Nonproliferation and the Global Nuclear Renaissance: Bridging the Gap

The Sam Nunn Bank of America POLICY FORUM

Georgia Institute of Technology

The Sam Nunn School of International Affairs
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Executive Summary

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- Keynote address: Dr. Tariq Rauf, Head of the Verification and Security Policy Coordination, International Atomic Energy Agency
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Executive Summary

With growing energy needs, rising oil prices, and mounting concerns over climate change, there is a renewed interest in expanding the use of nuclear power both in the United States and around the world. Nuclear power can play an important role in addressing current and future energy needs, but if the expansion of nuclear energy is not managed properly, it could result in the spread of nuclear weapons technology to dozens of countries around the world.

The nuclear proliferation risk arises because the same technology used to enrich uranium for use as a fuel in nuclear power plants can also be employed to enrich uranium to make a nuclear bomb. While, *de jure*, the Nuclear Nonproliferation Treaty allows countries that have met their nonproliferation obligations to enjoy the benefit of enrichment, *defacto*, it will be a much more dangerous world if the means to make nuclear weapons materials is spread to dozens of countries. Thus, the challenge is to meet growing energy needs without increasing the threat of nuclear nonproliferation and catastrophic nuclear terrorism.

To address this dilemma, International Atomic Energy Agency (IAEA) Director General Mohamed ElBaradei has challenged the international community to create multilayered backup nuclear fuel supplies so countries can have the confidence that they will have uninterrupted delivery of fuel in case of market disturbances or political disagreements with their fuel suppliers without resorting to national enrichment programs. Among the options being pursued are internationally controlled backup fuel supplies, nationally held strategic stockpiles, multinational fuel centers and control over fuel cycle facilities, fuel banks and leasing arrangements, and private sector insurance programs that could address fuel supply interruptions. By creatively integrating technical, commercial, and diplomatic solutions, the IAEA and others — including government leaders from Asia, Europe, Russia, and the United States, the World Nuclear Association, and the nonprofit Nuclear Threat Initiative — are exploring new international fuel assurances initiatives strong enough to withstand potential supply disruptions.

Leading experts discuss — from technological, economic, political, and strategic perspectives — new challenges and practical opportunities facing the global political and business communities for establishing fuel assurances to bridge the gap between growing interest in peaceful nuclear energy use and proliferation concerns.

Morning Session

8:00-9:00	Registration and Continental Breakfast
9:00-9:45	Introductions and Welcoming Remarks
	Dr. Sue Rosser, Dean, Ivan Allen College, Georgia Institute of Technology
	Former Senator Sam Nunn, Distinguished Professor, The Sam Nunn School of International Affairs
9:45-10:45	Keynote Address: Dr. Tariq Rauf, Head of Verification and Security Policy Coordination, International Atomic Energy Agency, "The prospects for an assured multilateral mechanism for nuclear fuel supply and spent fuel management"
	Special video presentation: Dr. Mohamed ElBaradei, Director General, International Atomic Energy Agency
11:00-12:15	Panel Discussion: "Contending with the proliferation challenges of an emerging nuclear renaissance"
	Mr. Jeff Combs, President, Ux Consulting
	Dr. Raymond J. Juzaitis, Department Head, Department of Nuclear Engineering, Texas A&M University
	Mr. Richard J. K. Stratford, Director, Office of Nuclear Safety and Security Affairs, U.S. State Department
	Dr. Ferhat Aziz, Director, Bureau of Cooperation, Legal, and Public Relations, Nuclear Energy Agency of Indonesia
	Moderator: Mr. Charles B. Curtis, President and Chief Operating Officer, Nuclear Threat Initiative
1:30-2:15	Ivan Allen Jr. Prize for Progress and Service
	Honored Recipient: Mr. Ted Turner, Chairman, Turner Enterprises

Afternoon Session

2:30-4:00	Panel Discussion: "Policy and technical recommendations for strengthening nuclear assurances and verification today"
	Dr. Thomas E. Shea, Senior Policy Advisor, Pacific Northwest National Laboratory, Department of Energy
	Admiral Frank L. Bowman (Retired), President and Chief Executive Officer, Nuclear Energy Institute
	Mr. Nabil Fahmy, Ambassador, Arab Republic of Egypt to the United States
	Dr. William Potter, Director, James Martin Center for Nonproliferation Studies, Monterey Institute of International Studies
	Moderator: Ms. Laura S. H. Holgate, Vice President for Russia/New Independent States (NIS) Programs, Nuclear Threat Initiative
4:00-4:15	Closing Remarks: "The way forward," Former Senator Sam Nunn

Former Senator Sam Nunn, Distinguished Professor, The Sam Nunn School of International Affairs, Georgia Institute of Technology

The purpose of the Sam Nunn/Bank of America Policy Forum is to gather together informed, innovative, and clear thinkers to discuss the most pressing issues facing our world. Nothing will move our government faster in the right direction than a public well-armed with the facts. That is not an original thought – that is the defining idea of democracy. It is also the founding idea of this Forum. We are bringing together experts on technology, public policy, and international affairs to take on some of the most important issues we face – to analyze them, debate them, and ultimately help solve them.

History will judge our generation largely on whether and how we are able to respond to the greatest challenges facing mankind. We must develop technologies and policies that make it possible to meet basic human needs – food, water, electricity, clothing, shelter, health (including the health of our environment) and security. We must maximize the positive potential of our technology and minimize and mitigate the negative:

- Our weapons technology can be used to deter wars – or to start them.
- Our biological technology can be used to make vaccines – or build weapons of mass destruction.
- Our information technology can be used to spread knowledge and promote commerce and bring people together from around the world – or for acts of sabotage or terror.
- Our nuclear technology can be used to supply a clean, affordable source of power to a world that badly needs more energy and less carbon – or to enrich uranium and reprocess plutonium to build nuclear weapons and enable catastrophic terrorism.

This Forum will consider how to avoid the perilous side of nuclear technology while enjoying its benefits. I believe that the gravest danger in the world today is the threat of use of a weapon of mass destruction by a terrorist group who does not have a return address and who cannot be deterred. Preventing the spread and use of nuclear weapons and weapons-usable nuclear material should be the top security priority and the central organizing security principle of the 21st century.

Today, the risk of a nuclear weapon being used is growing, not receding. There are terrorist groups seeking nuclear weapons. There are tons of poorly-secured nuclear bomb-making materials spread around the world. The know-how for making these weapons is spreading rapidly. The number of nuclear weapons states – and aspiring nuclear weapons states – is increasing. A world with 12-20 nuclear powers will be exponentially more dangerous than the world we have today – and terrorists' chances of getting nuclear weapons and materials grows dramatically with each new country that acquires them.

In addition, with the growing interest in nuclear energy, more and more countries are seeking the capacity to enrich uranium – ostensibly to use legitimately as fuel for nuclear energy, but this would also give many additional countries the capacity to move quickly to a nuclear weapons program if they chose to do so. The bottom line: the accelerating spread of nuclear weapons, nuclear know-how, and nuclear material has brought us to a nuclear tipping point in an age of terrorism.

Deeply concerned about these growing dangers, George Shultz, Bill Perry, Henry Kissinger and I published an op-ed in January 2007 in *The Wall Street Journal,* arguing that the United States should lead the world to the next stage in global security – to a solid consensus for reversing reliance on nuclear weapons across the globe, keeping them out of terrorists' hands, and ultimately ending them as a threat to the world.

We urged the leaders of countries with nuclear weapons to turn the goal of a world without nuclear weapons into a joint enterprise, and we outlined concrete steps for achieving this vision – steps which include changing nuclear force postures in the United States and Russia, securing nuclear weapons and materials around the world to the highest standards, phasing out highly enriched uranium in commerce, and stopping the production of fissile material for weapons purposes. The steps also focus prominently on the subject of this Forum: developing a multinational approach to civil nuclear fuel production – to create incentives to limit the number of countries that have the capacity to enrich uranium and potentially build a nuclear weapon or make it more likely that terrorists will gain control of weapons materials.

This vision of a world free of nuclear weapons – and the steps to lead us there – has led to the birth of the Nuclear Security Project. Shultz, Perry, Kissinger, and I are guiding this Project, with the Nuclear Threat Initiative (NTI) coordinating the work of the principals and managing the implementation of the Project in partnership with Hoover Institution at Stanford University.

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Whether eliminating highly enriched uranium stockpiles, supporting the International Atomic Energy Agency's activities, or informing the public of the all-too-real threat of nuclear terrorism, NTI has been able to achieve reductions in nuclear risks over the last eight years through projects that include the World Institute for Nuclear Security and financial support to the IAEA for an international fuel bank (this uranium stockpile would be available as a last-resort fuel reserve for nations that would accept a guaranteed supply of nuclear fuel as a cheaper and safer alternative rather than building the indigenous capacity to make it).

