclear terrorism continues to be a matter of grave concern to us. We are therefore committed to broaden participation in and further develop the Global Initiative to Combat Nuclear Terrorism that was launched last year at St. Petersburg. We invite all EU member states to join the initiative, the EU to support our efforts and the EU-institutions to join the intiative as observer. We call on all states to endorse the Statement of Principles adopted at the Initiative's meeting in Rabat on 30 and 31 October 2006 and join in strengthening our preparedness and defenses against this threat consistent with national legal authorities and obligations under relevant international legal frameworks. We urge States that have not done so to sign and to ratify the International Convention for the Suppression of Acts of Nuclear Terrorism and the Convention on the Physical Protection of Nuclear Materials in its amended version.

18. This year marks the tenth anniversary of the entry into force of the CWC, which is the first disarmament treaty freeing the world from a whole category of weapons of mass destruction under international verification and within a specific timeframe. The anniversary is an opportunity to take stock of the implementation of that Convention so far and to set the stage for the Second Review Conference scheduled to take place in April 2008. We believe that at the Conference States Parties should reaffirm their commitment to full compliance with the obligations under the Convention and to further strengthen the regime established by it.

19. Determined to exclude completely the possibility of biological agents and toxins being used as weapons, we welcome the outcome of the Sixth Review Conference of the BTWC in 2006, which made a significant contribution to strengthening the effectiveness of the Convention. We are committed to fully comply with the decisions taken by that conference and to work for successful outcomes of the meetings during the intercessional period leading to the next Review Conference in 2011.

20. We will continue to promote efforts to address the threat posed by proliferation of means of delivery of weapons of mass destruction. In this regard we remain committed to implementing the Hague Code of Conduct against Ballistic Missile Proliferation and call upon other subscribing States to follow suit. We also intend to render it more effective and urge all states which have not done so, to subscribe to the Code without delay.

## REPORT OF THE G8 NUCLEAR SAFETY AND SECURITY GROUP

***G8 Summit***
**June 6-8, 2007, Heiligendamm, Germany**

---

At the Kananaskis Summit, the G8 Leaders agreed to establish a G8 Nuclear Safety and Security Group (NSSG). The NSSG, responsible to Leaders, will, according to its mandate, provide technically informed, strategic policy advice on issues that could impact safety and security in the peaceful use of nuclear energy, in close cooperation with multilateral organizations and avoiding duplication of tasks or responsibilities that are being addressed adequately by existing organizations or entities.

We are committed to continue to consider nuclear safety and security issues in the Nuclear Safety and Security Group. We will continue to develop a common approach to selected nuclear safety and radiation protection issues and their regulation, by

- Sharing our experience feedback and our vision;

- Developing a common understanding of internationally acceptable safety and security levels in the fields of nuclear installations, radioactive sources, decommissioning, radioactive waste and spent fuel management facilities in order to benchmark our national practices.

**Importance of Nuclear Safety and Security**
The G8 are committed to the "nuclear safety first" principle, to recognised international accepted principles and best practices and to the highest level of standards in nuclear safety and security. We recognise the international conventions and IAEA standards form a good basis for the continuous improvement of national nuclear regulatory systems and nuclear safety as necessary.

It is our common interest to maintain and if necessary to improve nuclear safety, radiation safety, waste management, nuclear security and nuclear liability in our respective countries, and we call upon all other States to do the same.

**Nuclear Regulatory Infrastructure**
In view of the continuous safety and security challenges, we will continue to support measures to promote nuclear (safety and security) regulatory best practices.

We stress the need for effective national regulatory infrastructures, in particular the importance for national regulatory bodies to have sufficient authority, effective independence, competence and adequate resources.

The G8 have made use or intend to make use of the IAEA "Integrated Regulatory Review Services" to review and further improve their national regulatory bodies.

