INTERNATIONAL LUXEMBOURG
FORUM ON PREVENTING
NUCLEAR CATASTROPHE

SECURE TOLERANCE CRITERIA FOR THE NUCLEAR NONPROLIFERATION REGIME

Proceedings of the Conference
of the International Luxembourg Forum
on Preventing Nuclear Catastrophe

MONTREUX, 2013

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The book contains the proceedings of the Conference of the International Luxembourg Forum on Preventing Nuclear Catastrophe (May 21 – 22, 2013, Montreux), which started the process of defining criteria for non-declared weapons development that could be used by the IAEA and the UN Security Council to make a judgment about the nature and goals of the nuclear programs. The most authoritative experts from different countries participated in the meeting. In addition to various reference materials, the book includes the Final Document adopted by the participants in the Conference.

The publication is intended for experts on the subject, as well as for a wide readership.

The official website of the International Luxembourg Forum: www.luxembourgforum.org

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ABOUT THE INTERNATIONAL LUXEMBOURG FORUM ON PREVENTING NUCLEAR CATASTROPHE

The Forum was established pursuant to a decision of the International Conference on Preventing Nuclear Catastrophe held in Luxembourg on May 24—25, 2007. The Forum is one of the largest non-governmental organizations bringing together leading international experts on the subject of the nonproliferation of nuclear weapons and arms reduction and limitation.

The Forum's primary objectives are as follows:

To facilitate the process of arms limitation and reduction and to counteract growing threats to the nonproliferation regime and erosion of the fundamentals of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). This includes curtailing the growth of nuclear terrorism and attempts by individual states to gain access to nuclear materials and technologies;

To strengthen global peace and security by applying new approaches and developing practical proposals for political leaders regarding key nuclear nonproliferation and arms control issues.

The principal bodies of the Forum are the International Advisory Council (IAC) and the Supervisory Board (SB).

The International Advisory Council comprises approximately fifty leading experts from various countries. IAC members make proposals on the Forum's agenda, organize events, and participate in drafting the

Forum's final documents (declarations, special statements, memoranda, etc.) to be circulated to leading politicians, heads of international organizations, and public figures around the world.

The Supervisory Board consists of prominent politicians, public figures, and world-renowned scientists, including Sam Nunn, prominent U.S. politician and Co-Chair of the Nuclear Threat Initiative; William Perry, Professor at Stanford University, former Secretary of the U.S. Department of Defense; Hans Blix, former Director General of the International Atomic Energy Agency (IAEA); Rolf Ekeus, former Chairman of the SIPRI Governing Board and High Commissioner on National Minorities of the Organization for Security and Co-operation in Europe; Gareth Evans, Chancellor, Australian National University, Honorary Professor, former Minister of Foreign Affairs of Australia; Igor Ivanov, Corresponding Member of the Russian Academy of Sciences (RAS), President of the Russian International Affairs Council, former Russian Minister of Foreign Affairs and Secretary of the Security Council of the Russian Federation; Nikolay Laverov, RAS Academician and member of the Presidium of the Russian Academy of Sciences, former RAS Vice President; and Roald Sagdeev, RAS Academician and Professor at the University of Maryland (Russia/United States).

Members of the Supervisory Board advise on the directions of the activities of the Forum as a high-profile public organization that aims to strengthen international peace and security.

President of the Forum is Viatcheslav Kantor, Ph.D., a prominent international public figure, philanthropist, entrepreneur, and investor. Mr. Kantor leads a number of international public organizations. He chaired the Organizing Committee of the Luxembourg Conference and contributes significantly to the International Luxembourg Forum's activities.

On April 14, 2008, a Forum Working Group meeting was held in Moscow. Due to growing tensions around the Iranian nuclear program, the meeting focused primarily on possible political and diplomatic ways out of the existing crisis.

The result of the meeting was the adoption of a memorandum outlining a number of practical solutions for nuclear nonproliferation. Like the

preceding Luxembourg Conference Declaration, the memorandum was circulated to heads of states and the leadership of major international organizations.

The next event took place in Rome on June 12, 2008, in the form of a Joint Seminar of the Forum and the Pugwash Conferences on Science and World Affairs, an organization of scientists, politicians, and public figures who work toward peace, disarmament, security, and scientific co-operation. The seminar was dedicated to the outcomes and prospects of the Preparatory Committee for the 2010 NPT Review Conference.

The Supervisory Board of the International Luxembourg Forum met on December 9, 2008, in Moscow. Participants of the meeting, including Hans Blix, William Perry, Rolf Ekeus, and Igor Ivanov, summed up the outcome of the organization's work in 2008 and identified prospects and priorities for its activities in 2009. They also discussed the most urgent issues of nuclear weapons nonproliferation and international security, both worldwide and in the most problematic regions. On the previous day, December 8, Luxembourg Forum representatives had meetings in Moscow with Russian Foreign Minister Sergey Lavrov and Deputy Secretary of the Security Council of the Russian Federation Vladimir Nazarov.

The thematic work of the Forum in 2009, as before, was aimed at strengthening the nuclear nonproliferation regime. On April 22, the Working Group met in Moscow to discuss the reduction of strategic offensive arms and the prospects of the 2010 NPT Review Conference's Preparatory Committee.

The next Working Group meeting took place in Geneva on July 2. It reviewed the results of the 2009 Preparatory Committee meeting and the prospects of the 2010 NPT Review Conference, and it also analyzed the situation with the Iranian and North Korean nuclear and missile programs. In keeping with the Forum's traditions, final documents on the outcome of the meetings were agreed upon and adopted and then sent to leaders of major nations and heads of international organizations.

The Supervisory Board of the International Luxembourg Forum met on December 8, 2009, reviewed the outcomes of the Forum's work, and identified priorities for its activities in 2010. Hans Blix, William Perry, Gareth Evans, and Rolf Ekeus took part in that meeting. On the next day, Russian Foreign Minister Sergey Lavrov and Deputy Secretary of the Security Council of the Russian Federation Yuri Baluyevsky received a delegation from the Luxembourg Forum's Supervisory Council.

2010 saw the signing of the new Strategic Arms Reduction Treaty (START), which the Forum members had repeatedly called for. This event drew special attention to a range of interrelated problems in security and nuclear arms control. These issues were reflected in the work of the Luxembourg Forum and discussed at its meetings.

That same year, on April 8–9, the Working Group of the International Luxembourg Forum met in Vienna to discuss the prospects of the 2010 NPT Review Conference. This meeting was especially important on the eve of the Conference itself. A number of practical proposals aimed at strengthening the weapons of mass destruction (WMD) nonproliferation regime and addressing potential solutions to pressing issues on the Conference's agenda were outlined in the Final Document, which was forwarded to world leaders.

The International Luxembourg Forum Conference, which took place in Washington on September 20–21, 2010, focused specifically on the stumbling blocks on the way to the ratification of the new START Treaty, an analysis of possible subsequent steps in arms control, and the future of nuclear disarmament and WMD nonproliferation. Prospects for cooperation on ballistic missile defense (BMD) and areas for potential collaboration were subjected to thorough analysis.

The Luxembourg Forum Conference attracted significant attention from the academic community and general public. An American member of the Forum's Supervisory Board, prominent Senator Sam Nunn, actively participated in the discussions and the subsequent press conference.

The regular annual meeting of the Forum's Supervisory Board took place in Moscow on December 8–9, 2010. At the opening of the meeting, Russian Deputy Foreign Minister Sergey Ryabkov read President Dmitry Medvedev's address to the meeting's participants. The address expressed a high opinion of the Forum's role in issues such as strengthening the NPT regime, improving arms control mechanisms, and preventing the threat of nuclear terrorism. The statement also indicated that the Forum's proposals and recommendations were being applied in practice in the process of addressing the issues under consideration at the international level.

As usual, a delegation of the Forum had a meeting with Russian Minister of Foreign Affairs Sergey Lavrov, who presented his views on global security and the national interests of the Russian Federation and accepted proposals for review from the Forum's Supervisory Board for practical solutions to the most acute issues of WMD nonproliferation and arms control. Members of the Supervisory Council also met with Vladimir Nazarov, Deputy Secretary of the Russian Federation Security Council.

In their Declaration, members of the Forum's Supervisory Board paid special attention to and unanimously expressed strong support for an article by the four Russian "wise men" (Ye. Primakov, I. Ivanov, Ye. Velikhov, and M. Moiseyev) entitled "From Nuclear Deterrence to Common Security," published in the Russian newspaper *Izvestiya* on October 15, 2010. The principal directions of the International Luxembourg Forum's activities in 2011 were also identified. Among them was the absolutely innovative task of elaborating "red lines" on abiding by the spirit and letter of the NPT, the crossing of which would entail effective actions by the UN Security Council under articles 41 and 42 of the UN Charter.

In Stockholm on June 13–14, 2011, a joint Conference with the Stockholm International Peace Research Institute (SIPRI) was held on the topic "Prospects of Nuclear Proliferation and Disarmament after Entry into Force of the New START Treaty." In the course of the meeting, the status of the nuclear nonproliferation process, prospects for further reduction and limitation of nuclear weapons, and cooperation on WMD as a key problem for future nuclear disarmament were analyzed.

The annual meeting of the Forum's Supervisory Board took place in Moscow on December 12–13, 2011. In addition to presentations by William Perry, Rolf Ekeus, and other members of the Luxembourg Forum's Supervisory Board and International Advisory Council on current issues of WMD nonproliferation and arms control, the meeting was addressed by Anatoly Antonov, Deputy Defense Minister of the Russian Federation; Nikolay Spassky, Deputy Director General of Rosatom State Atomic Energy Corporation; and Vladimir Leontiev, Deputy Director of the Department for Security Affairs and Disarmament, Russian Ministry of Foreign Affairs.

An anniversary Conference marking five years of work of the International Luxembourg Forum on Preventing Nuclear Catastrophe was held in Berlin on June 4—5, 2012, under the title "Contemporary Problems of Nuclear Non-Proliferation." Russian Foreign Minister Sergey Lavrov sent an address to Conference participants. Igor Ivanov, Nikolay Laverov, William Perry, Roald Sagdeev, President of the Pugwash Conferences on Science and World Affairs Jayantha Dhanapala, German Federal Government Commissioner for Disarmament and Arms Control Rolf Nikel, as well as many other well-known politicians and experts, took part in the work of the Conference. The Conference participants discussed the current situation and prospects for the reduction and limitation of nuclear weapons, as well as key challenges to strengthening the nuclear nonproliferation regime.

The next international Conference took place in Geneva on September 11—12, 2012. This was a particularly important event, because there the first steps were taken toward the implementation of a new secure nuclear tolerance project. The Conference was held jointly with the prominent Geneva Centre for Security Policy.

The Conference concluded by announcing that experts of the International Luxembourg Forum had started to address the task of identifying criteria of undeclared nuclear weapons development activities to be potentially applied by the IAEA and the UN Security Council to determine the nature and purposes of NPT member states' nuclear programs. Such criteria could serve as a basis for the IAEA and the UN Security Council to take appropriate measures to prevent violations or the withdrawal of member states from the Treaty on the Non-Proliferation of Nuclear Weapons, as well as help to identify the limits of secure tolerance within the nuclear nonproliferation regime.