Nuclear proliferation risks arise because the same technology used to enrich uranium for legitimate reasons – peaceful use as fuel in nuclear power plants – can also be employed to enrich uranium to make a bomb. What is the role of the United States in these challenges? Can we continue to keep thousands of weapons on hair-trigger alert, Cold War status and still lead the world in preventing new weapons states and avoiding proliferation and catastrophic terrorism? Can the world develop nuclear fuel supply assurances that will encourage and incent additional countries who seek nuclear power not to begin their own indigenous enrichment capabilities?

The bottom line is this: the world is in a race between cooperation and catastrophe, and this is a race that we must win. Our panelists are well-known experts -- highly regarded around the globe – and I am confident that the discussions held during this Forum will help guide us toward a world of promise and away from a world of peril. This is our opportunity. This is our challenge.

Dr. Mohamed ElBaradei, Director General, International Atomic Energy Agency

The Sam Nunn / Bank of America Policy Forum is an important venue in which to discuss the challenges the international community faces in the areas of peace and security. Global security during the Cold War era was based on the concepts of Mutually Assured Destruction and Balance of Terror. While the world was relieved and euphoric at the end of the Cold War, the new world order envisioned by the international community was not to be.

New drivers of instability are now more diffused and complex, characterized by: 1) the growing gap between the rich and the poor, 2) the lack of regard for the sanctity of human life, and 3) the lack of mechanisms for conflict resolution. In addition, there is a new nuclear world order – a dangerous and complex new era where more and more countries are interested in acquiring the sensitive nuclear technologies that allow for the swift development of nuclear weapons. With nine nuclear weapons states, 27,000 intact warheads, and an increasing interest by extremist groups in acquiring nuclear weapons capabilities, the challenges facing the international community are daunting and require bold visions and bold actions.

Senator Sam Nunn and his colleagues bring a bold vision to the challenges of the new nuclear world order: a world without nuclear weapons. The need persists to strengthen the nuclear nonproliferation regime (NPT) to parallel the pathway to zero nuclear weapons in order to prevent additional countries from acquiring nuclear weapons capabilities. In order to strengthen the NPT, the following four actions are needed: 1) greater multilateral control over the more sensitive aspects of the nuclear fuel cycle (enrichment and reprocessing capabilities), 2) an international fuel bank managed by the IAEA or another international institution as a supplier of last support, 3) enhanced capabilities of the IAEA verification system, and 4) better protection of nuclear materials and facilities.

The last action – better protection of nuclear materials and facilities – is an area advanced by the work of Senator Nunn and the Nunn-Lugar and Nuclear Threat Initiatives. Senator Nunn and the Policy Forum participants should be lauded for thinking outside of the box and for the bold vision and bold action being put forth at the forum. Their deliberation will be an important step toward a world free from nuclear weapons; toward a world that does not depend on nuclear weapons for its security; toward a world that is more humane, more just, and fair.

Dr. Tariq Rauf, Head of Verification and Security Policy Coordination, International Atomic Energy Agency

The current challenge facing the IAEA is to preserve the vitality of the global nuclear nonproliferation regime, the pillars of which are: 1) nuclear nonproliferation, 2) nuclear disarmament, and 3) peaceful use of nuclear energy. In today's world the energy gap is large - in Africa the average per capita consumption of energy is only 800 kWh per year, while in Organization for Economic Cooperation and Development (OECD) countries the average rate of consumption is 8,000 kWh per year. This large gap is an indication of the need for more energy around the globe so that people can feed, clothe, and provide for themselves.

Worldwide there are currently 430 nuclear power plants, with 30 more plants under construction and expansion centered in the Far East and South Asia. While 16% of the world's energy comes from nuclear power – a percentage that has remained constant over the past 20 years – there is growing momentum to increase the percentage of nuclear power in the world's global energy mix. While some studies predict there to be 23 additional countries with nuclear power capabilities by 2030, the IAEA believes there are 11 countries serious about developing nuclear power capabilities by 2020. Whichever the case, nuclear expansion might mean the further spread of nuclear fuel cycle facilities. Where will the fuel come from to power these new reactors? There are three fuel sources: 1) Low Enriched Uranium (LEU), 2) natural uranium, and 3) mixed oxide fuels (for those states using reprocessed plutonium).

One option regarding fuel supply is for existing suppliers to continue to provide the market with fuel. However, it seems more likely that most states will want to develop their own sensitive fuel cycle capabilities for a variety of reasons ranging from sovereignty rights to technology demonstration and development. Our challenge is to see if we can come up with a new multilateral framework for nuclear energy that minimizes the need for additional players to develop sensitive nuclear fuel cycle facilities; ensures that any new facilities are multilateral from inception; converts existing facilities over time from solely national to multilateral auspices; and establishes an international, verifiable treaty banning further production of nuclear material for weapons purposes.

The focus in developing this new fuel cycle framework is on enrichment and reprocessing technology, and the primary concern is how to balance states' reliance on these technologies with ensuring the peaceful use of nuclear energy. In this context, IAEA Director General ElBaradei has since the fall of 2003 been proposing a new multilateral framework for the utilization of nuclear energy. Within this new framework, the following conditions apply: 1) approaches through the IAEA have to be on a non-discriminatory basis, 2) participation must be voluntary, 3) states must be free to choose their fuel cycle options, and 4) the framework must not compromise the rights of states. The IAEA has different proposals on the table to consider, ranging from a 2005 proposal in which the U.S. would donate 17.5 metric tons of Highly Enriched Uranium (HEU) no longer needed for military purposes to be down-blended to LEU and made available as part of a fuel bank for states that rely on the market – to a proposal by Russia to set up a fuel bank in Siberia with 120 metric tons of LEU provided by Russia that would be at the disposal of the IAEA for supply as a last resort.

In an unreleased 2007 IAEA report, Director General ElBaradei concluded that the framework for the assurance of fuel supplies is a three-step process. Step 1 is a state's reliance on the existing global market arrangements for nuclear fuel supply. Should states be denied nuclear fuel or suffer a supply disruption due to political reasons unrelated to nonproliferation and commercial factors, then they would move to Step 2 – legally binding assurances of fuel from suppliers of enrichment services and governments. Step 3 is the last resort option – a physical LEU reserve under IAEA control, or a virtual LEU reserve based on legal commitments by governments.

With regard to criteria for fuel supply assurances, the following will apply: 1) supply will be open to participation by all IAEA member states, 2) criteria will need to be the same for all states and applied in a consistent manner without prejudice, 3) the IAEA Board of Governors will establish supply criteria in advance, and 4) once a request for supply is received by the IAEA, the IAEA Director General will decide whether the country meets the supply criteria and whether to trigger the fuel supply. With regard to international fuel cycle centers, the IAEA believes the fuel cycle centers that will provide the highest level of assurances will be those where a certain quantity of nuclear material has been pledged to the IAEA and has become the property of the agency – or there is a very credible, prompt mechanism available for the agency to have access to these materials.

In conclusion, the potential benefits of a new multilateral fuel assurance framework are: 1) it facilitates the continued and expected increased use of nuclear energy for peaceful purposes, 2) it provides the benefits of cost-effectiveness and economies of scale in the use of nuclear technologies, and 3) it provides additional assurances to the international community that the sensitive parts of the civilian nuclear fuel cycle are less vulnerable to misuse for non-peaceful purposes.

Question & Answer Session with Tariq Rauf

Q: Involvement in international fuel assurance programs seems to deviate from the IAEA's charter role regarding nuclear energy. What are the steps the IAEA needs to take in this transition?

A: If one examines the statute of the IAEA dating back to 1957, it clearly envisages a role for the IAEA in working with its member states in providing access to nuclear technology and nuclear fuels. The 2007 report referred to previously cites multiple statutes which give the IAEA the legal authority to develop multilateral fuel assurance frameworks. In fact, over the past 30-40 years the IAEA has been facilitating the supply of nuclear fuel among its member states. The agency does have experience in this area, although we do not have experience in setting up, running, and managing a nuclear fuel bank. This is something that we are looking into and as we move forward on this the Director General will have more to say on how the agency would manage and run such fuel banks.

Q: Are the approaches to multilateral fuel assurances under consideration comprehensive and effective enough? Is there sufficient support from member states for these approaches or are there unaddressed concerns?

A: The discussion between the IAEA and its member states has so far been comprehensive. However, the effectiveness of these approaches is yet to be determined. During the past year, discussions between developed and developing countries have been increasingly polarized. Developing countries see these approaches as attempts by developed countries to restrict access to sensitive nuclear fuel cycle technology. Some of the countries currently interested in developing nuclear power are not convinced that they can rely on the market for fuel; therefore, they would like to keep their options open. However, the UAE recently announced its plans for civil-nuclear power and its intentions not to develop sensitive nuclear fuel cycle technology. Whether other developing countries will follow we don't know, but we believe that if we are able to demonstrate to developing countries a credible multilateral framework which would address their needs – together with an IAEA-controlled fuel bank of the type Senator Nunn and NTI are proposing – it will make a very powerful argument for countries to rely on the market and rely on the multilateral framework. What the Director General has said to the IAEA's Board of Governors and member states is that if they are able to give him an effective multilateral framework, then he can go out and ask countries that would still like to develop a sensitive nuclear fuel cycle facility for a reactor fleet of perhaps only one or two reactors the question of why they are investing such a high level of capital in a capability that is clearly uneconomical.