**National Nuclear Safety and Security Infrastructure and Partnerships**
We will promote strong and competent national nuclear safety and security infrastructure. We recall that the nations forming the G8 have initiated and monitored major national and international programs to address nuclear safety and security needs and to establish partnership relations on these issues. We welcome continued cooperation with relevant international organizations active in this area. Priority actions are:

- Use of the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management for open and critical peer review and a source for learning about the best safety practices of others;

- Promote utilization of IAEA Safety Standards for the modernisation of national safety regulations, to the extent feasible;

- Promote exchange of operation experience for improving operating and regulatory practices; and

- Multinational cooperation in the safety review of nuclear power plant designs.

The full implementation of international conventions on nuclear safety and security, the commitment to promote nuclear safety standards and security guidelines as well as the increased use of integrated review services are important prerequisites for the world's community to establish a global nuclear safety and security partnership. We call upon all states to join, as appropriate, and implement the respective international instruments.

**Chernobyl Commitments**
We reaffirm our commitments under former G7 / G8 summit declarations and memoranda of understanding – to undertake joint efforts with Ukraine to convert the dam-aged reactor unit site into safe conditions and to make available safe and reliable facilities at Chernobyl NPP site necessary for a safe decommissioning of the shut down reactor units. We urge the Government of Ukraine in collaboration with EBRD, to take all necessary measures to assist in timely and efficient implementation of these programmes and projects within the agreed frameworks.

**Nuclear Safety of NPP Medzamor, Armenia**
We urge Armenia to undertake further upgrades necessary to ensure that NPP Medzamor can operate in a safe manner until it can be shut down and decommissioned.

**Safety and Security of Radioactive Sources**
We will continue to support international efforts to enhance controls on radioactive sources. We welcome the fact that more than 88 countries have committed to implement the IAEA Code of Conduct on the Safety and Security of Radioactive Sources and urge all other states to adopt the code. We further note that to date 38 countries have committed to act in a harmonized manner in accordance with the IAEA Guidance on the Import and Export of Radioactive Sources, and we encourage all states to support international activities aimed to harmonizing the implementation of provisions of the guidance.

**Global Nuclear Safety Network**

We will continue to strengthen the Global Nuclear Safety and Security Partnership. We will support the further enhancement of the evolving web-based systems and networks for information exchange and co-operation in nuclear safety matters, as implementation of nuclear conventions, co-operation on safety standards, and harmonization of safety approaches, exchange of operational experience and resolution of generic nuclear safety issues. This evolving global nuclear safety network is based on considerable work of international organizations in particular the IAEA and OECD-NEA. It will substantially contribute to maintain competence and to continuously develop effective protection against nuclear hazards. We note the efforts for the collection and dissemination of regulatory information, actions, initiatives and lessons learned as an appropriate means to strengthen the effectiveness of national nuclear safety and security regulators.

**Nuclear and Radiological Emergency Response**

At previous summits, we agreed to enhance global controls on nuclear and radioactive materials and facilities in order to minimize the risk of the malicious use of these materials and facilities. We are implementing those decisions. However, we recognize that we must also enhance as necessary our ability to effectively respond to nuclear and radiological accidents and incidents if they do occur. We welcome the establishment of the IAEA Incident and Emergency Centre and will support the IAEA in this work.

# APPENDIX E

## AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED STATES OF AMERICA AND THE GOVERNMENT OF THE RUSSIAN FEDERATION FOR COOPERATION IN THE FIELD OF PEACEFUL USES OF NUCLEAR ENERGY

The Government of the United States of America and the Government of the Russian Federation, hereinafter referred to as the Parties;

Convinced that the use of nuclear energy for peaceful purposes is a reliable basis for meeting national energy sector requirements in a manner that is sustainable, environmentally safe, and economically beneficial;

Seeking to expand and enhance mutually beneficial cooperation in the field of the peaceful uses of nuclear energy on a stable, reliable, and predictable basis;

Recognizing that the expansion and enhancement of cooperation between the United States of America and the Russian Federation on an equal footing will help strengthen international stability, as well as promote political and economic progress;