In keeping with the tradition, the Final Declaration of the Conference was sent to leaders of major states and heads of international organizations.

The International Luxembourg Forum continues its work, proposes new initiatives, and produces proposals of practical value, actively engaging with authoritative experts from various countries to analyze current problems of arms control, international security, and WMD nonproliferation.

WELCOME ADDRESS

Viatcheslav KANTOR, Ph.D.
President of the International Luxembourg Forum on Preventing Nuclear Catastrophe (Russia)

Thank you for agreeing to take part in our annual Conference, the topic of which is "Secure Tolerance Criteria for the Nuclear Nonproliferation Regime." I am especially grateful to the Geneva Centre for Security Policy and its Director, Fred Tanner, for their cooperation in holding the Conference. I am also grateful to our guest Vadim Shulman, the initiator and organizer of a multi-part documentary cycle titled *World War III Has Begun*, which analyzes the problems of international terrorism, including nuclear terrorism. Mr. Shulman has a number of other functions, but he has no relation to the topic of the Conference.

The Conference we are holding today and tomorrow differs to a significant extent from those that we held over the six years of our Forum's existence. The topic of the Conference reflects the initial stage of research aimed at identifying the conditions and signs that states' nuclear technologies are nearing the borderline that we call the red line. The red line represents the point beyond which we can assert with a high degree of confidence that the state intends to create nuclear weapons. When the line is crossed, it requires extraordinary decisions and adequate measures to prevent such developments.

This is how this Conference is different from the previous ones at which we always analyzed current problems in the nuclear technologies and weapons nonproliferation regime, including the problems of reducing nuclear weapons, resolving the nuclear crises of North Korea and Iran, preventing nuclear terrorism, and other problems.

Allow me to remind you that during these six years, we held fifteen conferences, seminars, and workshops on topical problems in Washington, Moscow, Luxembourg, Rome, Vienna, Geneva, and Stockholm. Upon the completion of each meeting, we presented specific proposals for the resolution of the most pressing problems of nuclear security to the heads of leading states and the leadership of the main international organizations, including the UN, IAEA, NATO, CSTO, OSCE, and others. Practically all of the addressees took the Luxembourg Forum's proposals into consideration, which is evident in their responses.

Each December the members of the Forum's Supervisory Board evaluate the Forum's work over the course of the preceding year and recommend a program of further action. The Supervisory Council consists of such prominent, internationally recognized political figures and scholars as Sam Nunn, William Perry, Hans Blix, Rolf Ekeus, Roald Sagdeev, Nikolay Laverov, Igor Ivanov, and Gareth Evans.

Upon the completion of today's Conference, we expect that the studies we have begun will develop briskly in order to justify the acceptable limits of so-called nuclear tolerance. In other words, these limits apply when non-nuclear states have the right under the provisions of the Non-Proliferation Treaty to the complete nuclear fuel cycle for the purpose of developing nuclear energy generation, but signs appear suggesting that they are taking advantage of this right for the illegal development of weapons technologies. In such cases, a state's right to the full nuclear fuel cycle needs to be restricted.

In this connection, I cannot help but recall an interview of the ex-Director General of the IAEA, Mohamed ElBaradei. In response to the interviewer's question of why UN Security Council resolutions prohibit Iran from enriching uranium, while any member of the Nuclear Non-Proliferation Treaty has the right to the full fuel cycle, ElBaradei firmly replied that as long as Iran has not responded to all of the questions from the IAEA, it does not have such a right.

I believe that the restriction of such a right should be formalized through stricter decisions than even the respective UN Security Council resolutions, which, as experience has shown, can be ineffective. I have in mind the prohibitions for Iran on enriching uranium formulated in those resolutions. The position of the P5+1 group in talks with Iran proposes compromise solutions that involve restricting uranium enrichment only to 20 percent and permitting enrichment up to fuel level. This testifies to the arbitrary nature of such prohibitions. This undermines the authority of the UN Security Council, which I see as unacceptable.

Under these conditions, we expect to develop distinct criteria of how to define the limits of nuclear tolerance. A justification of the need to define such limits has been previously expounded upon in a more general work titled *Secure Tolerance*, which considers approaches to risks of various character but pays special attention to nuclear tolerance.

Of course, you can say that we have been late with these studies, since there is the illustrative experience of North Korea, which long ago crossed over the red line, and Iran, which is already balancing and dancing on that line. I will only note that our experts have already analyzed the evolution of those states in the field of weapons technologies and will continue that analysis further, including at this Conference. However, the development of nuclear power generation continues, and an ever greater number of countries aspire to such development — and not in Africa alone. It is not always possible to reliably predict the goals of certain countries' governments. That is why I consider our studies to be entirely relevant.

The list of signs that states have crossed beyond the boundaries of peaceful nuclear energy generation is rather long, and that list needs to be arranged by order of degree of danger. One such sign is the unjustified enrichment of uranium up to 3.5 percent for a small number of nuclear power plants and up to 20 percent for research reactors under conditions where it would be significantly cheaper to obtain the needed quantity of fuel from international centers under the control of the IAEA. Other signs include the operation of undeclared nuclear infrastructure facilities and building such facilities, including uranium-enriching enterprises, deep underground for the purpose of shielding them from various types of attack. Yet another sign is the possession and development of missiles and aircraft capable of delivering nuclear weapons. And so on. It is possible that when a state refuses to sign and ratify the Additional Protocol of 1997, that should be considered one of the first signs that the state plans to create nuclear weapons or is coming close to the capability of creating them.

According to IAEA data, as of April this year, 22 states have not ratified the Additional Protocol of 1997, including, once again, Iran, as well as Algeria, which claims to be developing nuclear power generation.

It is also necessary to consider states' attitudes to the Comprehensive Nuclear Test Ban Treaty. And, of course, we must take into consideration the governments of states that possess nonmilitary nuclear technologies.

The highest-qualified Luxembourg Forum experts in the field of nuclear security, who are well-known internationally, are taking part in this Conference as meeting moderators and speakers. They include Tariq Rauf, Mark Fitzpatrick, Ariel Levite, Alexei Arbatov, Vladimir Dvorkin, Sergey Oznobishchev, John Carlson, Jarmo Sareva, and Petr Topychkanov. It is satisfying for me to note that Army General Vladimir Iakovlev, the former Commander-in-Chief of Russia's Strategic Missile Forces, who has substantial experience with nuclear missiles, has now become involved in control issues and has become a member of the Luxembourg Forum's International Advisory Council.

I am confident that we will ultimately manage to handle the research tasks confronting us. And, of course, our experts, as previously, will continue to analyze the ongoing problems of securing nuclear nonproliferation regimes. There is no shortage of those problems. For example, in recent years, the lack of acceptable compromises on European and global missile defense has hindered progress toward further reduction of strategic and nonstrategic nuclear weapons. There are other barriers as well. We have already conducted detailed analyses of these issues on multiple occasions and have presented our proposals and recommendations. We will continue to do so in the future.

Thank you for your attention. We will begin our work according to the Conference program.

SESSION 1

TECHNICAL ASPECTS OF NUCLEAR WEAPONS DEVELOPMENT

Chairman –
Alexei ARBATOV

Head of the Center for International Security, IMEMO RAS; Academician RAS (Russia)

Nuclear Weapons and Delivery Vehicles

Vladimir DVORKIN, Professor
Chairman of the Organizing Committee, International Luxembourg Forum; Major-General, ret. (Russia)

The purpose of analyzing the development processes of nuclear weapons and missiles as a Conference topic is primarily to assess the road that countries must traverse when they are planning to create such weapons. This includes countries that are advancing toward the red line either overtly or covertly.

1. The experience of developing nuclear weapons in the Soviet Union/Russia, the United States, the United Kingdom, France, China, India, Pakistan, Israel, and North Korea has followed certain necessary stages: research, development, laboratory tests and integrated tests, and optimization of missile engines through bench and flight tests. There are minimum time requirements for development and flight testing (at least fifteen to twenty years). There are stages involving development of warheads suitable for ballistic missiles, cruise missiles, and air bombs for aviation, as well as nuclear tests. Finally, the weapons developed are deployed in the armed forces.

From beginning to end, all of these processes take fifteen to twenty years or more.

2. How can such processes be monitored?

Do these countries have to conduct nuclear tests? Unfortunately, the answer is not always "yes," especially in relation to warheads containing weapons-grade uranium. There is abundant information on the Internet on the construction of such warheads. Warheads that use plutonium require significantly higher technological experience in manufacturing, so it's entirely likely that they need to be tested.

It is very difficult to monitor the development processes of warhead construction, and it's impossible to do it in countries that have not ratified the Additional Protocol to the 1997 Non-Proliferation Treaty. Such work can be carried out secretly in any industrial design office or institution not connected with a nuclear infrastructure.

Monitoring the processes of nuclear missile creation during the period when there were no developed national monitoring systems differed quite substantially from the period after such systems were developed. Those systems include photographic, optical/electronic, and radio equipment. During the initial stages, it was possible to monitor missile flight trajectory and telemetric signals from missiles and warheads. Those signals were not very informative. For example, in order to prevent the telemetric signals from being monitored, telemetric information coming from the missiles in the Soviet Union was encrypted. Encryption was not used in the United States, but the transmission form was such that it was very difficult to interpret the signals, especially when the signals characterizing flight processes were transmitted continuously, although it was possible to determine signal parameters, such as the separation of the device from the warhead. And this was only under the terms of the START-I Treaty, when the parties exchanged not only magnetic tapes with recordings of the information transmitted from the missiles, but also so-called calibration data. Based on this information, it was possible to evaluate missile characteristics.

Later, with the significant development of spy spacecraft, land tests could be monitored, including, for example, bench firing tests of missile engines, preferably when such tests were performed on open test benches. Subsequently, bench complexes with a closed circuit that did not emit combustion products into the atmosphere were created.

3. How applicable is this experience for predicting the creation processes of warheads and delivery vehicles under today's conditions in relation to countries that are planning to create nuclear weapons? It is apparent that this experience can be used, to a significant degree, to monitor attempts to create nuclear missiles by developed countries with stable regimes and democratic or near-democratic forms of rule. Such countries will, to a significant degree, repeat the processes of developing such weapons that other nuclear countries have followed.

There are dozens of non-nuclear countries that possess missiles, but special conditions are required to equip those missiles with nuclear warheads, especially when the warheads are being attached to mid-range and long-range missiles. Upon their entry into the dense layers of the atmosphere, for example, internal temperatures, warhead body durability, and vibration become more critical for nuclear warheads than for warheads containing conventional explosives.

Therefore, intercepted telemetric information must be analyzed in order to determine how previous flight tests were different from subsequent ones. As I said already, it's impossible to determine the absolute values of the operational processes of missile systems in flight, but it is entirely possible to determine the differing parameters in a sequence of launches connected with the location conditions on nuclear-warhead-equipped missiles.