Q: What is the stance of the IAEA regarding nuclear waste disposal?

A: IAEA Director General Mohamed ElBaradei has been vocal on the issue of nuclear waste. The IAEA and its member states have performed a number of studies on different models for regional and international nuclear waste storage sites. There is currently a public perception problem regarding nuclear waste. No public in any country is willing to accept nuclear waste from another country. It will take greater education and scientific development to move this issue forward in the future.

Q: Could you clarify the degree to which nuclear reactors still use natural uranium fuel? Does the LEU program address this type of fuel?

A: Canadian CANDU-designed reactors still use natural uranium. These reactors do not require enriched uranium, although the Canadian nuclear industry is working on a slightly more advanced design of a CANDU reactor that will use slightly enriched uranium (enriched 1.2%). Most reactors in the world are Light Water Reactors (LWRs) which use LEU – typically enriched to 2.5-5%. For the international fuel bank initiative, the IAEA is looking at enrichment levels of 4.95%, which is the industry standard. The enrichment level for nuclear weapons is 90-95%. The bulk of the effort to enrich uranium is in enriching the material from 0.7% (natural uranium) to LEU levels. Bumping it up to weapons-grade levels takes relatively less effort.

Panel #1 Moderator: Mr. Charles B. Curtis, President and Chief Operating Officer, Nuclear Threat Initiative

The international community has to address the dangers of the atom and the nuclear legacy of the last 50 years more effectively and more comprehensively in order for the world to have a bright future. We should harvest the benefits of the atom for the betterment of mankind rather than its destruction.

In what has come to be known as "The Atoms for Peace Speech" given by President Dwight D. Eisenhower to the United Nations over 50 years ago, the following question was posed: "How to find a way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life." President Eisenhower's speech has led to the nonproliferation consensus and the NPT, on which the world relies to constrain nuclear weapons capabilities while sharing the fruits of nuclear learning. It is the responsibility of the morning panel to help answer the question posed by President Eisenhower and address further the current dangers of the atom.

Mr. Jeff Combs, President, Ux Consulting

Since 2004 uranium price-performance has greatly increased, exceeding the increase in oil prices during the same time period. Uranium is the hottest commodity in the world, reaching a value of approximately $137 U.S. dollars per pound in 2007. While uranium prices have dropped recently (approximately $75 dollars per lb.), the long-term price projection is still high. Since 2004, enrichment prices also have increased, although not nearly as much as uranium prices.

UX Consulting forecasts regarding nuclear power are more ambitious than even those of the IAEA. Currently, 31 countries operate 440 reactors with a combined 375,643 MWe capacity. By 2030 there is the potential for 58 countries to be operating 642 reactors with a total capacity of 650,736 MWe (an increase of 73%). China, Russia, and India are the center of the nuclear renaissance and all three states have ambitious expansion plans for increasing their nuclear energy capacities. In addition, states such as South Africa and the Ukraine also have nuclear power expansion plans, and Turkey and Egypt have plans to build nuclear reactors by 2015 and 2018, respectively. World-wide there are 22 new reactor orders; construction on 10 reactors has begun and 5 have entered into operation. In contrast, the U.S. has placed no new orders, despite expressing interest in up to 30 new reactors. There are several enrichment firms that are expanding their nuclear operations in order to meet the new uranium prices and demands, including – but not limited to – URENCO (Germany, Britain, and the Netherlands), AREVA (France), TENEX (Russia), and the China National Nuclear Corporation (CNNC).

Ux Consulting sees the demand for enrichment in the future continuing to increase. URENCO and Russian centrifuge technology will handle most of the demand and are considered the Boeing and Airbus of the centrifuge world. In addition, while technologies such as gaseous diffusion will be phased out, there will be growth in other areas - such as Silex laser technologies - illustrating that enrichment demands in the future will be met. Regarding the future of uranium supply and demand, there will be enough uranium to meet the world's range of demands through 2020. The reason uranium prices have risen so high recently is due to the fact that new production has not kept up with rising demand.

In conclusion, since the end of the Cold War the down-blending of nuclear weapons material has proven to be a useful source of energy and a productive manner in which to secure and dispose of nuclear weapons material. Materials from obsolete weapons/warheads have been blended down to reactor levels (1kg of weapons grade uranium = 50 kg of reactor fuel) and used for energy. This down-blending illustrates one of the real benefits of nuclear power: the fact that it can consume this former weapons material.

Dr. Raymond J. Juzaitis, Department Head, Department of Nuclear Engineering, Texas A&M University

The nuclear challenge has transitioned from the legacy challenges of the 20th century to the new threats of the 21st century. Whereas the legacy challenges in the past were grim, the challenges were traceable – while the U.S. and Russia had nuclear weapons, both sides knew approximately where the weapons were, how many there were, and that there were technically-based protocols for establishing confidence in arms control agreements. However, the world is proceeding into a future where the nature of the nuclear threat is very different: nuclear power is spreading throughout the world and there is greater free transit of nuclear materials across commercial markets. These new threats call for a technological response that demands greater global awareness of all nuclear materials.

The vital question is: how do you apply technologies to verify nuclear arms agreements and/or to verify that nuclear materials are not getting into the wrong hands? The answer is two-fold: 1) secure the entire nuclear fuel cycle – from mining through reprocessing and disposition. Three things are required in order to secure the nuclear fuel cycle: a) technologies which will ensure intrinsic proliferation resistance (e.g. advanced reactor fuels). These are reactor designs that have inherent proliferation resistant characteristics or that have fuel characteristics that make it particularly difficult to process fuel for use in an explosive device; b) advanced safeguards technology (reducing uncertainty, improving costs, doing things more efficiently, and effectively); and c) movement on societal, governmental, and organizational issues (e.g. international fuel supplies and international take-back of spent nuclear fuel).

However, focusing exclusively on the nuclear fuel cycle is not enough. Nuclear materials are too ubiquitous to be localized solely where there are reactors, enrichment facilities, and the like. Thus, the second answer is: 2) nuclear materials are available everywhere – they are in constant commercial transit, and therefore the following are needed: a) the development of technologies to completely secure all legacy materials and facilities, including a greater global awareness of all transit and nuclear materials; b) advanced border security (e.g. radiation detection); and c) advanced detection and monitoring technologies – it is important to understand the huge volume of information that is coming from these monitoring and sensing networks. Knowledge discovery and precision intelligence are important for integrating information from all sensors in order to create estimates of not only where the material is at any given moment as it is being stored, transported, or used, but also in answering the question of how far a state is away from being able to produce a nuclear weapon.

Application of new technologies toward ensuring greater nuclear security also can assist the international community in applying Additional Protocols and in the inventorying of materials within reactors. While safeguards technology involves design constraints due to the complexities of the implementation environment (including functionality, usability, and reliability), Additional Protocols (attempting to assess whether there are undeclared activities in a given country) offer a great opportunity to implement a broader set of technologies. There is also the challenge posed by operating reactors and the inventory of materials within reactors. Less is understood about the fuel once it enters the core of a reactor. There are technologies under development (such as Antineutrino radiation) that can penetrate to the core of an operating nuclear reactor. In the case of Antineutrino detection, this technology allows inspectors to infer the amount of plutonium built up in the core of a nuclear reactor. These types of tools can allow real-time, unattended monitoring of power in reactors as well as reveal how the materials build up and are burned up.

Ultimately the integration of all our nonproliferation and homeland security efforts, as combined with more intense international cooperation, can establish a multi-layered defense against nuclear terrorism. At each level of this defense and depth barrier, there are technologies that need to be optimized for the given purpose that they are deployed. Not only do they need to improve detection, but these technologies also have to be designed to be used in commercial environments. Just because you can detect a neutron or a gamma ray coming out of a truck in the Holland Tunnel doesn't mean you should shut down the Holland Tunnel. And, in fact, those challenges are very significant because this kind of multilayered defense needs to be deployed in a way that makes it almost transparent to the public.

Dr. Leonardo J. Sobehart, Professor of Nuclear Engineering, Balseiro Institute of the National University of Cuyo

The IAEA Director General has for some time defended the creation of mechanisms with the objective of guaranteed access by all nations to nuclear fuel and reactor technology (with the ultimate goal of bringing sensitive aspects of the nuclear fuel cycle under multinational control). These mechanisms freeze access to nuclear technology so that it is difficult to produce material for nuclear weapons. This kind of solution inevitably impinges upon the right of Non-Nuclear Weapon States to have access – without discrimination – to nuclear technologies, as guaranteed by Article IV of the NPT.

A major point of contention for Argentina regarding these mechanisms rests with striking an adequate balance between the right to develop nuclear technology – and thus improve the quality of life for Argentineans – and the peace guarantees which help bring safety and security to the international community. Argentina's stance on this issue is two-fold: 1) this balance between a nation's rights and peace guarantees was previously reached through the NPT – what is legally condemnable is the use of nuclear technology contrary to the NPT's stated goals and purposes, and 2) the international system to prevent proliferation is represented by the NPT and other regional agreements. If these agreements are not enough, existing agreements need to be reinforced in the forms of safeguards and Additional Protocol. The international community must be extremely prudent in not sending a negative message to the world by restricting the use and/or ownership of technology. These negative acts could strengthen the desire of several nations to have their own nuclear programs, even though these nations may have more urgent issues needing attention.