Taking into account that both the United States of America and the Russian Federation have achieved an advanced level in the use of nuclear energy for production of electric power and in the development of nuclear industry and scientific research in this field, and guided by the common goals of achieving a higher level of safety and protection of populations and the environment;

Mindful of their respective obligations under the Treaty on the Non-Proliferation of Nuclear Weapons of July 1, 1968 ("NPT"), to which both the United States of America and the Russian Federation are parties;

Reaffirming their commitment to the international development and use of nuclear energy for peaceful purposes that are consistent with the provisions of the NPT;

Taking into account that the United States of America and the Russian Federation are members of the International Atomic Energy Agency ("IAEA");

Affirming their support for the objectives and Statute of the IAEA and their commitment to the Guidelines of the Nuclear Suppliers Group;

Acknowledging the importance of the provision of nuclear fuel supply assurances under the auspices of the IAEA;

Acknowledging the need for measures for the physical protection of nuclear material and facilities and affirming compliance with the obligations set forth in the Convention on the Physical Protection of Nuclear Material of October 26, 1979, to which the United States of America and the Russian Federation are parties;

Expressing a firm commitment to strengthening the international regime of nuclear non-proliferation and IAEA safeguards;

Noting the need to establish conditions governing the transfer for peaceful purposes of nuclear material, relevant equipment and technologies between the United States of America and the Russian Federation that avoid interference in the civilian nuclear programs of the United States of America and the Russian Federation;

Mindful that peaceful nuclear activities must be undertaken taking into account the need to ensure protection of the international population and environment from radioactive, chemical and thermal contamination;

Have agreed as follows:

ARTICLE 1

For the purposes of this Agreement, the terms listed below shall have the following meanings:

1. “Component” means a component part of equipment or other item so designated by agreement of the competent authorities of the Parties;

2. “Equipment” means any reactor, other than one designed or used primarily for the production of plutonium or uranium-233, or any other item so designated by agreement of the competent authorities of the Parties. “Reactor” means any apparatus, other than a nuclear weapon or other nuclear explosive device, in which a self-sustaining fission chain reaction is maintained. The phrase “designed or used primarily for the production of plutonium or uranium-233” shall not apply to breeder reactors that do not produce nuclear material for use in nuclear explosive devices, nor with respect to reactors primarily used for the production of plutonium-238;

3. “High enriched uranium” means uranium enriched to twenty percent or greater in the isotope uranium-235;

4. “Information” means scientific, commercial or technical data or information in any form that are appropriately designated by agreement of the competent authorities of the Parties to be provided or exchanged under this Agreement;

5. “Low enriched uranium” means uranium containing less than twenty percent of the isotope uranium-235, but more than the content ofuranium-235 in natural uranium;

6. "Major critical component" means any part or group of parts essential to the operation of a sensitive nuclear facility;

7. "Moderator material" means heavy water, or any other material suitable for use in a reactor to slow down neutrons and increase the likelihood of further fission, as jointly designated by the competent authorities of the Parties;

8. "Nuclear material" means source material and special fissionable material, and includes, *inter alia,* irradiated source material and irradiated special fissionable material. "Source material" means uranium containing the mixture of isotopes occurring in nature; uranium depleted in the isotope uranium-235; thorium; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate; any other material containing one or more of the foregoing in such concentration as the Board of Governors of the IAEA shall from time to time determine; and such other materials as the Board of Governors of the IAEA shall from time to time determine or as may be agreed by the Parties. "Special fissionable material" means plutonium, uranium-233, uranium enriched in the isotopes uranium-233 or uranium-235; any material containing one or more of the foregoing; and such other fissionable material as the Board of Governors of the IAEA shall determine or as may be agreed by the Parties. "Special fissionable material" does not include "source material." Any determination by the Board of Governors of the IAEA under Article XX of the IAEA Statute or any determination by the Board of Governors of the IAEA that otherwise amends the list of materials considered to be "source material" or "special fissionable material" shall have effect for the purposes of this Agreement only when the Parties have informed each other in writing that they accept this amendment. For the purposes of this Agreement, "plutonium" does not include plutonium with a content of the isotope plutonium-238 exceeding eighty percent;