It's extremely important to estimate the character of signal parameters, which is easier to do. For example, if signal parameters appear in flight tests when the warheads are moving at an altitude of 300—600 meters, then that may be a command to detonate a nuclear warhead, since there is no sense in detonating a conventional warhead at such an altitude. There are other differences known to specialists that I'm not going to talk about here.

4. It's significantly more difficult, but still possible, to apply the experience described above to countries with abhorrent and secretive regimes, such as, for example, North Korea and Iran. And the attitude toward them in terms of them coming close to the red line and preventing them from approaching it needs to be different.

The experience of the creation of nuclear weapons in North Korea is well-known, and there were no special differences there from other countries. But the experience of the development of long-range missiles is completely different in terms of the threat of those missiles being used. After just two failed launches of *Taepodong* missiles, North Korean specialists managed to launch a satellite. Nobody else had been able to do this before. Moreover, in light of its power performance, the missile is entirely capable of carrying a nuclear warhead. The Iranians also have launched a very light satellite, but, according to estimates, their missile cannot be equipped with a nuclear warhead. It's true that *Shahab-3* and *Sajjill* missiles are fully capable of carrying nuclear warheads, and their telemetric information should be monitored very closely.

Dozens of non-nuclear states have shorter-range Scud-type missiles with a range of 300—600 kilometers. Such missiles can also be equipped with nuclear warheads, and therefore monitoring can be mainly concerned with the illegal development of such warheads. It is relatively easier to attempt to create such warheads in countries that have ratified the 1997 Additional Protocol, but 22 states remain outside the application of that Protocol.

5. Finally, I must note that ballistic missiles are far from being the sole delivery vehicles of nuclear warheads. Here are two examples.

There are twelve units of Iran's Azarakhsh and Saeqeh fighter jets in operation. Their payload is 3.5—4.4 tons.

There are approximately 120 units of the old American F-5 fighter jets with a payload of 2800—3175 kilograms. With such payloads, there is no need even to minimize the mass and physical dimensions of nuclear warheads, as is required for ballistic missiles. We're not even speaking of the possibility of loading a nuclear explosive device onto a ship.

Under these conditions, we are left to rely upon the operations of leading states' intelligence communities. Such cooperation exists, but there remains significant room to improve its effectiveness while raising the level of mutual trust.

Thus, the task in monitoring states' evolution toward the red line is a complex scientific and technical problem. The IAEA has many highly-qualified inspectors at its service, but they are not capable of resolving the problems of instrumental monitoring of potential bearers of nuclear arms (for example, analyzing telemetric information).

Under these conditions, I propose that we discuss the possibility of forming a special closed Center (or Agency) for monitoring the processes of the creation of not only nuclear weapons, but nuclear weapon delivery vehicles as well. The Center could operate in close contact with the IAEA. It should cull not just information from the monitoring systems of Russia, the United States, the United Kingdom, France, China, and Germany (including optical-electronic, radio, and other devices), but also real-time intelligence information. The Center should be manned by highly-qualified specialists from the leading countries. The big five nuclear states, and possibly other interested states, could make the decision to create and finance the Center.

If you agree today with this proposal, then we can include it in our final declaration.

Certain Issues of Control over Nuclear Energy in Non-nuclear-weapon States

Vladimir IAKOVLEV
Principal Researcher at the Center for International Security, IMEMO RAS; General of the Army, ret. (Russia)

Dear colleagues, I am certain that you know well the main problems of controlling technologies in nuclear power generation. These are not new problems. Just consider who pioneered their development: Szilárd, Fermi, Kurchatov, Bhabha, and many others foresaw the global character of the consequences of developing such technologies. At the same time, they emphasized the necessity of creating an international nuclear security system and placing the use and proliferation of nuclear technologies under international control.

Much has been done since then. Most importantly, the Nuclear Weapons Non-Proliferation Treaty and other official documents that fortify the nuclear nonproliferation regime have come into effect.

However, problems remain in this area that are attributable to the following factors:

— On the one hand, it is possible to isolate and to exert complete control over practically all radioactive waste. On the other hand, we have yet to achieve a practical solution to the problem of the final disposal of such waste.

— On the one hand, a global nonproliferation regime has been created. On the other hand, there is a black market for nuclear materials and technologies, and there is no sufficiently reliable means of preventing the possible appearance of new countries possessing nuclear weapons, as nuclear technologies spread. There is also the potential threat of nuclear terrorism.

— On the one hand, there is a renaissance in the nuclear power generation industry. On the other hand, there is the insoluble problem of creating a commercial closed nuclear fuel cycle and a commercial plutonium breeder reactor that would fully comply with the requirements of WMD nonproliferation.

— On the one hand, the system of state management, international initiatives, and agreements has come to exert more influence on the formation of strategies for nuclear fuel cycle development. On the other hand, states have refocused toward market-oriented strategies that increase the openness of the market for nuclear materials, services, and the conduct of commercial transactions for the transmission of nuclear fuel cycle technologies and production facilities.

As a result, the insufficiently controlled spread of nuclear technologies has substantially complicated the international environment and has led to the appearance of countries suspected of having created or creating nuclear weapons (including North Korea, Iran, Iraq, Syria, and others).

Nuclear power plants with reactors that use an insignificant amount of uranium resources (approximately 0.5 percent) currently comprise the basis of nuclear power generation. The program for the development of fast breeder reactors has been rolled back or abandoned for a number of reasons, primarily economic ones.

The nuclear fuel cycle originally developed and continues to develop on the basis of a technology meant for the production of ultrapure weapons-grade plutonium, generating reserves of free plutonium and the potential risk that they will spread. At the same time, technologies for the processing of spent nuclear fuel that are technically protected from the risk of WMD proliferation through the use of laminar barriers have been created on the laboratory level and demonstrated.

However, the rejection of weapons-grade plutonium production technologies that have already been created on an industrial scale and the transition to new protected technologies requires new investments and involves the loss of profits from billions of capital investments already made. Therefore, private companies are unlikely to do this voluntarily. The same situation has also occurred with the centrifuge technology of uranium enrichment — the most sensitive technology in terms of nuclear proliferation and the simplest and most efficient way of producing weapons-grade material. It is widely used and brings in billions in profits.

The problem of nuclear waste disposal has turned into one of the most sensitive problems at the current stage. At present, the creation of closed nuclear fuel cycle infrastructure has not yet been completed; there is no industrial processing of plutonium fuel; the problem of the final disposal of highly radioactive waste has yet to be resolved; and nuclear fuel burnup has yet to reach the necessary level.

I will cite some actual data.

The total amount of spent nuclear fuel discharged from nuclear power reactors throughout the total period of their operation amounts to over 300,000 tons, only 30 percent of which has been processed. The amount of discharged spent nuclear fuel increases each year by approximately 11,000—12,000 tons, two-thirds of which is put into storage. Moreover, 67 percent is located in cooling ponds and 33 percent is in centralized storage facilities.

At present, the quantity of spent nuclear fuel in Russia at nuclear power plants and the storage facilities of radiochemical plants is approximately 14,000 tons. That number rises each year by about 850 tons.

Calculations have been made that show that by 2030, the total quantity of plutonium contained in spent nuclear fuel will grow to 3500—3700 tons. Also by 2030, the quantity of spent nuclear fuel accumulated in the countries of Asia and Africa will grow by 3.4 times, in East Eurasia by 6.2 times, in Latin and North America by 1.8 times, and in Western Europe by 1.2 times.

The absence of a market for the provision of spent nuclear fuel storage services and the presence of political restrictions on the provision of such services, while such reserves are accumulating at such high rates, is leading to a situation where existing containers for the storage of spent nuclear fuel as well as those currently being built will all be filled some time in the 2015—2020 time frame. This will unquestionably become yet another factor that will impact the WMD nonproliferation regime.

The temporary storage of spent nuclear fuel in countries that have surplus storage capacity (a total of 25 countries in the world have such capacity) makes it possible to overcome the storage container deficit. However, there are difficulties on this path connected with the fact that 75 percent of spent nuclear fuel reserves are under the control of the United States. Washington has imposed restrictions on the handling of that spent nuclear fuel. But even if those restrictions were lifted, that would not solve the problem of the spent nuclear fuel storage capacity deficit.

There are significant disproportions between the countries that consume nuclear power generation services and those that supply such services in terms of their industrial infrastructure. Nuclear fuel cycle enterprises have been created and are currently in industrial operation in 35 countries. Some 437 reactors operate in 28 countries, while 56 others are in the construction stage. However, only seventeen countries are capable of producing uranium ore. In spite of the fact that most uranium conversion and enrichment units are concentrated in several countries of the Organization for Economic Cooperation and Development (including Canada, France, Germany, the United Kingdom, and the United States) and in Russia, eighteen countries have the capacity to produce nuclear fuel using uranium supplied by such enterprises.

At present, the market for nuclear fuel cycle goods and services is acquiring an international character. Such services as the production, conversion, and enrichment of uranium and the manufacture of nuclear fuel and the supply of that fuel to nuclear power plants are performed by a limited number of countries and are provided to other countries on a commercial basis. There are five companies operating on the international services market that convert uranium; there are four companies that enrich uranium; and sixteen companies provide services for the manufacture of nuclear fuel. The question arises of whether the nuclear fuel production services market is capable of resolving all of the problems of WMD nonproliferation in spite of the commercial and political restrictions.

To a certain extent, the final part of the fuel cycle also bears an international, albeit limited character. In particular, France, Russia, and the United Kingdom have had a positive experience of handling foreign spent nuclear fuel.

There are only four countries that have facilities for the industrial processing of spent nuclear fuel on their territory: France, Japan, Russia, and the United Kingdom.

In spite of the global nuclear nonproliferation regime that has been created and approved by the majority of countries, such disproportions are incapable of dealing with the potential appearance of black markets in nuclear materials and technologies and creating an international mechanism to prevent the appearance of new countries that possess nuclear weapons as nuclear technologies continue to spread throughout the world.

Since the IAEA was formed in 1957, a system of safeguards has maintained confidence that the participants of the Non-Proliferation Treaty are performing the obligations they undertook. However, concerns have recently been growing over the situation with inspections, which specialists characterize as inadequate for contemporary conditions.

There are 151 member states in the IAEA. The organization has 171 safeguards agreements, 2300 employees, and centers in 90 countries with a budget of $300 million. Moreover, the IAEA conducts approximately 200 inspections each year, which is considered to be insufficient.

Nuclear energy generation has been developing and the quantity of nuclear materials supplied under the safeguards has been increasing in proportion to cumulative power produced, and not the capacity for nuclear power generation. For example, the quantity in Significant Quantity (SQ) units of materials under the safeguards rose by five times from 1980 to 2000, while capacity merely doubled. At present, slightly more than 50 percent of the entire quantity of the most attractive nuclear materials that are used for civil nuclear energy generation have been put under safeguards. This mostly consists of the materials of non-nuclear states.