The world is extremely diverse, containing regions with many different natural and human resources, not to mention different cultural values. It's becoming almost impossible to bring the nations of the world together into a single agreement, thus making necessary an increase in the number of regional agreements. In South America, the need for integration exists in order to satisfy the energy requirements of the region. South American integration is currently taking place between Argentina, Brazil, Uruguay, Paraguay, and Chile in their integrated electricity networks, and should take place between Argentina and Brazil in cooperation on new nuclear technology and uranium enrichment.

However, one can establish common criteria to serve as the basis for different solutions across the globe. In this sense, any system implemented to strengthen the non-proliferation regime should: 1) coordinate compliance by the IAEA, 2) allow states that are beginning a nuclear program because of electrical power needs to voluntarily decide how to cooperate to contract supply of fuels – with the IAEA providing a back-up supply of fuel through an international fuel bank, 3) encourage the principle of responsibility among nuclear technology-supplying nations to supply guaranteed enrichment and reprocessing services, 4) enable access to information on the capacity and project needs of these nations, 5) promote the expansion of comprehensive safeguard agreements, 6) use the United Nations Security Council in cases where nations are not fulfilling their obligations under the NPT, 7) promote programs that foster cooperation under IAEA safeguards agreements, and 8) reassure the inalienable right of nations to peaceful uses of nuclear power, including access to the complete nuclear fuel cycle.

Mr. Richard J.K. Stratford, Director, Office of Nuclear Safety and Security Affairs, U.S. State Department

While the unnecessary spread of sensitive enrichment and reprocessing technologies has been an issue for over 30 years, the real fear for the international community is the acquisition of nuclear weapons. In order to develop nuclear weapons, states need to acquire either HEU or separated plutonium. States acquire these materials either by receiving them from other countries or by successfully pursuing enrichment & reprocessing (E&R) capabilities.

The IAEA and the international community are discussing the multilateralization of the fuel cycle process as a way to address the fear of countries acquiring E&R capabilities in the pursuit of obtaining nuclear weapons. In these discussions the underlying thought is the same: if countries pursuing nuclear power are absolutely sure that nuclear fuel will be available and commercial or political reasons cannot prevent access, then hopefully they will not feel the need to pursue indigenous enrichment. However, the reprocessing issue is a more difficult one, as the greatest incentive for nations to pursue multilateral reprocessing is the ability to return the spent fuel to the originating country. The issue of returning spent fuel presents a political/waste-management problem for the originating country. Currently, France and, potentially, Russia are the only two countries willing to take back spent fuel.

There are several worldwide efforts being made to provide incentives to states to participate in the multilateralization of the fuel cycle process, including the July 3, 2007 Joint Declaration on Energy and Nonproliferation signed by Vladimir Putin and George W. Bush. This Joint Declaration provides incentives such as additional funding for IAEA assistance, help developing infrastructure, and additional training opportunities in the U.S. – in exchange for not pursuing E&R capabilities. In addition, the U.S. Department of Energy is currently down-blending 17.4 metric tons of HEU for an international fuel bank in the U.S. – completion expected in 2010 – which will produce low enriched uranium (LEU) worth over $800 million U.S. dollars.

Yet, fuel recipients in various country groups have voiced suspicion over these measures, due to the following: 1) voluntary involvement in these programs might at some point cease to be voluntary, 2) the Nuclear Supplier's Group (NSG) could become a cartel, and 3) ambiguity over the meaning of "good-standing" for member states (i.e. who gets the fuel)? The NSG has moved toward examining a more criteria-based approach to answering the last question about who gets the fuel, but this initiative too has run into road-blocks, the main one being differing opinions among NSG countries over the criteria that should be included in the check-list and how tough should it be to meet each criteria.

In conclusion, it is important to highlight the efforts currently underway to make fuel cycles more proliferation-resistant. Perhaps the biggest benefit of the Global Nuclear Energy Partnership (GNEP) is if it allows us and others to move to a fuel-leasing or a take-back program. The safest spent fuel is the spent fuel that does not remain in the recipient country.

Panel #1: Q&A: "Contending with the Proliferation Challenges of an Emerging Nuclear Renaissance"

Q: With regards to "beating the system" and using nuclear materials for weapons use, do we have engineers that are more advanced than the cheaters?

A: Dr. Raymond Juzaitis, Texas A&M University: The problem is not that the U.S. doesn't have great engineers, but that the U.S. does not have enough multidisciplinary engineers. With high detection capabilities, the real importance lies in putting together all of the information that is coming from the detection devices – to integrate the detector people with people who are also knowledgeable in gathering and analyzing information. What we face is the way we educate our professionals to be multidisciplinary so they can look at technical problems in a non stove-piped way and come up with transformational solutions.

Q: Are the plans of the international community to expand nuclear reactor programs unrealistic given the needs of some countries to replace existing technology and reactors? After so many years of not building new reactors, does the international community have the capacity to meet a nuclear renaissance?

A: Jeff Combs, Ux Consulting: There are definitely challenges to expansion because nuclear power has undergone such a long period of inactivity. The same also is true for uranium production and enrichment. The interesting issue is that countries can build enrichment capacity more quickly than they can build reactors, and they can build reactors quicker than they can find uranium and develop uranium mines. From a fuel standpoint, countries are always going to have enough fuel to meet the reactor growth, but they also will be facing several other obstacles to overcome if they are going to achieve projected rates of growth.

Q: Should greater efforts be undertaken by the IAEA and/or the nuclear industry to secure spent fuel and nuclear facilities in the U.S. and across the world against accidents, terrorist attacks, and other dangers?

A: Charles Curtis, NTI: Nuclear fuel is a very challenged and brittle fuel. As Chernobyl and Three Mile Island illustrate, nuclear fuel is vulnerable to nuclear safety accidents and terrorist incidents anywhere in the world. It has enormous front-end capital costs, and the international community does not yet have a reliable and generally acceptable solution to issues involving the back-end of the cycle. What counters the concern regarding nuclear fuel is the tremendous challenge that the world community has in addressing the primary fuels balances. Long-term, not only does the international community have to ask itself where are the 1.6 billion people who do not have electricity going to acquire it, but it also has to ask itself where are the 6-8 billion people that do depend on electricity in the mid-century going to get it? Combined with the challenge of global climate change, the international community has to say: "We have to do whatever we can to preserve a nuclear option." It is possible in the future that the international community discerns that nuclear power is a path that it cannot secure and that it cannot address in acceptable terms the environmental challenges of this technology. However, right now the international community is short of this conclusion. At this point we must do whatever we can to secure this option on the safest, soundest, most environmentally acceptable, and most security-assured terms that we can for future generations.

Q: The individuals and institutions that tend to back the rapid expansion of nuclear power frequently point to the development of inherently safe nuclear and proliferation-resistant reactors as support for their efforts. Yet, some industry experts state that while we may have pilot variances of these inherently safe reactors, we are not going to be in a position to export them anytime soon. If the nuclear renaissance moves forward, are we in fact likely to ship to developing countries older generation reactors that are neither inherently safe nor proliferation-resistant?

A: Dr. Raymond Juzaitis, Texas A&M University: There are plans that are not far from completion for nuclear reactors that use long-lived fuels and work for 30-40 years without needing refueling. This technology would allow the U.S. to send a country a reactor, have it used for a period of time, and then ship it back without having to use a fuel recycling infrastructure. While there are still technical challenges to meet regarding this technology, it shows that there are solutions to the problems that arise regarding proliferation-resistant reactors.

In addressing the overall nuclear renaissance, it is good that the U.S. is not rushing to deploy all of the current technologies. The current Bush administration's Global Nuclear Energy Partnership (GNEP) bases itself on the principles of matching the needs of a global nuclear energy market with the realization that the recycling technology that is prevalent today came from the nuclear weapons business. The recycling technology was optimized to separate plutonium and uranium. It is the wrong recycling technology. The United States needs to get in the middle of the world's scramble for nuclear energy if it is to have a say in it. It is difficult for any country, including the U.S., to fully understand the dangers of nuclear energy. Therefore, for the U.S. not to be playing the game and developing the new civilian technologies is just the wrong thing for the world.

Panel #2 Moderator: Ms. Laura S. H. Holgate, Vice President for Russia/New Independent States (NIS) Programs, Nuclear Threat Initiative

While there is very little new about how to reduce the risks that may attend the spread of global nuclear power, the important question to analyze is: what is different now that would allow these ideas to be put into effect?