9. "Peaceful purposes" or "peaceful use(s)" include the use of information, nuclear material, moderator material, equipment and components in such fields as scientific research, electric power generation, medicine, agriculture and industry, but do not include their use in, or use for research on or development of, any nuclear explosive devices or any military purposes. Military purposes shall not include provision of power for military bases drawn from any power network, production of radioisotopes to be used for medical purposes in military hospitals, and other similar purposes as may be agreed by the Parties;

10. "Authorized person" means any individual subject to the jurisdiction of the United States of America and any legal entity, including a joint venture or partnership, subject to the jurisdiction of either Party, that is authorized by the relevant Party to implement cooperation under this Agreement, but does not include the Parties to this Agreement;

11. "Restricted Data" means all data concerning (1) design, manufacture or utilization of nuclear weapons, (2) the production of special fissionable material, or (3) the use of special fissionable material in the production of energy, but shall not include data that the Government of the United States of America has declassified or removed from the category of Restricted Data;

12. “Russian Federation State Secret Information” means information protected by the Russian Federation in the area of its military, foreign policy, economic and other activities, whose dissemination could be detrimental to the security of the Russian Federation;

13. “Sensitive nuclear facility” means any facility designed or used primarily for uranium enrichment, reprocessing of irradiated nuclear material, heavy water production, or fabrication of nuclear fuel containing plutonium;

14. “Sensitive nuclear technology” means any information, including information that is incorporated in equipment or an important component, that is not available to the public and is important to the design, construction, fabrication, operation or maintenance of any sensitive nuclear facility, or any other such information that may be so designated by one of the Parties prior to its transfer under this Agreement.

ARTICLE 2

The Parties may cooperate in the field of peaceful use of nuclear energy in the following areas:

- Scientific research and development pertaining to the nuclear power sector, including nuclear reactors and their fuel cycles.

- Scientific research and development in the field of controlled thermonuclear fusion, including multilateral cooperation.

- Radioactive waste handling, decommissioning of nuclear facilities and environmental restoration.

- Nuclear and radiation safety, including issues of regulation.

- Nuclear industry and commerce.

- Shipments, based on the provisions of this Agreement, of moderator material, nuclear material, technologies and equipment, as well as services in the area of the nuclear fuel cycle, either for use in the United States of America or in the Russian Federation.

- International issues related to the peaceful use of nuclear energy, including issues of non-proliferation, IAEA safeguards, and environmental protection.

- Other areas that may be agreed upon by the Parties in writing.

ARTICLE 3

1. The Parties shall cooperate in the field of peaceful use of nuclear energy in accordance with the provisions of this Agreement and the respective legislation, regulations, norms and license requirements of the United States of America and the Russian Federation as may be applicable, and international agreements to which they are parties.

2. The Parties shall facilitate trade in moderator material, nuclear material, equipment, and technologies, as well as services pertaining to the nuclear fuel cycle, between authorized persons of the United States of America and the Russian Federation in the field of peaceful use of nuclear energy.

3. Authorizations, including import and export licenses, as well as the issuance of authorizations to third parties, relating to trade, industrial operations or nuclear material movements to the territory of the United States of America or of the Russian Federation shall not be used to restrict trade.

4. The cooperation contemplated by this Agreement as cooperation between the Parties may also be carried out between authorized persons.

ARTICLE 4

In conformity with the provisions of this Agreement, the Parties undertake to facilitate commercial relations between authorized persons of the Parties involved in cooperation in the nuclear power sector, which may include, but need not be limited to:

- investment cooperation;

- the establishment of joint ventures;

- environmental projects on an industrial or commercial scale;

- trade in nuclear material, moderator material, and relevant services.

ARTICLE 5

For the purposes of implementation of this Agreement, the Parties hereby designate the following competent authorities:

- For the United States of America, the U.S. Department of State, the U.S. Department of Energy, and the U.S. Nuclear Regulatory Commission.