It has been established that concerns over the spread of spent nuclear fuel processing technologies and uranium enrichment technologies have led to a state of affairs in which the IAEA was compelled to propose multifaceted approaches to strengthen WMD nonproliferation safeguards. The objective of those approaches was to fortify existing commercial agreements in relation to the given nuclear fuel cycle limits by establishing international guarantees for the supply of nuclear fuel and the voluntary submission of existing units to multinational control, as well as the creation of new multinational units.

Russia and Germany have well-established initiatives for the creation of international nuclear fuel cycle centers for the enrichment and processing of spent nuclear fuel and the creation of international nuclear fuel banks for new countries to obtain guaranteed access to nuclear fuel cycle products and services.

One of the most important initiatives is for the priority provision of qualified personnel for nuclear power generation. The international community has set out upon the path of integration in this area:

An organization of the heads of 41 nuclear engineering departments at universities has been active in the United States since 1982.

Six universities and a number of organizations have formed the UNENE (University Network of Excellence in Nuclear Engineering) in Canada.

The European Nuclear Education Network (ENEN), including 21 universities and six research centers from seventeen countries, was created in 2003.

The Worldwide Universities Network (WUN), a global research alliance, is being created in the United Kingdom. It consists of sixteen universities, including nine in Europe, five in America, and two in China.

The Asian Network for Education in Nuclear Technology (ANENT) was founded in 2004 in Malaysia.

In light of the WMD nonproliferation problem, on the one hand, the tasks of controlling and managing nuclear knowledge require the free exchange of information and experience. On the other hand, the nonproliferation of military nuclear technologies requires that a certain degree of control and secrecy be maintained. Therefore, in managing nuclear knowledge, it is necessary to establish the correct balance between nuclear security and the requirements for the nonproliferation of sensitive nuclear technologies.

The U.S. program for international assessment of the nuclear fuel cycle can be noted separately. The program has demonstrated convincingly that the influence of technical measures on the entire range of WMD proliferation risks is limited. This means that the development of technologies that resist WMD proliferation by itself cannot guarantee that WMD proliferation will be prevented.

As a whole, there are a number of lacunae in international nuclear law connected with the fact that technological progress proceeds faster than international lawmaking. Unfortunately, the initiatives proposed by various states and organizations in recent years that were mentioned above remain mere initiatives, and they do not transform into international treaties with a system of control and sanctions.

The entire system of international nuclear law is built on the obligations and responsibilities of states. The commercialization of the nuclear industry and the creation of international companies leads to a certain blurring of responsibilities for WMD nonproliferation.

The conferences held in recent years that reviewed actions under the NPT periodically proposed a number of important and necessary initiatives. For example, in 2010, a number of Western countries proposed that a state that had made the decision to leave the NPT should return all of the nuclear materials and technologies that were supplied to it during the period when it was a participant of that Treaty and be held accountable for any violations of the NPT that it commits before exiting the treaty. Another proposal promoted the requirement that a state should have an effective Additional Protocol of 1997 to the Agreement with the IAEA on the application of safeguards in order to receive nuclear materials and technologies.

However, certain member states of the Non-Aligned Movement are opposing these initiatives, while Iran, Libya, Syria, and a number of others categorically reject these measures, considering them tantamount to a reorientation of NPT provisions.

Events in the area of improving Treaty relations reveal certain weaknesses of the nuclear nonproliferation regime.

While a process of forward motion is nearly constantly observed in the area of strategic offensive arms, such is not the case, unfortunately, in the area of international nuclear law.

If constructive measures are not found for the implementation of the initiatives and proposals of scientists and the public in the area of WMD nonproliferation in the 21st century, then the process of any state's movement toward the red line may remain unrecognized.

SESSION 2

SCIENTIFIC, TECHNICAL, AND INDUSTRIAL POTENTIAL AS A PRECONDITION FOR NUCLEAR WEAPONS DEVELOPMENT

Chairman –
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Director of the Geneva Centre for Security Policy (Switzerland)

Preconditions for the Creation of Nuclear Weapons: Scientific, Technological, and Industrial Aspects

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Four main stages should be identified in the evolution of a state's technological and industrial potential on the way to the possession of nuclear weapons.

– Stage 1: Initial planning and development of a nuclear infrastructure;

– Stage 2: Planning and creation of a technological basis that will have the potential to produce weapons-grade nuclear materials (development of the nuclear fuel cycle);

– Stage 3: Production of a nuclear warhead (weaponization);

– Stage 4: Conduct of nuclear tests with the purpose of confirming the performance and improvement of the warheads.

Each stage characterizes a corresponding group of states that have reached that level of development of technological and industrial potential. Furthermore, this model comprises a sort of *matryoshka* [Russian nesting doll]: the higher the level of development of technological and industrial potential, the fewer states there are that have reached that level. Transitions between stages can occur in either the upward or downward directions. In particular, downward movement is possible when a state renounces its existing nuclear arsenal.

A state may reach the first two stages regardless of whether it plans to develop nuclear technologies for exclusively peaceful purposes or whether it has secret plans to use the technologies to develop and produce nuclear weapons.

We can further elaborate this model by introducing intermediate stages and subgroups. However, for the purposes of this report, and considering that this material is part of the first stage of scholarly discussion on this subject, we will limit ourselves to the basic model set forth above.

We will now consider in greater detail these stages in the evolution of states' technological and industrial potential, as well as examples of countries with the respective potentials.

Stage 1: The initial planning and development of a nuclear infrastructure. At this stage, the state makes the decision to create the first nuclear laboratories and research centers, to acquire nuclear research infrastructure and nuclear materials, and to begin educating personnel.

This is the stage where the primary accumulation of the state's practical experience in work with nuclear materials and the operation of nuclear facilities takes place. As a rule, this happens with the assistance of other states. Thus, the U.S. Atoms for Peace program provided a strong impetus for the development of knowledge and nuclear technologies in a number of countries, as did a similar Soviet program based on a declaration of the government of the Soviet Union entitled "On the provision of aid to foreign countries in the creation of nuclear physics research centers," issued in January 1955. The programs established by Moscow and Washington made it possible, for example, for North Korea to send dozens of scientists to the Soviet Union for training and to build a research reactor patterned after a Soviet design (IRT-2000). Likewise, the programs also made it possible for Iran to begin training personnel in the United States and to build a research reactor based on an American design, which initially ran on highly-enriched uranium fuel. At present, the only highly-enriched uranium present in Iran is contained in the spent fuel from that research reactor, which was supplied by the United States nearly fifty years ago.

We are now able to say that approximately seventy countries in the world have reached the first stage of technological potential. These primarily consist of countries that have at least one research nuclear unit on their territory or plans to build such units that are in the advanced stage of implementation. In particular, Burma is in the first stage of development. Although many concerns were voiced until recently regarding Burma, it still has no nuclear facilities on its territory.

Stage 2: The planning and creation of a technological basis that will have the potential to produce weapons-grade nuclear materials (development of the nuclear fuel cycle).

As a rule, a state at this stage begins developing the nuclear fuel cycle, including its most sensitive stages in terms of the proliferation of weapons of mass destruction: enrichment and/or chemical processing of spent nuclear fuel and the separation of plutonium. Producing weapons-grade nuclear materials is one of the greatest bottlenecks in the production of a nuclear explosive device. Even weaponization, which has an important political aspect in addition to the technological aspect, does not screen out as many states as the production of weapons-grade nuclear materials does.

As for the number of states, less than fifteen countries have reached this stage of development, including the five official nuclear states as well as Brazil, Germany, India, Iran, Israel, Japan, Pakistan, and others.

As indicated above, intermediate stages and subcategories can be elaborated within the model I am proposing. For example, in this case, the second stage can unfold into the following intermediate stages:

Planning and development work involving the nuclear fuel cycle;

Creation of pilot units for running the nuclear fuel cycle;

Creation of industrial enterprises that run the nuclear fuel cycle.

Furthermore, we can also add subcategories related to whether weapons-grade materials have been developed yet or not.

Such detailed elaboration can help show, for example, the difference between Iran's technological potential in the 1970s and today. Under the basic classification, Iran belonged to the same category of countries then as it does now. The above elaboration will make it possible to show that Iran has made impressive progress from planning and development involving centrifuge enrichment in the 1970s to a semi-industrial uranium-enriching enterprise based on gas centrifuges today.

The detailed classification also better illustrates the difference between the modern weapons potentials of South Korea and Japan. Uranium enrichment projects are ongoing in both countries, but while there is a small-capacity (about 1 million SWU) plant in Japan, such operations in South Korea are only at the stage of planning and preparation of the necessary legal basis.

I must note that Seoul is currently working actively to establish the legal preconditions for the creation of production facilities in that country for the enrichment of uranium and reprocessing of spent nuclear fuel. By the way, this should concern us, considering that undeclared nuclear activity has taken place in South Korea on at least two occasions in the past. One of those occasions involved the separation of plutonium and the second one involved the enrichment of uranium. All of this is happening under conditions of growing pro-nuclear attitudes in the country (approximately 70 percent according to opinion polls) as a result of North Korea's continuing nuclear program.

Stage 3: The production of a nuclear warhead (weaponization). The category of countries that have reached the third stage of development of technological potential, where the decision was made at a certain point in time to create nuclear weapons, includes nine countries: the five official nuclear states, India, Pakistan, Israel, and North Korea.

World history also has seen the example of South Africa. For reasons of domestic policy, that country's government made the decision to disassemble its six completed nuclear weapons, and it later decommissioned its uranium enrichment plant, where highly-enriched uranium had previously been produced for weapons. Thus, according to my model, South Africa voluntarily left the third group of countries and crossed over into the first.

In essence, Belarus, Kazakhstan, and Ukraine, where nuclear weapons were present after the collapse of the Soviet Union, never belonged to the third group of states. Those countries' nuclear weapons were brought over to Russia. During the Soviet period, independent infrastructure for weaponization, uranium-enriching enterprises, and enterprises for the chemical processing of spent nuclear fuel were not created on the territories of those states. Thus, these post-Soviet states can be categorized within the first group.

Stage 4: The conduct of nuclear tests with the purpose of confirming the performance and improvement of warheads.

The next stage in the development of states' nuclear potentials after weaponization is the conduct of nuclear field tests, which will make it possible to verify the performance of the chosen warhead structure and obtain technological information on the improvement of warheads, including ways to miniaturize warheads in order to fit them onto delivery vehicles. Israel is the only country that has produced nuclear weapons but most likely has not conducted nuclear tests. For many years, it was official Israeli policy neither to confirm nor deny the country's possession of nuclear weapons. Thus, there are eight countries that can be categorized within this group.

It has been established that South Africa, after assembling six nuclear weapons in the 1980s, was preparing to test them. However, it first postponed tests under pressure from both Moscow and Washington, and later the decision was made to give up the country's nuclear weapons program.

By now, North Korea has performed three nuclear tests. However, it is apparent that it is still too early to tell whether Pyongyang is capable of producing a compact nuclear warhead that could be fitted onto one of that country's delivery vehicles.