There are three key changes that will galvanize the international support required to realize the solutions to these challenges: 1) technological changes: in terms of enrichment, the move is from gaseous diffusion plants that are large and which consume a lot of electricity, to smaller plants based on centrifuges and laser technologies. These new enrichment plants are more difficult to find, easier to build, and potentially more likely to spread. In terms of reprocessing, new U.S. attitudes have arisen. This has sparked new conversations on what needs to be done with the back-end of the fuel cycle; 2) the spread of weapons-related knowledge, as evidenced in part by the A.Q. Khan network; and 3) the two above-stated trends now take place within the context of apocalyptic terrorism, characterized by the interest in killing millions of people at once. Only a handful of technologies have the capacity to cause that type of destruction and nuclear is one of them.

Dr. Thomas E. Shea, Senior Policy Advisor, Pacific Northwest National Laboratory, Department of Energy

Currently there is a global drive toward greater use of nuclear power on the basis of energy security, economic development potential, global warming, and sound management for improvement in quality of life. The global expansion of nuclear power requires two actions: 1) increasing existing nuclear fleets both abroad and in the U.S. (current projections see a growth in the U.S. from 104 operating reactors to possibly 138); and 2) overcoming three major obstacles for countries that currently do not operate nuclear power plants (a. gaining access to technology, goods and services; b. preparatory activities needed in the way of infrastructure development; and c. developing the capacity to finance these large front-loaded investments). The challenge involved in the global drive toward greater use of nuclear power is in doing so while at the same time preventing accidents, proliferation, and terrorism.

In gaining access to technology, goods and services, non-nuclear power producing states need the following: 1) access to nuclear power plant technology – currently there are about six nuclear power plant designs that are common and safe; 2) fuel fabrication technology - designed and planned for the specific sight where the nuclear power plant will be located; 3) uranium mining, milling, conversion, and enrichment – all a part of mature commercial enterprises; and 4) spent fuel storage - as the spent fuel comes out of the reactors there are storage ponds next to the reactors where it is kept. Storage facilities are needed, and locations are not readily available in all countries.

As the international community begins to look toward the spent fuel legacy, one of the easiest things to do from a physical standpoint is one of the most difficult things to do from a political standpoint – to transport all spent fuel to international reception centers at convenient locations around the world. The spent fuel would then be stored under monitoring until the proper recycle technology is available, thus removing the legacy problem. As a long-term consideration for the expansion of nuclear power, this is really the way to go.

Currently, of available spent fuel disposition options, Transuranic Transmutation is the best long-term solution, because it includes the following: a) direct disposal; b) plutonium (Pu) Light Water Reactor (LWR) recycle (where plutonium is recycled into a replacement fuel and the waste goes through a vitrification process and then is put into a repository); and c) Transuranics Transmutation (this process separates out the uranium first, then other products, and the leftover "transuranics" are cooked until they are essentially gone. The produced waste then goes through the vitrification process and is put into a repository).

Currently in development is the concept of a Proliferation Resistant Institutional Arrangement – a transparent arrangement embedded within the IAEA that would assist the global drive toward greater use of nuclear power. Recognizing states' right to access technology, goods and services, infrastructure development, and finances, this arrangement matches supplier and user needs and allows any country to be a supplier or a receiver, depending upon individual needs. States that are otherwise concerned that they may not have access to the right technology, infrastructure, and financing will gain confidence. Under this type of arrangement, states that wish to be suppliers will have certain technical and contractual conditions to meet in order to qualify as a supplier, and states that wish to receive an assurance of supply of nuclear fuel will have certain conditions they have to meet before the matching process moves forward.

The following are five suggestions for strengthening proliferation resistance: 1) emphasize positive solutions that meet states' energy security needs in safe and secure ways; 2) focus on removing the spent fuel legacy by introducing an international network of spent fuel reception centers under IAEA extra-territorial arrangements early; 3) drive R&D towards reducing the infrastructure required for states to realize the benefits of nuclear power, especially in LWRs, and stimulate deployment arrangements that engage experienced utilities and regulatory authorities with new states; 4) continue cooperative R&D aimed at the separation and transmutation of transuranics, to be carried out as soon as possible by a limited number of states acting on behalf of all nuclear power users; and 5) develop, demonstrate, and deploy reactors for limited grid applications, emphasizing walk-away safety, no fresh fuel containing HEU or PU, and no refueling over the life of the reactor.

Admiral Frank L. Bowman (Retired), President and Chief Executive Officer, Nuclear Energy Institute

The world is approaching a crossroads regarding energy supply and electricity, with two potential futures: 1) a world in which we fail to supply the energy needed to ensure that the rest of the world's people are fed, sheltered, educated, and employed – a world in which children yet to be born are condemned to a life of poverty, misery, and sickness; or 2) a world in which energy development is managed in a sustainable way – a world in which we no longer fight wars with guns and bullets – a world instead in which we use science and technology, including nuclear energy technology, to fight poverty, sickness, and environmental challenges.

In order to achieve the second path, the international community must meet the staggering growth in electricity demand. Due to rapid population and economic growth, global energy demand estimates are doubling for the time period between now and 2050. In addition, meeting the world's energy needs may require a new paradigm in the deployment of nuclear power plants. First however, these problems must be met with conservation, efficiencies, and demand-side approaches. Second, they must be met with wind, solar, and other renewable energies. Even after achieving the first two aims, a gap will still exist between demand and supply, illustrating the need for greater nuclear energy.

Global nuclear energy expansion brings with it multiple concerns, some justified and some not. One of these concerns is the potential for the proliferation of nuclear weapons. Open, commercial nuclear energy has never led to the creation of nuclear weapons. States serious about clean, peaceful nuclear energy do not cheat. Cheaters will cheat no matter what the protocols are. Nonetheless, several fuel assurance proposals have grown from the proliferation concern. At first glance, all of these ideas have merit. If we can make accessible large amounts of clean electricity from nuclear energy and other means while simultaneously addressing climate change and do so while obviating proliferation concerns, this would be great. However, the following should give us pause: while U.S. utilities agree with the moral imperative to expand nuclear power globally – the fiduciary responsibilities of this expansion cause the companies to examine the impact it would have on their investors and consumers, concern regarding adequate uranium supply for the existing reactors, and concern regarding adequate uranium supply for the new-build reactors in the U.S. and abroad.

Regardless of these concerns, we should move forward and let the market system work, ideally resulting in the deployment of multiple new enrichment facilities in developed nations that already operate enrichment facilities. With proper market incentives and predictable global demand, global supply also will be adequate and predictable. New-build countries will have incentive to buy from these stable, existing markets and avoid the huge capital expense associated with new in-country enrichment capability as a sovereign decision.

Mr. Nabil Fahmy, Ambassador, Arab Republic of Egypt to the United States

Egypt's nuclear program began in 1961 with a 2 MWe Soviet research reactor which doubled in power with the help of India. The Soviet reactor constituted Egypt's complete nuclear program until 1975 when the U.S. agreed in principle to supply Egypt with eight nuclear power plants. Egypt subsequently engaged in safeguards agreements with the IAEA and the U.S. In the late 1970's and early 1980's Egypt embarked again on a nuclear power program, going so far as to choose a site on the Mediterranean for the reactor locations and tendering bids to three different companies. However, in the aftermath of the Chernobyl disaster, Egypt did not pursue this program. In February 2008, Egypt once again released a tender for four nuclear power plants with a predicted completion date of 2022.

Since the February 2008 announcement, the international community has asked Egypt whether it intends to obtain sensitive nuclear technology. Egypt takes issue with this question and the premise on which it lies. Egypt has been in the past – and is currently – compliant with its NPT obligations, and in the one instance in which there was a violation of the safeguards agreement Egypt reached a resolution with the IAEA. The question itself comes from the international community's general approach to nuclear nonproliferation and the Middle East, in particular and is based on the premise that the real threat of proliferation is from the emerging non-nuclear states rather from the existent nuclear states. The premise that you can deal with nonproliferation by not allowing others to pursue nuclear power or adding restrictions to what they can do seems to be the generally accepted solution to proliferation. However, the solution to proliferation is actually more nuclear disarmament.

The rationale behind Egypt's decision to restart its nuclear program is to satisfy growing Egyptian energy needs in light of decreasing gas and oil reserves. A desire to develop nuclear weapons is not the motivation for Egypt's decision to restart its nuclear program; rather, the need for nuclear power is the complete motivation. That being the case – and because Egypt is NPT compliant – Egypt takes issue with an approach in any of the fuel assurance initiatives that is restrictive. Egypt is open-minded toward any initiative that provides it with the motivation not to put up the substantial capital needed to obtain the full fuel cycle. However, if Egypt has to move toward nuclear power in the near-term, there will be a tremendous upfront investment, regardless of whether it decides to pursue the full fuel cycle or not. This is an investment that Egypt has to protect by ensuring that its nuclear program has a lifetime and effectiveness that is not disrupted by political changes worldwide, proliferation by another state, or changes in technology. If, through fuel assurance proposals, Egypt cannot achieve an assured supply of nuclear fuel free from these disruptions, then it will be inclined to pursue its own domestic ability.

In conclusion, if Egypt were to agree not to pursue its own domestic capacity and acquire its supply from other sources, it will not be at the price of giving up any of its rights. Egypt's motivation is what's going to drive it; its rights won't change. And, if Egypt does have to choose between the two, it won't be choosing to go with the international dimension. Egypt joined the international agreement based on the package of rights and obligations which it feels it has fulfilled and it does not feel that it is obliged to give away further rights because Egypt has been compliant.