- For the Russian Federation, the State Corporation for Atomic Energy "Rosatom" and the Federal Service for Environmental, Technological and Nuclear Oversight.

In case of a change in the competent authorities specified in this Article or the designation of new competent authorities, the Parties shall immediately inform each other thereof in writing through diplomatic channels, without amendment to this Agreement.

ARTICLE 6

1. This Agreement does not require the transfer of any information that the Parties are not permitted to transfer under their respective national laws and regulations, or whose transfer is inconsistent with international agreements to which the United States of America or the Russian Federation is party.

2. Restricted Data shall not be transferred by the United States of America under this Agreement.

3. Russian Federation State Secret Information as well as information similar to the information defined in paragraph 11 of Article 1 of this Agreement shall not be transferred by the Russian Federation under this Agreement.

4. The Parties recognize that they may need to protect certain information to be transferred under the terms of this Agreement by one Party to the other in connection with activities undertaken by the Government of the United States of America and the Government of the Russian Federation or on their behalf pursuant to this Agreement. In order to protect such information:

- Protected information transferred by one Party to the other shall be stamped, marked, or designated by the releasing Party as protected in accordance with its national laws and regulations. The medium in electronic, paper, or another format, containing this information, if in English, must have the marking “Protected”; if in Russian, “конфиденциально [Confidential].”

- Protected information transferred by one Party shall be protected by the recipient Party in accordance with its national laws and regulations in a manner at least equivalent to that afforded by the releasing Party. The recipient Party shall not use or permit the use of protected information for any purpose other than that for which it was transferred, and, to the extent permitted by its national laws and regulations, shall not disclose such information or transfer it to any third party not participating in the activities of the two Parties under this Agreement in connection with which the protected information was transferred, without the prior written consent of the transferring Party.

- In accordance with the laws and regulations of the United States of America, protected information transferred to the Government of the United States of America by the Government of the Russian Federation shall be treated as foreign government information transferred in confidence and shall be provided with appropriate protection from disclosure. In accordance with the legislation of the Russian Federation, protected information transferred by the Government of the United States of America to the Government of the Russian Federation shall be handled as official, restricted-distribution information and shall be provided with the appropriate protection from disclosure.

- Each Party shall limit access to protected information to persons who require access to perform a lawful and authorized government function.

ARTICLE 7

1. Nuclear material, moderator material, equipment (except for sensitive nuclear facilities, sensitive nuclear technology and major critical components) and components may be transferred for applications consistent with this Agreement.

2. Sensitive nuclear facilities, sensitive nuclear technology and major critical components may be transferred under this Agreement if provided for by an amendment to this Agreement.

3. Nuclear material may be transferred for use as fuel for reactors, in experiments, for irradiation in reactors, for enrichment to less than 20 percent in the isotope uranium-235, for conversion or fabrication, for temporary storage for purposes of further use, for use as samples, standards, detectors, targets, or for other purposes as agreed by the Parties that are consistent with the provisions of this Agreement and with the laws and regulations of the United States of America and the legislation of the Russian Federation.

4. Nuclear material, moderator material, equipment or components transferred from the territory of the United States of America to the territory of the Russian Federation, or from the territory of the Russian Federation to the territory of the United States of America, whether directly or through a third country, shall be regarded as having been transferred pursuant to this Agreement only upon confirmation, by the relevant competent authority of the recipient Party to the relevant competent authority of the supplier Party, that such nuclear material, moderator material, equipment or components will be subject to this Agreement.

ARTICLE 8

1. Plutonium, uranium-233 and high enriched uranium, transferred pursuant to the provisions of this Agreement or used in or produced through the use of nuclear material, moderator material, or equipment transferred, shall only be stored in a facility agreed upon by the competent authorities of the Parties.

2. Nuclear material, moderator material, equipment, and components transferred pursuant to this Agreement and any special fissionable material produced through the use of any nuclear material, moderator material, or equipment transferred shall be transferred only to authorized persons, and shall not be transferred beyond the territorial jurisdiction of the recipient Party unless the Parties agree otherwise.