Signs That a Decision Has Been Made to Create Nuclear Weapons

It is obvious that, out of national security considerations, a state will not announce whether its leadership has made the decision to produce a nuclear explosive device (weaponization). However, it is apparent that there are a number of signs that may indicate that such a decision has been made. The signs that a state has made the decision to develop a military nuclear program and thereby advance from the second group of states to the third in the model presented above include the following:

Enrichment of uranium begins to exceed 20 percent (i.e. up to highly-enriched uranium per the IAEA classification), while the state in the near- to mid-term continues to lack educational, research, energy-producing, or shipboard nuclear power plants that use fuel based on highly-enriched uranium.

Creation of an industrial reprocessing facility, while the state has no near- to mid-term prospects of possessing a developed network of nuclear power plants and other infrastructure for the use of MOX fuel.

If a state that belongs to the second group of countries (and possesses enrichment or reprocessing technology) announces that it plans for whatever reason to suspend application of IAEA safeguards at respective sites, that would also deserve close attention and urgent investigation.

At the same time it is apparent that if a country builds underground nuclear fuel cycle facilities, including facilities for the enrichment of uranium, that by itself is insufficient to conclude that the state intends to acquire the potential to create nuclear weapons. This is so in light of the accumulated historical experience of military operations against critical infrastructure facilities (e.g. the Osirak research reactor in Iraq and the Al Kibar military site in Syria).

In conclusion, I would like to call your attention to the fact that the IAEA considers 25 kg of highly-enriched uranium and 8 kg of plutonium with the respective isotopic characteristics to be a significant quantity. It is considered that approximately that much nuclear material can be used to manufacture the simplest nuclear explosive device. Under contemporary conditions, when nuclear energy has achieved large-scale development and nuclear materials and technologies have been widely distributed, it is necessary to study the feasibility of revising downward the minimum quantitative criteria for a significant quantity, with consideration for the wide use of this unit in the system of accounting for nuclear materials for the purpose of ensuring IAEA safeguards. There is no doubt that the five official nuclear states are capable of building a nuclear warhead with a smaller quantity of nuclear material. However, the possibility remains that newcomers to the nuclear field may also be capable of this, considering general technological development and the availability of the technologies we have considered.

SESSION 3

Regional Problems of Nuclear Nonproliferation

Chairman –
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North Korea's Special Path to Nuclear Weapons

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The beginning of North Korea's nuclear program goes back to 1947 – 1950, when Soviet specialists conducting geological exploration work in North Korea discovered large reserves of uranium-containing ore (up to 26 million tons), a significant quantity of which (approximately 4 million tons) was found to be suitable for industrial development. During the same period, the industrial development of uranium ore also began, and at least 9000 tons of monazite ore were exported to the Soviet Union. It is obvious that the Korean War of 1950 – 1953 had a substantial impact on North Korean leader Kim Il Sung's decision to acquire nuclear weapons. During that war, American military leaders considered the possibility of using nuclear weapons. This can explain the North Korean leadership's decision in 1952 to create a nuclear power research institute in their own country.

In 1956, North Korea signed an agreement with the Soviet Union for the training of Korean specialists in the field of nuclear research. North Korean students were trained at MEPhI National Research Nuclear University, Bauman Moscow State Technical University, and Moscow Power Engineering Institute. They also received practical training at the Joint Institute for

Nuclear Research in Dubna. A total of about 300 Korean specialists were trained before the 1990s. North Korea concluded agreements with the Soviet Union and China on cooperation in the field of the peaceful use of nuclear energy. Subsequently, construction of a nuclear research center began in Yongbyon (80 km north of Pyongyang). The Soviet Union supplied the IRT-2000 research reactor, a radiochemical laboratory, and a critical assembly for that center. By 1965, the research center in Yongbyon was complete.

The IRT-2000 is a pool-type nuclear reactor with a beryllium reflector. The reactor's core consists of 48 vertical channels, sixteen of which are designed for fuel. The reactor's capacity was 2 MW using EK-10 fuel assemblies made of uranium enriched to 10 percent with uranium-235. By converting to IRT-2M fuel assemblies, the reactor's power was increased to 6—8 MW. The reactor has up to ten horizontal channels to conduct various studies with neutron beams.

The Soviet Union's training of nuclear specialists and the reactor and laboratory for isotope production that it supplied created the basis for research with the purpose of developing technologies for processing spent nuclear fuel and plutonium production. As was later revealed, in 1975 North Korean specialists produced approximately 300 mg of plutonium from the uranium samples irradiated in the IRT-2000 reactor. This reactor and laboratory were used to educate and train personnel and essentially laid the foundation for finding the best way to produce weapons-grade nuclear material.

For technical reasons, in those years, it would have been unrealistic for North Korea to expect to develop nuclear weapons through the production of highly-enriched uranium. North Korea was unable to build its own enrichment facilities, and it would have been impossible to acquire the necessary equipment abroad. Therefore, the North Koreans chose the path of producing weapons-grade plutonium.

After North Korea acceded to the IAEA in 1974 and signed a safeguards agreement with the IAEA in 1977, the IRT-2000 reactor and its critical assembly were put under the IAEA's safeguards.

North Korea's accession to the IAEA made it possible to obtain access to the organization's materials and essentially choose the best way to acquire nuclear weapons under the pretext of developing nuclear energy. To this end, North Korean specialists chose a Magnox-type reactor developed in the United Kingdom in the late 1940s and early 1950s. Twenty-six reactors of this type had been built at eleven sites in the United Kingdom. The design of the Magnox reactors had been declassified in the late 1950s. These reactors had a dual purpose. They were used both for producing electric power and for the production of plutonium.

In this type of reactor, graphite is used as a neutron moderator. Carbon dioxide is used to cool the reactor core, and the fuel elements are manufactured from metallic natural uranium and are covered with a cladding of magnesium oxide.

The choice of this type of reactor was entirely appropriate for North Korea for the following reasons:

- The reactor runs on fuel made from natural uranium. Therefore, there is no need to enrich the fuel.
- The country has significant reserves of natural uranium and graphite.
- Due to irradiation, the fuel elements have a tendency to swell, which damages the fuel cladding. Consequently, unprocessed fuel is not intended for long term storage, and the irradiated fuel must be processed.

In brief, the choice of gas-graphite technology appeared entirely natural for the development of nuclear power and was, in essence, the ideal cover for implementing a program for the creation of nuclear weapons.

The construction of an experimental reactor with a thermal power of 20 MW (and an electrical power of 5 MW) began at Yongbyon in 1979 and was completed in 1986. The reactor's core has 812 fuel channels. The reactor was loaded with fuel elements 50 cm in length and 2.9 cm in diameter, each weighing 6.25 kg, with up to ten fuel elements loaded into each channel. Thus, approximately 8000 fuel elements with a total mass of approximately 50 tons can be placed into the reactor core. Operating at maximum capacity without interruption, such a reactor is capable of producing 6.2—6.5 kg of weapons-grade plutonium per year.

Plants were also built for the production of metallic uranium and fuel elements.

It is likely that the first discharges of irradiated fuel were carried out during shutdowns of the reactor in 1989, 1990, and 1991. This could consist of either destroyed fuel rods or fuel with the optimal level of burnup for the production of weapons-grade plutonium.

In 1985, construction of a plant for the processing of spent fuel began in Yongbyon. It was named the Radiochemical Laboratory. As was later determined, the laboratory's operative production line was capable of processing up to 100 tons of spent nuclear fuel per year. PUREX technology was used for that reprocessing, as well as for the extraction and purification of plutonium. North Korea used technology for this plant that was developed by the EUROCHEMIC company for a processing plant in Belgium. In the 1970s, this technology, along with production process diagrams, was published in IAEA publications, and the North Koreans simply replicated that technology. Experimental reprocessing of spent nuclear fuel began in North Korea before 1992.

Therefore, by 1992, North Korea had a functional experimental production reactor and all plants for the initial and final stages of the nuclear fuel cycle, which made it possible for the country to produce up to 6 kg of weapons-grade plutonium per year. Two more gas-graphite reactors with capacities of 200 MW and 800 MW were in the construction stage.

It should be pointed out that the experimental reactor and all of the fuel cycle plants were built without informing the IAEA, and therefore the IAEA did not perform inspections at those sites. North Korea signed the NPT in 1985. It did this under pressure from the Soviet Union, since the signing of that Treaty was one of the Moscow's conditions for providing aid to Pyongyang in constructing four units of the VVER-440 power reactor. Negotiations regarding a possible agreement between North Korea and the IAEA on the application of full-scale safeguards continued with intermittent success from 1985 to 1992. Pyongyang made conclusion of this agreement contingent upon political conditions, including progress in the normalization of relations between North and South Korea. Consequently, during this period, North Korea had no formal legal obligations to notify the IAEA about its nuclear activities.

The safeguards agreement between North Korea and the IAEA was concluded in January 1992. Under that agreement, the IRT-2000 research reactor, the 5 MW(e) experimental reactor, the plants for fuel production and reprocessing spent nuclear fuel, the nuclear fuel storage facility, and the critical assembly were put under IAEA safeguards.

According to North Korea's initial statement on its stock of nuclear materials, it possessed approximately 100—300 g of plutonium that had been produced during the processing of damaged fuel rods that had been removed during a shutdown in 1989 of the 5 MW experimental reactor. However, during the IAEA's inspection of initial uranium and plutonium stocks that was performed as the first step in applying NPT safeguards, the IAEA inspectors discovered discrepancies, indicating that the spent nuclear fuel processing plant had been used more frequently than North Korea had declared. Information passed to the IAEA by a member state indicated that there were two other waste storage facilities in Yongbyon, which Pyongyang had not declared. This provided a basis to suppose that North Korea had more weapons-grade plutonium than had been declared by the North Korean government. Various estimates put the quantity of plutonium produced from 1986 to 1989—1990 in the range of 10—15 kg.

In order to verify the information obtained, in February 1993 the IAEA asked North Korea to allow special inspections of two sites in North Korea. Pyongyang refused, and on March 12 it announced its intention to withdraw from the NPT. In April 1993, the IAEA Board of Governors concluded that North Korea was not in compliance with its safeguards obligations and informed the UN Security Council of this. In June 1993, North Korea announced that it was "suspending" its withdrawal from the NPT, but demanded a "special status" for its safeguards obligations. The IAEA refused this request.

In June 1993, North Korea announced that it was "suspending" the effectiveness of its decision to withdraw from the NPT in exchange for promises by the United States not to interfere in North Korea's internal affairs and not to threaten the use of force. At the same time, Pyongyang predicated its final decision on whether or not to continue participation in the NPT upon the resolution of military political issues on the Korean peninsula and the normalization of its relations with the United States.

After North Korea refused to admit IAEA inspectors to certain sites, the IAEA Board of Governors decided to stop technical support to Pyongyang for implementation of a number of projects. In response to that, on June 13, 1994, North Korea announced that it was withdrawing from the IAEA and that the IAEA would no longer perform inspections there. On June 15, 1994, the 5 MW reactor was fully discharged.