Dr. William Potter, Director, James Martin Center for Nonproliferation Studies, Monterey Institute of International Studies

While emphasizing support for the general concept of fuel supply assurances as a means to reduce incentives for nations to develop indigenous sensitive fuel cycle technologies, it is important to discuss three potential downsides to the currently proposed fuel supply assurance programs. The first downside is, while well intentioned, there is little chance the IAEA Board of Governors will adopt the fuel supply assurance proposals or implement them in a timely fashion because of their complexity and their perceived discriminatory approach. How realistic is it that the international community will be able to reach consensus, or even a significant convergence of views, in the next decade on useful fuel assurance mechanisms? It is unlikely the diverse body of nations that sit on the IAEA Board of Governors will endorse anytime soon one or more of the fuel supply arrangements that are sound from a nonproliferation, economic, and political standpoint.

The second downside to the currently proposed fuel supply assurance programs are the different liabilities that arise as a part of these programs, even in the two or three proposals that have a realistic chance of being endorsed by the IAEA Board of Governors in the next few years. In limiting these comments to the Russian multinational fuel center proposal, although this initiative was originally conceived as a means to forestall indigenous uranium enrichment activities in Iran, and as such was a forward-looking nonproliferation measure, it has subsequently transformed into a commercial enterprise in which most of its attractive nonproliferation features have been diluted, if not temporarily shelved. Not only are there no requirements for participants to forego indigenous fuel cycle activities – or to adopt the Additional Protocols – but a nation does not even need to be a party to the NPT to participate in the Russian multinational fuel center. Unfortunately it appears that Russian readiness to lower the nonproliferation bar as a condition for participation in the Russian fuel supply assurance program is reinforced

by the IAEA's encouragement of this stance in order to get quick endorsement of the proposal by its board. While it's certainly understandable why the IAEA wants a fuel supply assurance success as soon as possible, one has to as: what is the price of such success if the product has no direct nonproliferation impact?

The third downside to fuel supply assurance programs is the potential for these programs to accelerate proliferation. Acceleration of proliferation could take place should these programs provide sweeteners that distort economic rationality in order to overcome resistance to nuclear supply proposals by many developing states. This might already be happening as the principle nuclear suppliers rush to seize as large a share of the nuclear market as possible, regardless of the economics of nuclear power for the states in question, the adequacy of nuclear regulatory bodies in the state to provide independent oversight of nuclear power, and the lag-time of the commercial availability of the proliferation-resistant technology and the demand for new nuclear power plants.

In conclusion, there are three steps that reduce the emergence of unintended negative consequences stemming from multinational fuel arrangements. The common denominator of these steps is a focus on non-exceptionalism, maintaining a balance between nonproliferation and peaceful use, and building trust by example. The steps are as follows: 1) reinforce the principle of economic rationality with respect to sensitive fuel cycle activities while recognizing that insistence that different standards should apply to allies undermine these efforts. To adopt different rules for some states is to assure that most others will perceive the action as confirming the claims of those who portray all fuel supply initiatives as designed to erode their article IV rights; 2) pursue all fuel supply assurance initiatives in tandem with efforts to strengthen adherence to NSG guidelines without exceptions, to promote the application of the IAEA's additional protocol, and to insist on full-scope safeguards as a condition for nuclear export; and 3) in order for multinational approaches to have any prospect of overcoming the enormous suspicion that exists on the part of many non-nuclear weapons states, it will be necessary for the nuclear suppliers to build trust by demonstrating their commitment to all three pillars of the NPT.

In conclusion, it is now time for both nuclear weapons states and non-nuclear weapons states to demonstrate their commitment to the NPT – the nuclear weapons states by moving unequivocally to a world free of nuclear weapons and the non-nuclear weapons states by matching their rhetoric with proven nonproliferation and peaceful-use policies.

Panel #2: Q&A: "Policy and Technical Recommendations for Strengthening Nuclear Assurances and Verification Today"

Q: What is the opinion of the panel members on Iran and its nuclear program?

A: Ambassador Nabil Fahmy, Egypt: Iran is compliant with the NPT and has completely fulfilled its IAEA obligations, and as such has the right to full nuclear fuel cycle technology. The problem with the Iranian nuclear program is that it took Iran so long to respond to IAEA inquiries regarding its program and consequently there are suspicions about what exactly Iran did and why it has been so late in trying to respond to concerns. In light of its tardiness, Iran needs to do more than other states who have responded to the IAEA more quickly to assure the international community that it doesn't have intentions to weaponize its nuclear program. What Iran should do is agree to cap its technology for a period of time in exchange for assurances of supply of nuclear fuel. Iran would probably reject this proposal unless in parallel to this condition its regional neighbors and the U.S. agree to a more general discussion addressing each state's national security concerns and interests. However, at the end of the day, the only way to conclusively deal with questions about the Iranian nuclear program is to establish a zone free of nuclear weapons throughout the Middle East and including Israel.

Q: Unless the people who are manning the nuclear technology are committed to ethics, then proliferation will not work. Can the panel discuss the ethical responsibilities of these people and how the international community can promote the development of the nuclear nonproliferation culture?

A: Dr. William Potter, Monterey Institute of International Studies: The human factor is absolutely critical when discussing nuclear nonproliferation. While the capabilities of the nuclear reactors and the technical solutions dealing with safety and proliferation are sound, the safety and nonproliferation culture needs strengthening. United Nations Security Council Resolution 1540 states that all countries, not just NPT states, be mandated to have in place regulations and laws governing safeguards and export controls. The problem is this doesn't guarantee that these laws will be applied in an effective fashion as intended by the legislation. What states really need to do is change the mindset regarding nuclear technology – thus making education extremely important.

Q: Given the occurrence of past incidents such as Chernobyl and Three Mile Island, and more recent issues such as Yucca Mountain, how does public opinion effect nuclear technology development and implementation, especially in the U.S.?

A: Admiral Frank Bownman, NEI: Public opinion is extremely important to the future development of nuclear power and the current operation of the 104 U.S. reactors. This nuclear industry is not the same industry that operated in the 1970's. This nuclear industry now operates online producing 100% electricity 92% of the time. Nuclear power generates 20% of U.S. electricity with only 12% of the installed capacity. This is extremely efficient. What we're now seeing in the U.S. is a confluence of events which is pushing U.S. citizens toward greater support for nuclear energy, both for the 104 operating plants and for an expanded role for nuclear power in the future. Opinion polls that currently average about 62% approval by U.S. citizens for the production of new nuclear plants in the U.S illustrate this support.

Q: With regard to some of the various nuclear fuel bank proposals, will the fuel banks provide the fuel at affordable prices (which might imply some sort of subsidized pricing) or at market prices?

A: Dr. Thomas Shea, DOE: In the case of the Russian nuclear fuel bank proposal, the plan is definitely to make this a profitable undertaking. What Russia is doing is selling shares in an existing facility that is underutilized. This affects pricing mechanisms. Regarding some of the last resort mechanisms discussed at the Nunn Forum, there have been no firm positions on pricing. It appears as if these mechanisms will end up using spot market pricing and not subsidized pricing mechanisms.

Q: How can the international community expect other states to listen to – and follow the direction of – the U.S. regarding nuclear technology when the U.S. has such a large nuclear program and is discussing the production of new nuclear weapons?

A: Dr. William Potter, Monterey Institute of International Studies: The question is one of trust and will require action by nuclear suppliers to demonstrate trust and over time build the confidence of the parties who are the assumed beneficiaries of the nuclear fuel assurance proposals.

Ambassador Nabil Fahmy, Egypt: In addition, the question of public perception often arises during these debates. The first reaction of the public is, "If they have capabilities, then we want to have the same capabilities." The second reaction is one of concern over where the facilities will physically lie. The other main concern is whether these are programs that are not needed and/or are not cost effective. Developing countries should greatly depend on the IAEA in terms of gaining advice and expertise that is objective, neutral, and not driven by commercial needs (and which are instead driven by the peaceful use of nuclear energy).

Participant Bios

Frank L. "Skip" Bowman

Frank L. "Skip" Bowman is President and Chief Executive Officer of the Nuclear Energy Institute (NEI). NEI is a policy organization that represents more than 270 domestic and international corporations and organizations involved in nuclear energy and related technologies.

Prior to joining NEI, Bowman served over 38 years in the U.S. Navy, rising to the rank of Admiral. He served as Director of the Naval Nuclear Propulsion Program and was the third successor to Admiral Hyman G. Rickover in that command. Bowman was also Deputy Administrator-Naval Reactors in the National Nuclear Security Administration at the U.S. Department of Energy (DOE). In these dual positions, he was responsible for the operations of more than 100 reactors aboard the U.S. Navy's aircraft carriers and submarines, four training sites, and two Department of Energy laboratories.

Bowman is a 1966 graduate of Duke University. He completed a dual master's program in nuclear engineering and naval architecture/marine engineering at the Massachusetts Institute of Technology (MIT) in 1973 and was elected to the Society of Sigma Xi. Bowman has been awarded the honorary degree of Doctor of Humane Letters from Duke University.