ARTICLE 9

Nuclear material transferred pursuant to this Agreement, and nuclear material used in or produced through the use of nuclear material, moderator material, or equipment transferred, may be altered in form or content only if the Parties agree. The Parties agree that conversion, enrichment to less than twenty percent in the isotope uranium-235, fabrication of low enriched uranium fuel, irradiation or further irradiation, post-irradiation examination, and blending or downblending of uranium to produce low enriched uranium, are permissible alterations in form or content for purposes of this Agreement.

ARTICLE 10

For the purposes of implementing the rights specified in Articles 8 and 9 of this Agreement with respect to special fissionable material produced through the use of nuclear material or moderator material transferred pursuant to this Agreement, and not used in or produced through the use of equipment transferred pursuant to this Agreement, such rights shall in practice be applied to that proportion of special fissionable material produced that represents the ratio of transferred nuclear material or moderator material used in the production of the special fissionable material to the total amount of nuclear material or moderator material so used, and similarly for subsequent generations. The exact procedure for establishing the aforementioned proportion shall be agreed upon by the competent authorities of the Parties.

ARTICLE 11

1. Adequate physical protection, as specified in paragraph 2 of this Article, shall be maintained with respect to nuclear material and equipment transferred pursuant to this Agreement and special fissionable material used in or produced through the use of nuclear material, moderator material, or equipment transferred.

2. With respect to the obligation in paragraph 1 of this Article, each Party shall apply physical protection measures in accordance with its national laws and regulations at levels at least equivalent to the recommendations published in IAEA document INFCIRC/225/RevA entitled "The Physical Protection of Nuclear Material and Nuclear Facilities," and in subsequent revisions of that document accepted by both of the Parties, and the provisions of the Convention on the Physical Protection of Nuclear Material of October 26, 1979 as well as amendments to that Convention in the event of their entry into force for both Parties.

3. The Parties shall consult at the request of either Party regarding the physical protection measures maintained pursuant to this Article.

4. The Parties shall keep each other informed through diplomatic channels of those organizations or authorities responsible for ensuring levels of physical protection for nuclear material and facilities in their territory or under their jurisdiction or under their control and responsible for coordinating response and recovery operations in the event of unauthorized use or handling of nuclear material subject to this Article. Each Party shall also keep the other Party informed through diplomatic channels of the designated points of contact within its national authorized organizations for purposes of cooperation on matters involving transportation of nuclear material from the territory of its country to the territories of other countries and other matters of mutual concern.

5. The provisions of this Article shall be applied in such a manner as to avoid undue interference in the Parties' activities in the field of peaceful use of nuclear energy and to be consistent with prudent management practices required for the safe and economically justified conduct of their nuclear programs.

ARTICLE 12

Nuclear material, moderator material, equipment and components transferred pursuant to this Agreement and nuclear material used in or produced through the use of any nuclear material, moderator material, equipment or components transferred shall not be used for any nuclear explosive devices, for research on or development of any nuclear explosive devices, or for any military purpose. As specified in paragraph 9 of Article 1, military purposes shall not include provision of power for a military base drawn from any power network, production of radioisotopes to be used for medical purposes in a military hospital, and other similar purposes as may be agreed by the Parties.

ARTICLE 13

1. Nuclear material transferred to the Russian Federation pursuant to this Agreement and any other nuclear material used in or produced through the use of nuclear material, moderator material, equipment, or components transferred shall be subject, to the extent applicable, to the Agreement between the Union of Soviet Socialist Republics and the International Atomic Energy Agency for the Application of Safeguards in the Union of Soviet Socialist Republics of February 21, 1985, and the Additional Protocol that entered into force October 16, 2007 between the Russian Federation and the International Atomic Energy Agency to the Agreement between the Union of Soviet Socialist Republics and the International Atomic Energy Agency for the Application of Safeguards in the Union of Soviet Socialist Republics.