On October 21, 1994, North Korea and the United States signed a framework agreement that would resolve the North Korean nuclear problem. The agreement stipulated that North Korea would cease implementation of its program for the construction of gas-graphite reactors in exchange for the United States' promise to build two light water reactors and supply heavy fuel oil to North Korea during the construction of those reactors. Pyongyang undertook the obligation to return to full performance of its duties under the IAEA safeguards agreement during the final stage of construction of the energy reactors. Under the terms of the agreement, all enterprises in Yongbyon were shut down and IAEA inspectors began monitoring them again. Spent fuel elements removed from the 5 MW experimental reactor were encapsulated and placed in a cooling pool. They were put under the surveillance of the IAEA.

Thus, North Korea's plutonium program was suspended from 1994 to 2002. However, it is entirely possible that during that period North Korea concentrated its efforts on developing its uranium enrichment program. There are grounds to believe that North Korea received information and materials from Pakistan for enriching uranium using centrifuge technology, and there is some evidence that the North Koreans had successfully mastered that technology by 2002.

In December 2002, North Korea removed the IAEA seals from its sites in Yongbyon and expelled the IAEA inspectors from the country. In April 2003, Pyongyang announced its withdrawal from the NPT. That withdrawal took effect on July 11, 2003, thereby making North Korea the first country to withdraw from the Treaty. Operation of the 5 MW experimental reactor restarted in early 2003 and continued until July 2007. In April 2005, the reactor was defueled and refueled with fresh fuel. The reactor resumed operation in June 2005. Processing of the 8000 spent fuel elements removed in 1994 was completed by mid-2003. All of the plutonium extracted, about 16 – 20 kg, was converted into metal. Processing of the batch of spent nuclear fuel that had been removed in 2005 was completed in late August of that year. This made it possible to extract 8 – 10 kg more plutonium.

On October 6, 2006, North Korea conducted its first nuclear test, which, according to various assessments, was recognized as only partially successful.

In February 2007, within the framework of the Six-Party Talks (which had begun in 2003 with the participation of China, Japan, Russia, South Korea, and the United States), North Korea agreed to shut down its 5 MW experimental reactor and the enterprises associated with it, including the spent nuclear fuel processing plant in Yongbyon. The reactor and spent nuclear fuel processing plant were sealed and were supposed to have become subject to IAEA control. The spent fuel was supposed to be sent to the Mayak production enterprise in Russia or to the United Kingdom. In June 2008, North Korea detonated the 5 MW experimental reactor's cooling tower as confirmation that it had agreed to shut down its plutonium program.

However, in September 2008, North Korea refused to permit IAEA inspections, explaining that the agreement for construction of light water reactors was not being carried out. The Six-Party Talks held in December 2008 did not resolve anything, and North Korea once more expelled IAEA inspectors from the country. Operation of the processing plant in Yongbyon was restarted. The spent fuel elements from the irradiation campaign between mid-2005 and February 2007 were processed, which gave Pyongyang about 10 kg more plutonium. As a result, the total quantity of plutonium produced in North Korea amounted to 44 – 55 kg.

In May 2009, North Korea conducted yet another underground detonation of a nuclear device. This time, the test was more successful than in 2006.

On November 12, 2010, the North Koreans presented proof that uranium enrichment technology existed in that country by showing a uranium enrichment plant to American specialists in Yongbyon. According to the Americans, that plant's facilities have the capacity to produce up to 20 kg of weapons-grade uranium per year.

Thus, North Korean specialists have proven their ability to find the best methods for implementing their nuclear program and addressing the complicated technical issues associated with the creation of explosive nuclear devices.

The unique path that Pyongyang has traversed successfully to nuclear weapons compels us to take a critical approach to evaluating the existing WMD nonproliferation regime and the functioning of its institutions. North Korea is situated in one of the most unstable regions of the world, and the country and its regime are in a state of profound international isolation. Therefore, the possibility that the North Korean leadership would decide to implement a nuclear program aimed at acquiring its own nuclear weapons should have been predictable. North Korea's choice of Magnox type reactors and Purex technology for processing spent nuclear fuel (which make it possible to produce weapons-grade plutonium) as the basis for the development of its nuclear energy program did not attract the attention of the international community. This was a demonstration of how ineffective international controls over the proliferation of nuclear technologies have been, primarily on the part of the IAEA. The lack of any agreement on safeguards under the NPT over a seven-year period (1985—1992) has made it possible for North Korea to implement its nuclear program without supervision and to produce weapons-grade plutonium, thus allowing the country to cross the red line. The fact that North Korea now possesses plutonium has allowed its government to behave arrogantly, as shown by its expulsion of the IAEA inspectors from the country and the country's demonstrative withdrawal from the NPT. To a large extent, North Korea's problematic behavior has been the result of the absence of any decisive and concerted action by the international community aimed at thwarting North Korea's intentions to acquire nuclear weapons, which has made it possible for Pyongyang to carry out nuclear testing. The North Korean example remains a persuasive demonstration of the need to develop distinct criteria that the IAEA and the UN Security Council could use to identify the nature and true goals of the nuclear programs in other countries.

Iran's Growing Nuclear Weapons Capability

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Given the tragedy unfolding in Syria and the interesting election campaign spectacle in Iran, less media attention is being paid of late to the Iranian nuclear issue, which continues to worsen. The time it would take for Iran to effectuate its nuclear weapons capability grows shorter nearly every day. At some point, maybe within a year, it will be too short for comfort for one or two countries that have the will and the means to stop it.

It is natural that diplomacy has been stalled in the run-up to the June 14 election. Any progress in negotiations on the nuclear program would require compromises by Iran that would be criticized by rivals for political advantage. Such political grandstanding is certainly not unique to Iran, of course. Washington is awash with it. Nevertheless, it must be noted that Iranian politics makes it very difficult to find a way out of the nuclear crisis. Recall what happened in autumn 2009 after chief nuclear negotiator Saeed Jalili tentatively agreed to the nuclear fuel swap deal proposed by the United States with the support of France, Russia, and the International Atomic Energy Agency (IAEA). When Jalili presented the plan in Tehran, it was vociferously attacked from all parts of the political spectrum as giving away too much. Among the many ironies in the kaleidoscope of Iranian politics is that it was the hard-line Jalili and his then boss, President Mahmoud Ahmadinejad, who were the only players in Tehran identified as supporting the deal. Since that time, Jalili has become known for his non-compromising posture in the diplomatic talks, and he is now allied with the Supreme Leader Ali Khamenei against the Ahmadinejad camp.

Once the election is over and a new president takes office in August, then appoints his team, there may be a possibility for progress in the diplomatic efforts to resolve the nuclear issue. Politics in Iran will not necessarily quiet down after the election. As happened in 2009, political turmoil may even intensify. Ahmadinejad has made it clear he will not quietly fade away. Yet at least come August, the two men occupying the two key positions in Tehran will again be in sync. For over two years now, this has not been the case, as Ahmadinejad and Khamenei have been locked in an extraordinary power struggle. A restored alignment between the president and the supreme leader will at least allow for the possibility of compromise on the nuclear program. This possibility is not a probability, however, because the gulf between Iran and its negotiating partners is so deep.

The fundamental issue has remained unbridgeable since the beginning of the Iranian nuclear crisis a decade ago: Iran seeks the capability to produce nuclear weapons quickly, and the international community, as represented by the UN Security Council, seeks to deny that capability. Hence the insistence, repeated in five Security Council resolutions and more IAEA Board of Governors resolutions, that Iran suspend all enrichment-related activity. The six nations that have been negotiating with Iran[1] have proposed that this suspension need not be permanent. Their June 2008 proposal, which remains valid, said Iran's nuclear program would be treated "in the same manner as that of any non-nuclear-weapon state party to the NPT once international confidence in the exclusively peaceful nature of Iran's nuclear programme is restored."[2]

1 China, France, Germany, Russia, the UK, and the United States, typically referred to as the P5+1 or as the E3+3.

2 Proposal to Iran by China, France, Germany, the Russian Federation, the United Kingdom, the United States of America and the European Union presented to the Iranian authorities on June 14, 2008, in Tehran.

Nuclear Capability

A nuclear capability should be regarded as a continuum. The Islamic Republic already can be said to have a nuclear capability, in that it possesses enriched uranium sufficient for several weapons if further enriched and the facilities and material to carry out higher enrichment. It also seems apparent that Iran has studied all of the technologies necessary to make a weapon from the fissile material. The IAEA's November 2011 report contained 48 paragraphs detailing the information it had assembled, from both member states and the agency's own investigations, about what it diplomatically calls activities of a "possible military dimension" (PMD). This included, for example, development of exploding bridgewire detonators and experiments with multi-point initiation systems to detonate a hemispherical shell of high explosives. Most of that work was suspended in late 2003, but four paragraphs of the November 2011 report refer to activities that reportedly continued afterwards.

The IAEA has been trying for many years to clarify what it calls these "strong indicators of possible weapon development." In addition to asking Iran for credible explanations, the Agency has sought to interview scientists who were reportedly involved in the weapons work, beginning with Mohsen Fakhrizadeh, whose name appears on so many documents associated with the PMD activities. The Agency also has asked to visit certain sites at the Parchin military complex, where high-explosives tests of a nuclear nature were said to have taken place before 2004. Over the past year and a half, Iran has indicated several times that it was ready to take steps to address the IAEA's questions, but final agreement has consistently been put off pending progress in a separate diplomatic forum. Iran wants to use the IAEA request for transparency about past activities as leverage in talks with the six powers about on-going nuclear development.

Some Russian experts have expressed doubt that Iran has the ability to manufacture nuclear weapons, given the complexity of the task and the limitations of Iran's industrial sector.[3] Such doubts strike me as ill-founded and policy driven. Nuclear weapons do not require cutting-edge science. The technology is nearly seventy years old and the know-how is freely

3 See, for example, Vladimir I. Sazhin, "The Iran Nuclear Problem: Take-away from 2012," *Bulletin of Moscow University*, scientific journal number 4, Series 25 — "International relations and world politics" (October 2012): 70—96.

available on the Internet. If Pakistan and North Korea were able to master the technology, surely it would not be impossible for Iran, whose industrial level is no lower than that of those two states. For sure, Pakistan and North Korea received certain foreign assistance, but so too has Iran. In fact, Iran received more foreign help than is known to be the case with North Korea, which received civilian nuclear technology cooperation from the Soviet Union but then on its own built a 5MW(e) reactor at Yongbyon and a reprocessing facility.[4] In Iran's case, the A. Q. Khan network provided nuclear weapons design information[5] and Vyacheslav Danilenko and reportedly other former nuclear weapons scientists provided hands-on assistance.[6]

Iran achieved a nuclear weapons capability through steady, incremental advancement. The enrichment effort started in about 1985, some twenty-seven years ago. By contrast, it took Pakistan eleven years from the time A. Q. Khan stole enrichment technology from the Netherlands to the first cold test of a nuclear device. Iran has not sought to achieve a capability as quickly as possible, but, rather, as safely as possible.[7] The work has been methodical and largely successful. Sanctions, sabotage, and assassinations slowed the acceleration but never stopped the program. The capacity has now reached the point where enough 90 percent highly-enriched uranium (HEU) could be produced within weeks. Some theoretical calculations put the timeframe as low as two to two and a half months.[8] In practice, however, it would take longer for a state that is new at the task.