Bowman serves on the MIT Nuclear Engineering Visiting Committee, the Engineering Board of Visitors at Duke University, and the Nuclear Engineering Department Advisory Committee at the University of Tennessee. He also serves on the U.S. Chamber of Commerce Committee of 100, the British Petroleum U.S. Refineries Independent Safety Review Panel, and the boards of directors for the National Energy Foundation, U.S. Energy Association, American Council for Capital Formation, and the Armed Services YMCA of the USA. In 2006, Bowman was made an Honorary Knight Commander of the Most Excellent Order of the British Empire in recognition of his commitment in support of the Royal Navy submarines program.

Bowman is an ex officio member of the boards of directors for the Institute of Nuclear Power Operations, Electric Power Research Institute, and Nuclear Electric Insurance Limited, and is a member of the American Nuclear Society, the Council on Foreign Relations, the Management Committee of the Alliance for Energy and Economic Growth, Women in Nuclear, and the World Nuclear Association's Council of Advisors.

Jeff Combs

Jeff Combs is owner and President of The Ux Consulting Company LLC (UxC). He has over 30 years experience providing economic analysis and forecasting for the front-end of the nuclear fuel cycle. He is responsible for all UxC consulting and information services and publications, including The Ux Weekly and Market Outlook Reports.

Prior to joining UxC in 1994, Combs was a Senior Economist at Science Applications International Corporation, where he developed the U-PRICE model of the uranium market, and the managing editor of The Nuclear Fuel Market Quarterly. From 1975 to 1980, he served as the principal economist associated with nuclear fuel market matters for the U.S. government in his position at the Department of Energy (DOE).

During his tenure at the DOE, as well as in private industry, Combs has written and presented a number of papers at a variety of industry conferences and has been quoted in the international media as an authority on nuclear fuel markets.

In 1973, Combs earned a bachelor's degree in economics at the University of Virginia, where he also completed his doctoral course work in economics in 1975. He is a charter member of the International Association of Energy Economics and has contributed to The Energy Journal, an academic journal for which he has also served as a referee.

Charles B. Curtis

Charles B. Curtis is the President and Chief Operating Officer of the Nuclear Threat Initiative (NTI). He previously served as the Executive Vice President and Chief Operating Officer of the United Nations Foundation and was a partner in Hogan & Hartson, a Washington based law firm with domestic and international offices.

Curtis served as Under Secretary and, later, Deputy Secretary of the U.S. Department of Energy from February 1994 to May 1997. He was Chief Operating Officer of the Department of Energy and, among other duties, had direct programmatic responsibility for the Department's energy, science, technology, and national security programs.

Curtis is a lawyer with over 15 years of private practice experience and more than 18 years in government service. He was a founding partner of the Washington law firm Van Ness Feldman. Curtis served as Chairman of the Federal Energy Regulatory Commission from 1977 to 1981 and has held positions on the staff of the U.S. House of Representatives, and at the U.S. Treasury Department, and the Securities and Exchange Commission. He is a current member of the Council on Foreign Relations.

Mohamed ElBaradei

Mohamed ElBaradei is currently serving his third term as Director General of the International Atomic Energy Agency (IAEA), an intergovernmental organization sponsored by the United Nations. From 1984, he was a senior staff member of the IAEA Secretariat, holding a number of high-level policy positions, including that of the Agency's Legal Adviser and subsequently the Assistant Director General for External Relations.

ElBaradei began his career in the Egyptian Diplomatic Service in 1964, serving in the Permanent Missions of Egypt to the United Nations in New York and Geneva in charge of political, legal, and arms control issues. From 1974 to 1978, he was a Special Assistant to the Foreign Minister of Egypt and a member of various presidential and ministerial bilateral delegations including the negotiating team that led to the conclusion of the disengagement agreements between Egypt and Israel. In 1980, he left the Diplomatic Service to join the United Nations and became a Senior Fellow in charge of the International Law Program at the United Nations Institute for Training and Research. From 1981 to 1987, he was also an Adjunct Professor of International Law at the New York University School of Law.

During his career as diplomat, international civil servant and scholar, ElBaradei has become intimately involved with the work and processes of international organizations, particularly in the fields of international peace and security, and international development. He has lectured widely in the fields of international law, international organizations, arms control, and the peaceful uses of nuclear energy; has authored various articles and books; and belongs to a number of professional associations.

In October 2005, ElBaradei and the IAEA were jointly awarded the Nobel Peace Prize for their efforts to prevent military use of nuclear energy and to ensure the safe use of nuclear energy for peaceful purposes. In its citation, the Nobel Committee referred to the importance of IAEA's work calling ElBaradei an "unafraid advocate" of new measures to strengthen the nuclear non-proliferation regime.

ElBaradei received his Bachelor's degree in Law in 1962 at the University of Cairo and a Doctorate in International Law from the New York University School of Law in 1974. He has received multiple awards for his work as a public servant and as an advocate of tolerance, humanity, and freedom; has been awarded honoris causa degrees from various universities; and has received a number of decorations, including the Greatest Nile Collar - the highest Egyptian civilian decoration.

Nabil Fahmy

Nabil Fahmy became Ambassador of the Arab Republic of Egypt to the United States on November 29, 1999. Throughout his distinguished career, Fahmy has focused on curbing nuclear proliferation and has written numerous books and articles on the subject.

Ambassador Fahmy began his career in 1974 in the cabinet of the Secretary of the President for External Communications. From 1975-1976, he was a political officer in the cabinet of the Vice President. In 1976, he began his work in the cabinet of the Minister of Foreign Affairs. From 1978-1982, he was the Second Secretary of the Egyptian Mission to the United Nations' Conference on Disarmament. He continued his work on disarmament and peaceful nuclear energy issues with the Ministry of Foreign Affairs from 1982-1984. In 1986, he became the First Secretary to the United Nations (U.N.) and later counselor, where he worked on disarmament issues. In 1991, he became the senior disarmament official for the Department of International Organizations in the Ministry of Foreign Affairs. He quickly rose to the position of counselor and remained there until 1995.

In 1997, Fahmy was appointed Ambassador to Japan, a position that he held until 1999, In January of 1999, he became a member of the U.N. Secretary General's Advisory on Disarmament Matters.

Fahmy holds Bachelor of Science and Master of Arts degrees from the American University in Cairo.

Laura S. H. Holgate

Laura S. H. Holgate is the Vice President for Russia/New Independent States (NIS) Programs, at the Nuclear Threat Initiative (NTI). She joined NTI after serving in a number of senior positions in the federal government. She managed the Nunn-Lugar Cooperative Threat Reduction program at the U.S. Department of Defense, which provides assistance to Russia and the new independent states in securing and destroying excess nuclear, chemical, and biological weapons and materials. She also served as Director of the Office of Fissile Materials Disposition at the U.S. Department of Energy.

Holgate has received numerous public service awards and is a member of the Council on Foreign Relations and the International Institute of Strategic Studies. She is President of Women in International Security and sits on advisory panels of the Pacific Northwest National Laboratory and the Oak Ridge National Laboratory.

Raymond J. Juzaitis

Raymond J. Juzaitis assumed the role of Department Head of the Nuclear Engineering Division of Texas A&M's College of Engineering in 2007. Prior to moving to Texas A&M, he was Associate Director of Nonproliferation, Homeland and International Security (NHI) at Lawrence Livermore National Laboratory (LLNL). In this role, he was responsible for organizations that provide expertise, analyses, and systems solutions to preclude the spread or use of weapons of mass destruction (WMD). Major areas of program emphasis included nonproliferation and global nuclear materials management; radiological, nuclear, chemical, and biological countermeasures; infrastructure and force protection; and international assessments.

Juzaitis' career with the national laboratories spanned nearly 30 years as a nuclear and chemical engineer with extensive experience in weapons and computational physics. Prior to joining LLNL's nonproliferation program in 2004, he was at Los Alamos National Laboratory, first as a doctoral researcher, then as a staff scientist in the weapons program, and later holding various senior management positions, most recently Associate Director for Weapons Physics. During his Los Alamos tenure, he also held several senior advisory positions on assignment. From 1998 to 1999, he served as Senior Technical Advisor for the Office of Defense Programs, Department of Energy; and from 1988-1990, he was Special Scientific Advisor to the Office of the Assistant Secretary of Defense for Atomic Energy. His early career research interests included uranium enrichment technologies, computational nuclear reactor physics, and radiation transport simulation and analysis.

Juzaitis is the recipient of three DoE Weapons Excellence Awards and is a member of the American Nuclear Society. He re-

ceived his B.S.E. (1974) in chemical engineering from Princeton University and his M.E. (1976) and Ph.D. (1980) in nuclear engineering from the University of Virginia.