2. Nuclear material transferred to the United States of America pursuant to this Agreement and any other nuclear material used in or produced through the use of nuclear material, moderator material, equipment, or components transferred shall be subject, to the extent applicable, to the Agreement between the United States of America and the IAEA for the Application of Safeguards in the United States of America of November 18, 1977, and an Additional Protocol thereto in the event of its entry into force.

3. The Parties understand that paragraphs 1 and 2 of this Article do not require that the nuclear material referred to in those paragraphs must be in a facility that appears on the recipient Party's list of facilities that are eligible for IAEA safeguards.

4. In the event that the IAEA safeguards agreement referred to in paragraph 1 or in paragraph 2 of this Article is not being implemented, the Parties shall consult and establish a mutually acceptable alternative to that safeguards agreement consistent with their status as nuclear weapon States Parties to the NPT.

5. Each Party shall establish and maintain a system of accounting and control of nuclear material transferred pursuant to this Agreement and nuclear material used in or produced through the use of nuclear material, moderator material, equipment, or components transferred. The procedures for this system shall be those specified in the IAEA safeguards agreement referred to in paragraph 1 or 2 of this Article for the Party concerned, or, if the Parties agree, those specified in any revised version of the relevant safeguards agreement.

6. Upon the request of either Party, the other Party shall inform the requesting Party of the status of all inventories of nuclear material subject to this Agreement.

ARTICLE 14

If an agreement between either Party and another nation or group of nations provides such other nation or group of nations rights equivalent to any or all of those provided for under Article 8 or Article 9 of this Agreement with respect to nuclear material, moderator material, equipment or components subject to this Agreement, the Parties may, upon request of either of them, agree that the implementation of any such rights will be accomplished by such nation or group of nations.

ARTICLE 15

The Parties shall endeavor to avoid taking any actions that would negatively affect cooperation under this Agreement. If either Party does not comply with the provisions of this Agreement, the Parties shall promptly hold consultations on the problem, it being understood that the other Party shall have the right to temporarily suspend or to cease further cooperation under this Agreement.

ARTICLE 16

The Parties shall consult at the request of either Party regarding the implementation of this Agreement. The Parties also intend to consult regarding the development of further cooperation in the field of peaceful use of nuclear energy.

ARTICLE 17

The Parties shall consult, with regard to activities under this Agreement, to identify the world-wide environmental implications arising from such activities and shall cooperate in protecting the international environment from radioactive, chemical or thermal contamination arising from peaceful nuclear activities under this Agreement and in related matters of health and safety.

ARTICLE 18

Any dispute between the Parties concerning the interpretation or application of the provisions of this Agreement shall be promptly discussed by the Parties with a view to resolving that dispute through consultations or negotiations.

ARTICLE 19

The competent authorities of the Parties shall work out appropriate arrangements in order to effectively apply the provisions of this Agreement as they relate to nuclear material, moderator material, equipment and components subject to this Agreement. The principles of fungibility and equivalence shall apply to nuclear material subject to this Agreement. Detailed provisions for applying these principles shall be set forth in a relevant agreement.

ARTICLE 20

1. This Agreement shall enter into force on the date of the last written notification of completion by the Parties of their internal procedures necessary for its entry into force and shall remain in force for a period of 30 years. The term of this Agreement may be extended by mutual agreement of the Parties. This Agreement may be terminated by either Party by sending the relevant written notice to the other Party. In that case the Agreement shall terminate one year from the date of such notice.

2. Notwithstanding the suspension or termination, including by expiration, of this Agreement or of any cooperation hereunder, Articles 8, 9,10,11,12 and 13 of this Agreement shall continue in effect so long as any nuclear material, moderator material, equipment or component subject to these Articles remains in the territory of the United States of America or the Russian Federation or under the jurisdiction or control of either Party anywhere, unless such item is no longer usable for any nuclear activity relevant from the point of view of international safeguards or has become practicably irrecoverable, or unless otherwise agreed by the Parties.

DONE at Moscow, this 6th day of May, 2008, in duplicate, each in the English and Russian languages, both texts being equally authentic.