Completing the design work that was stopped in 2003 would probably take several months more. How long is unknowable, especially given the lack of clarity on how far this work had progressed before Iran, under the

4 There is no reliable evidence that North Korea received nuclear weapons-related assistance from experts from China or the former Soviet Union. The uranium enrichment assistance that North Korea received from Pakistan via A. Q. Khan only supplemented the plutonium-based weapons develop work that North Korea was already mastering on its own.

5 IAEA, GOV/2011/65, Annex, para 35.

6 Ibid., paras 42, 44; Joby Warrick, "Russian scientist Vyacheslav Danilenko's aid to Iran offers peek at nuclear program," *Washington Post*, November 13, 2011.

7 Amos Yadlin, transcribed in "Red Lines and Hot Rhetoric: Israel Weighs Threat of, Action Against Nuclear Iran," *PBS Newshour*, January 31, 2013, http://www.pbs.org/newshour/bb/world/jan-june13/israel_01-31.html.

8 For a two-and-a-half-month estimate, see William C. Witt, Christina Walrond, David Albright, and Houston Wood, "Iran's Evolving Breakout Potential" (ISIS Report, October 8, 2012). A two-month calculation is offered by Gregory S. Jones, "Iran's Rapid Expansion of its Enrichment Facilities Continues as the U.S. Concedes That Iran Is Getting 'Closer and Closer' to Having Nuclear Weapons," Non-Proliferation Education Policy Center, March 19, 2013, http://npolicy.org/article.php?aid=1206&rid=4.

glare of intense IAEA inspections and watching the U.S.-led invasion of neighboring Iraq, called a halt to the structured work on nuclear weapons design. Some of that work apparently continued in a diffuse way after 2003, which is why the intelligence agencies of France, Germany, Israel, and the UK, drawing on the same body of information, disagreed with the headline conclusions of the 2007 U.S. National Intelligence Estimate.[9]

To the timeline must also be added the physical work of weapon fabrication. Converting the weapons-grade UF_6 to metallic form and casting it can be done quickly in theory. In 1945, the United States was able to manufacture a weapon within days after the fissile material was produced. Iran undoubtedly would first practice with dummy materials. But Iran does not have a cadre of nuclear scientists and engineers of the caliber and number that the United States assembled under the Manhattan Project.

Together, the U.S. government estimates that it would take a minimum of one year for Iran to be able to produce a nuclear device if it made a decision to do so.[10] The United States estimates that another year or more would be required for Iran to have a deliverable nuclear weapon that could be mated with a ballistic missile, such as the liquid-fueled *Ghadr-1*, which has a reach of 1,600 km and the solid-fueled *Sajjill-2*, which has a longer, 2,000 km reach, but which is still in development and has not been tested since February 2011.

Nuclear weapons also can be delivered by other means, including by ship, truck, or even the proverbial donkey cart — if both donkey and driver are suicidal or unwitting. For this and other reasons, Israel is most focused on the time line for the first of the three steps: how long would it take to produce enough HEU for a weapon? Iran's production of 20 percent enriched uranium has been of particular concern because this level is on the cusp of being weapons usable, which is why 20 percent is the point of distinction between low-enriched uranium (LEU) and HEU.

According to the latest quarterly report by the IAEA, by February, Iran had produced 8,271 kg of UF_6 enriched up to 5 percent. Iran has used about

9 Office of the Director of National Intelligence, *Iran: Nuclear Intentions and Capabilities*, November 2007, http://graphics8.nytimes.com/packages/pdf/international/20071203_release.pdf.

10 House Committee on Foreign Affairs, "Hearing: Preventing a Nuclear Iran," May 15, 2013 (video), http://foreignaffairs.house.gov/hearing/hearing-preventing-nuclear-iran.

one-quarter of this to produce 280 kg of 20 percent enriched uranium. This amount may be sufficient for six weapons if further enriched to 90 percent. This is also above the 140 kg figure that Israel had said would be sufficient for a nuclear weapon, which in September Prime Minister Benjamin Netanyahu said should be considered to be a red line.[11] So as not to exceed Israel's red line, however, since summer 2012 Iran has repeatedly moved a portion of the 20 percent UF_6 to Esfahan for conversion to U_3O_8 for use in fuel rods for the Tehran Research Reactor (TRR). This conversion gave Israel a justification last September for extending its deadline for military action, because the enriched uranium in solid oxide form cannot immediately be further enriched.

The conversion is a welcome confidence-building measure, but the tactic should not be over-valued. It would not take more than a few weeks to reconvert the entire stockpile of 20 percent U_3O_8 back to UF_6.[12] Amos Yadlin, former head of Israel's Military Intelligence Directorate, asserted that reconversion could be accomplished in less than a week,[13] although this depends on certain worst-case assumptions. To lengthen the time, it would be best if Iran produced fuel assemblies from the 20 percent U_3O_8 and irradiated them in the TRR, which would make the 20 percent enriched uranium truly unavailable for further enrichment. But production bottlenecks limit the amount of 20 percent U_3O_8 that can be put through these additional steps.

The 20 percent U_3O_8 is under safeguards, so the IAEA would quickly know if reconversion work were underway. Given the risks of criticality when reconverting uranium at this stage of enrichment, if Iran sought to accumulate more 20 percent in UF_6 form, it would probably be easier to ramp up production of 20 percent UF_6 at Fordow. As of February, only one fourth of the 2,710 centrifuges installed at Fordow were being used for enrichment. This is in line with Iran's practice of waiting some time before newly installed centrifuges are fed with uranium. Whether this delay is purely for technical reasons or includes a political motivation is unclear.

11 Julian Borger, "Israel's Red Line on Iran: 240kg," *Guardian*, November 1, 2012.
12 Mark Hibbs, "Reconverting Iran's 2308 to UF_6," *Arms Control Wonk*, April 27, 2013, http://hibbs.armscontrolwonk.com/archive/1748/reconverting-irans-u3o8-to-uf6.
13 Yaakov Lappin, "Yadlin: Iranian nuclear program crossed 'red line'," *Jerusalem Post*, April 23, 2013.

Incrementally expanding the enrichment program may be a political tactic to gradually lull the international community into acquiescing in enhanced capabilities, akin to "salami slicing."

Putting the additional centrifuges at Fordow to use producing 20 percent UF_6 would soon cross Israel's announced red line, unless the U_3O_8 conversion process is also ramped up. As noted, this may be hard to do in practice, given technical limits. Israel's red line will also come closer to being crossed if Iran succeeds in introducing 3,000 IR-2m second-generation centrifuges that are two to four times more efficient than the first-generation models used by Iran to date.

Discussion of the calculations about timelines for Iranian weapons production must recognize several caveats. One is that the entire discussion is based on the hypothesis that Iran would egregiously violate the Nuclear Non-Proliferation Treaty as well as the Supreme Leader's own religious prohibition on producing nuclear weapons. Granted, the *fatwa* is not immutable. As an oral dictum, it has been expressed in different ways, so it is difficult to pin down exactly what is *haram*. This may explain why some Iranian activities in the nuclear field have been incompatible with a prohibition on, say, "developing" — in contrast to "possessing" — nuclear weapons. In addition, fatwas can be overturned if circumstances change: for example, if the nation were seen to be facing a mortal threat. But given Iran's religious identity, the prohibition cannot be dismissed as irrelevant.[14]

A second caveat is that the calculations are based on formulas that do not take into account the uncertainties of actual production, especially when industrial processes are attempted for the first time. As a former senior U.S. official told me, "the timelines are make-believe." A former official in another government, who had hands-on experience in uranium enrichment for nuclear weapons, told me the machines never work as they are supposed to when put to new enrichment levels. Iran's adversaries may base assessments on worst-case assumptions about ideal operational performance, but Iran would not be able to assume this would be the case if it were to gamble on break-out.

14 See Seyed Hossein Mousavian, "Globalising Iran's Fatwa against Nuclear Weapons," *Survival* 55, No. 2 (April-May 2013): 147 — 162. For a strong counter-argument, see Ali Ansari, "Iran: A Nuclear 'Fatwa'?," Chatham House Expert Comment, September 28, 2102, http://www.chathamhouse.org/media/comment/view/186019.

A third caveat is that if Iran were to produce weapons-grade HEU, it is very unlikely to do so at a declared facility that is under close IAEA inspection, with coordinates that are well known to adversary air forces. The most likely break-out scenarios would rely on clandestine plants for the HEU production, which makes it difficult to calculate break-out timelines. Under some clandestine HEU production scenarios, Iran would use diverted 20 percent or 5 percent feedstock, in which case the quantity of the stockpile matters. In the event that Iran has a totally separate clandestine production line for UF_6 production and enrichment, then the size of the declared stockpiles matters less. This latter scenario is unlikely, however, because Iran has not been able to keep its enrichment-related facilities secret.

Negotiations

Diplomacy shows no sign of success. In negotiations that began in spring 2012, the six powers asked Iran to take a set of steps that would lengthen the time it would take Iran to make a dash for nuclear weapons. Under what was nicknamed the "stop, ship and shut" package, Iran was asked to stop producing 20 percent enriched uranium, to ship out the accumulated stockpile, and to shut down operations at Fordow, in exchange for minor sanctions relief. When negotiations resumed in Almaty on February 27, 2013, after a half-year interregnum, the sanctions relief part of the package was amended to include a relaxation on the ban on gold for oil sales and petrochemical exports, but nothing was offered in the oil and gas sector of most concern to Iran.

The three steps asked of Iran would not resolve the crisis. They would only be confidence-building measures, to build trust in negotiations and to reduce reasons for Israel or any other country to consider military options. The idea is that a later stage of negotiation would need to address the remaining issues of the stockpile of LEU that has no civilian purpose in the foreseeable future and the research reactor in Arak, which is scheduled to come online in 2014, and which will be able to produce a bomb's worth of weapons-grade plutonium annually. The Arak completion date is worth greater notice, because it could become an action-forcing event. If military action is ever undertaken to destroy Iranian nuclear facilities of concern, Arak would be included in the target set because of its dual-use capability to produce weapons-grade plutonium. Bombing the reactor after it comes on line would spew deadly radiation into civilian areas. The calculation could be made that if it is to be crippled through bombing, such action would be better taken before it goes on line.