William Potter

William Potter is Sam Nunn and Richard Lugar Professor of Nonproliferations Studies and Director of the James Martin Center for Nonproliferation Studies at the Monterey Institute of International Studies (MIIS). He is the author or editor of fourteen books, the most recent of which is the The Four Faces of Nuclear Terrorism (2005). Potter has been a member of numerous committees of the National Academy of Sciences and currently serves on the Nonproliferation Panel of the Academy's Committee on International Security and Arms Control. He is a member of the Council on Foreign Relations and the Pacific Council on International Policy, and served for five years on the U.N. Secretary General's Advisory Board on Disarmament Research. He currently serves on the International Advisory Board of the Center for Policy Studies in Russia (Moscow). He was an advisor to the delegation of Kyrgyzstan to the 1995 Nuclear Nonproliferation Treaty (NPT) Review and Extension Conference and to the 1997, 1998, 1999, 2002, 2003, 2004, and 2007 sessions of the NPT Preparatory Committee, as well as to the 2000 and 2005 NPT Review Conferences.

Tariq Rauf

Tariq Rauf is the Head of Verification and Security Policy Coordination in the Office of External Relations and Policy Coordination at the International Atomic Energy Agency (IAEA.) His office is responsible for negotiating safeguard agreements and additional protocols intended to prevent states from diverting material from peaceful uses to military applications.

Rauf brings many years of expertise in the domain of nonproliferation to his work for the IAEA. Before moving to Vienna to work for the IAEA, he was Director of the International Organizations and Nonproliferation Project at the Monterey Institute of International Studies' Center for Nonproliferation Studies. He served as an advisor with Canada's delegations to the Nuclear Nonproliferation Treaty beginning in 1990. Rauf has published articles on various aspects of nonproliferation including the NPT review process, disarmament, and multilateral fuel cycle programs in such publications as *The Nonproliferation Review and Bulletin of the Atomic Scientists*.

Thomas E. Shea

Thomas E. Shea is Director of the Global Nuclear Policy Forum at World Nuclear University (WNU). He is currently pursuing measures to stimulate the global expansion of nuclear power to moderate the impacts of global warming, stimulate economic growth in the developing areas of the world, and strengthen the international nuclear nonproliferation regime.

Prior to joining WNU in August of 2007, Shea served as Chief Nonproliferation Scientist at the Pacific Northwest Center for Global Security and as the Director of Defense for Nuclear Nonproliferation Programs at the Pacific Northwest National Laboratory.

Earlier, at the International Atomic Energy Agency (IAEA) Safeguards Department, Shea developed safeguards policy and implementation arrangements for plutonium processing and use facilities and for uranium enrichment and other facilities. He headed the IAEA Trilateral Initiative to develop an IAEA verification system for weapon-origin fissile material released from military use and IAEA fissile material cutoff treaty studies.

Shea was awarded a Special Fellowship from the United States Atomic Energy Commission and received his Ph.D. in Nuclear Science from Rensselaer Polytechnic Institute. He is a Fellow of the Institute of Nuclear Materials Management (INMM) and received the 2007 INMM Distinguished Service Award. He was elected as a member of the International Nuclear Energy

Academy in 2007.

Leonardo J. Sobehart

Leonardo Sobehart's professional activities have spanned the domains of engineering, law, and commerce. He headed the legal division of INVAP (INVestigaciones Aplicadas Sociedad del Estado), Argentina's leading nuclear technology development firm. In addition to his credentials as an engineer, he holds degrees in law and business administration from the National University of Buenos Aires.

Previously, Sobehart was deputy chairman of the Board of the Nuclear Regulatory Authority of Argentina. He was an alternative representative of the nation of Argentina to the Board of Governors of the International Atomic Energy Agency (IAEA). He served as a member of the Liaison Committee for the Safeguards Agreement between Argentina, Brazil, ABACC (the Brazil-Argentine Agency for Accounting and Control of Nuclear Material), and the IAEA, and coordinated the Argentine Support Program for the Safeguards Agreement.

Sobehart is a member of the Nuclear Group of the Argentine Council for International Relations (CARI), and of the Program Committee of the 12th Congress of the International Radiation Protection Association to be held in Buenos Aires in October of 2008.

Richard J. K. Stratford

Richard J. K. Stratford is Director of the Office of Nuclear Energy Affairs in the Bureau of Nonproliferation in the U.S. Department of State. He is responsible for guidance on international nuclear affairs, nuclear safeguards, nuclear export control policies, nuclear cooperation agreements, and international initiatives on nuclear energy technology. He frequently has served as a U.S. delegate to meetings of the IAEA Board of Governors and the General Conference.

Stratford is the U.S. Head of Delegation to the Nuclear Suppliers Group (NSG), the NSG's Dual-Use Regime, and the Nuclear Nonproliferation Treaty (NPT) Exporters Committee. Additionally, he was the U.S. Head of Delegation and Chief Negotiator of the Nuclear Safety Convention and the Convention on the Safe Management of Spent Fuel and Radioactive Waste. From 1987 to 1993, he was the Deputy Assistant Secretary of State for Nuclear Energy and Energy Technology Affairs in the Bureau of Oceans and International Environmental and Scientific Affairs. From 1982 to 1987, Stratford was the Executive Assistant to the Ambassador-at-Large and Special Adviser to the Secretary on Nonproliferation Policy and Nuclear Energy Affairs.

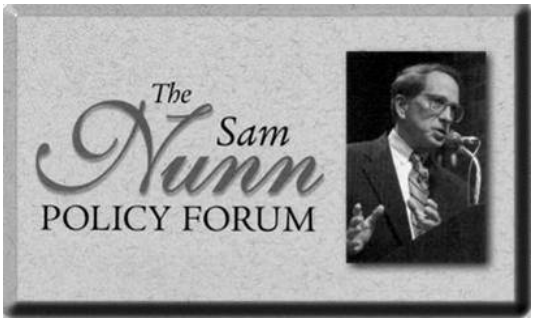
Prior to his service in the Department of State, Stratford was an associate with the Washington law firm of Hogan & Hartson dealing primarily with energy regulatory and development matters. From 1975-78, he was Special Council with the Nuclear Regulatory Commission. Stratford received his B.S. degree in Public Administration from Georgetown University in 1970, and his J.D. from American University in 1974.

The Sam Nunn Bank of America Policy Forum is a policy meeting that brings together noted academic, government, and private-sector experts on technology, public policy, and international affairs to address issues of immediate importance to the nation. It was developed from former Senator Sam Nunn's vision of increasing understanding among policymakers, academic researchers, technologists, and citizens regarding important issues facing them. Senator Nunn is a Distinguished Professor at The Sam Nunn School of International Affairs at Georgia Tech.

The Policy Forum is open to the public and is designed to foster informed discussion of critical issues confronting the United States in the 21st century. Offering a significant venue for policy-relevant research and dialogue, the Policy Forum transcends disciplinary boundaries and engages scholars, practitioners, students, and the public. The insights and findings produced at the Forum are shared with policymakers and the broader public through congressional testimony, circulation of proceedings, policy papers, journal articles, and educational television and Internet broadcasts. The Forum connects the academic and policymaking communities to craft effective and creative responses to the critical challenges facing the nation and engages and informs interested citizens on these issues.

History of the Sam Nunn Forum

The initial Policy Forum series was held annually from 1997 to 2002; was co-sponsored jointly by the University of Georgia, the Georgia Institute of Technology, and Emory University; and was hosted in turn by each institution. Since 2002, the Policy Forum, has been held biennially, sponsored by and held at the Georgia Institute of Technology. The Policy Forum is funded by a generous endowment provided by Bank of America.



Sam Nunn is co-chairman and chief executive officer of the Nuclear Threat Initiative (NTI), a charitable organization working to reduce the global threats from nuclear, biological, and chemical weapons. He served as a U.S. senator from Georgia for 24 years (1972-1996) and is retired from the law firm of King & Spalding.

Raised in the small town of Perry, in middle Georgia, he attended Georgia Tech, Emory University, and Emory Law School, where he graduated with honors in 1962. After active duty service in the U.S. Coast Guard, he served six years in the U.S. Coast Guard Reserve. He first entered politics as a member of the Georgia House of Representatives in 1968.

During his tenure in the U.S. Senate, Senator Nunn served as chairman of the Senate Armed Services Committee and the Permanent Subcommittee on Investigations. He also served on the Intelligence and Small Business Committees. His legislative achievements include the landmark Department of Defense Reorganization Act, drafted with the late Senator Barry Goldwater, and the "Nunn-Lugar" Cooperative Threat Reduction Program, which provides assistance to Russia and the former Soviet republics for securing and destroying their excess nuclear, biological, and chemical weapons.

In addition to his work with NTI, Senator Nunn has continued his service in the public policy arena as a distinguished professor in the Sam Nunn School of International Affairs at Georgia Tech and as chairman of the board of the Center for Strategic and International Studies in Washington, D.C.

He is a board member of the following publicly-held corporations: Chevron Corporation, The Coca-Cola Company, Dell Inc., and General Electric Company. He is married to the former Colleen O'Brien and has two children, Michelle and Brian, and two grandchildren.

Georgia Tech Ivan Allen College
The Sam Nunn School of International Affairs

The Sam Nunn School of International Affairs
781 Marietta Street, NW
Atlanta, Georgia 30332-0610