In the talks to date, Iran has offered only to talk about suspending 20 percent enrichment, for which it seeks a lifting of all sanctions and acknowledgment of a right to enrichment. Some observers advocate that the right to enrichment should be granted from the start, to signal to Iran that talks will turn out in its favor. The suggestion is not without logic, in that any plausible solution will have to involve some level of enrichment on Iranian soil. Without such a gain, Iran's leaders would not be able to sell the deal domestically as a victory. The solution has to be a "win-win." But giving in to preconditions from the start would be an unusual form of negotiating. Concessions should be negotiated. What the six could do in advance, however, is to clarify what is meant by the language in the 2008 proposal about treating Iran the same as other NPT non-nuclear-weapons state parties once concerns are satisfied. The six powers might look for a way to use the words "right to enrichment" and to note the conditions under which this right will be acknowledged.

If Iran were to move from its opening position with its maximalist demands, the six powers would have to consider what kind of sanctions relief would be appropriate for what Iran has to offer. To date, the six have not had to consider seriously what additional sanctions relief to table. Having applied many kinds of sanctions over the past two years, the United States and the EU have many bargaining chips that can be played. Although many of the U.S. sanctions are encased in legislation that is unlikely to be lifted by the current Congress, other sanctions were imposed by Presidential authority and could be up for negotiation. EU measures, such as the ban on Iranian banks using SWIFT financial communications, also could be considered for selective lifting, if the 27 EU members were to agree.

Prospects for Military Action and for Deterrence

One argument advanced for sanctions is that they are an alternative to military action, which, if undertaken prematurely, could be tragically counterproductive. Iran would likely respond to a military strike by putting all the resources of its economy into quickly producing nuclear weapons — and without the meddling interference of IAEA inspectors, who would surely be expelled. This is not an argument, however, against military action under any circumstance. If Iran were to be caught crossing the line from latent nuclear capability to weapons production, then military action that nipped this in the bud might be both necessary and efficacious.

I have contended for several years that Iranian production of nuclear weapons can be deterred.[15] Such deterrence only works so long as Iran believes that a decision to cross the line would be detected and would invite military preemption. Iran has every reason to believe that Obama is not bluffing when he says that it is unacceptable for Iran to possess nuclear weapons. It would be problematic, however, if Iran attempted to advance its nuclear program right up to the line, in the mistaken belief that it is safe as long as it does not "tighten the last screw." This was also mentioned as a red line by Obama in the third presidential debate last October. If Iran's nuclear program advances so far that break-out cannot be detected in time, the line between capability and production will become faint to the point of invisibility.

According to some estimates, Iran's program is on a trajectory to reach such a point by mid-2014.[16] There are ways to make the line more visible in order to increase the chances of detecting break-out, including by increasing the frequency of inspections and by real-time video monitoring of the inspection halls. The best way, however is to strictly limit the size of the stockpile and the production capability. The negotiations must continue to strive toward this objective.

15 Mark Fitzpatrick, *The Iranian Nuclear Crisis: Avoiding Worst-case Outcomes* (London: IISS, 2008).
16 David Albright, Mark Dubowitz, Orde Kittrie, Leonard Spector, and Michael Yaffe, "US Non-Proliferation Strategy for the Changing Middle East," January 2013, http://isis-online.org/uploads/isis-reports/documents/FinalReport.pdf.

The Experience of India and Pakistan Creating Nuclear Weapons

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Over many years, the politics of India and Pakistan were characterized by the intent to retain the "nuclear option," while aspiring to take advantage of the benefits of international cooperation in the field of nuclear power generation. This explains why India and Pakistan did not accede to the Nuclear Weapons Non-Proliferation Treaty, but placed certain facilities under IAEA safeguards. What was the basis for their decision to create nuclear weapons at the expense of cooperation with other countries in the field of peaceful nuclear energy?

Domestic Policy Factors

The following factors should be identified among the domestic policy factors that motivate a country to decide to exercise the nuclear option: the head of state's position on the issue, the growing influence of pro-nuclear attitudes, and the question of nuclear weapons transforming into part of a political agenda upon which a national consensus has been reached.

India's nuclear program (as well as its ballistic missile development program) began during the rule of Indira Gandhi (1966—1977, 1980—1984), although her public position was that "India aims to use the atom for peaceful purposes."[17] This contradiction can be explained by the fact that, on the one hand, the prime minister could not openly oppose the ideas of her father, Jawaharlal Nehru, who was a consistent advocate of nuclear disarmament. On the other hand, she was compelled to respond to the growing popularity of the idea of creating nuclear weapons.

As a whole, three groups formed within the Indian elite in the 1960s:

— The first group advocated a rejection of India's nuclear ambitions and support for the process of nuclear disarmament. This group was the most influential under the rule of Jawaharlal Nehru (1947—1964) and Morarji Desai (1977—1979).

— The second group insisted that it was necessary to create a nuclear weapon to deter Chinese and Pakistani threats. The first prime minister to represent this group was Charan Singh (1979—1980).

— The third group considered it reasonable to have an untested nuclear bomb, i.e. to create a scientific and industrial basis that would make it possible to build a nuclear weapon quickly.

The first group lost its influence in the late 1960s, as is evinced in opinion poll data. In 1966—1968, 70 percent of Indians supported nuclear weapons.[18] Most of India's citizens also supported the nuclear tests in 1974 and 1998.

The rapid development of Pakistan's military nuclear program is associated with the name of Zulfikar Ali Bhutto, who was president in 1971—1973 and prime minister in 1973—1977. He began advocating nuclear development in Pakistan in the 1960s. In his book "The Myth of Independence," published in 1969, he wrote of nuclear weapons: "Our problem, in its essence, is how to obtain such a weapon in time before the crisis begins."[19]

As a whole, we can say that in the 1970s, the question of nuclear weapons transformed into part of a political agenda shared by nearly all political

17 I. Gandhi, *Articles, Speeches, Interviews*, translated from English by N.V. Alipova and G.A. Pribegina (Moscow, 1975) p. 320.
18 R.K. Betts, "Incentives for Nuclear Weapons: India, Pakistan, Iran." *Asian Survey* 19, No. 11 (November 1979): 1068.
19 F.H. Khan, *Eating Grass: the Making of the Pakistani Bomb* (Stanford: Stanford University Press, 2012), p. 63.

forces both in India and in Pakistan. Furthermore, they took advantage of this question in order to achieve their goals in both domestic and foreign policy.

Russian researchers believe that throughout the history of India's nuclear program, the considerations of national prestige and power remained invariably important for the Indian elite.[20] This meant that the country aspired to attain the status of a global power, and nuclear weapons were seen as one of the attributes of that status. These interests manifested themselves in both the state's domestic policy and its foreign policy. This is confirmed by many examples.

After the nuclear tests in 1998, there were many emotional pronouncements, of which the statement of Bal Thackeray, leader of the Hindu Shiv Sena party (1966—2012), is best known: "We have to prove that we are not eunuchs."[21] Later, after the test of the *Agni-V* ballistic missile on April 19, 2012, Indian officials emphasized that the country had joined the "elite club" of states that possess intercontinental-range missiles.[22] Such attitudes are common in Pakistan as well.

The significance of the topic of nuclear weapons for the domestic political life of Pakistan is apparent also in the example of the lionization of Abdul Qadeer Khan.[23] As one of the leaders of Pakistan's nuclear program, he became the sole "father of the nuclear bomb" in popular discourse, and his image is frequently used in political rallies.[24]

An illustration of how Pakistan aspired to achieve foreign policy goals using nuclear weapons can be found in the idea of an "Islamic bomb," which was successfully used by Zulfikar Ali Bhutto in order to obtain aid from Arab countries. On the other hand, Pakistan stopped referring to this concept after the nuclear tests in 1998.

20 V.Ya. Belokrenitsky, V.N. Moskalenko, and T.L. Shaumyan, *Yuzhnaya Aziya v mirovoy politike* [South Asia in International Politics] (Moscow: *Mezhdunarodnye otnosheniya* [International Relations], 2003), p. 217.
21 S. Krishna, "The Social Life of a Bomb: India and the Ontology of an 'Overpopulated' Society," *South Asian Cultures of the Bomb*, Ed. I. Abraham, 72 (Bloomington: Indiana University Press, 2009).
22 "India Test-Fires Agni-V; Joins Elite Missile Club," *Deccan Herald*, Apr. 19, 2012.
23 S.P. Cohen, *The Idea of Pakistan* (Washington: Brookings Institution Press, 2006) pp. 119—120.
24 An example of such activism would be the website and Facebook page belonging to the Tehreek-e-Tahaffuz-e-Pakistan [Movement for the Protection of Pakistan] political party, of which Abdul Qadeer Khan is the chairman: http://www.ttp.org.pk/; https://www.facebook.com/TehreekTahafuzePakistan?filter=1. *See also:* D. Frantz and C. Collins, The Man from Pakistan: *The True Story of the World's Most Dangerous Nuclear Smuggler* (New York: Twelve, 2008), pp. 355, 365.

An important peculiarity that India and Pakistan share is that there is no consensus among military leaders on the necessity of creating nuclear weapons.[25] According to a retired high-ranking military officer, there were generals who were against following India's example among the representatives of Pakistan's armed forces who participated in discussions with political leaders on how to react to the 1998 Indian tests.[26] This peculiarity makes it possible to suppose that despite the various roles played by the armed forces in the sociopolitical life of India and Pakistan, the choice to go nuclear, to a large extent, had a political, rather than military significance.

Foreign Policy Factors

One of the factors that motivated India and Pakistan to exercise the nuclear option was the tense situation in South Asia, which was determined by a number of factors both during and after the Cold War, including the following:

a) Disputes between India and Pakistan;

b) Disputes between India and China;

c) Disputes between Pakistan and Afghanistan;

d) Transborder terrorist activity;

e) Separatist movements;

f) Rivalry between the Soviet Union and the United States (during the Cold War).

The security challenges in South Asia were not limited to these factors. They caused India and Pakistan to feel that they were in danger. That feeling of insecurity became deeper after neither state managed to obtain security guarantees from the superpowers. This happened for New Delhi after China's nuclear tests in 1964, and it happened for Islamabad during the Indo-Pakistani War of 1971, which resulted in a defeat for Islamabad and the disintegration of the country. The first serious suspicions that India and Pakistan had begun military nuclear programs go back to that time.

25 Betts, "Incentives for Nuclear Weapons," p. 1068; Cohen, *Idea of Pakistan*, pp. 119 – 120; Khan, *Eating Grass* , p. 80.
26 Private conversation between the author and the general under condition of anonymity (April 3, 2012, Islamabad).

The other important factor in India's and Pakistan's respective decisions to go nuclear was the presence of an opponent who possessed superior general-purpose forces and a program for developing nuclear weapons or other types of WMD. For India, the main sources of the threat were and still are China and Pakistan.

As for China, this threat became manifested in the escalation of Indian-Chinese relations after the Tibetan events of 1959, India's defeat in an armed conflict with China in 1962, China's entry into the "nuclear club" in 1964, the launch of China's first satellite in 1970, and the existence of territorial disputes between India and China.

The authors of a report prepared by the U.S. CIA in 1964 concluded that after the Chinese tests, India would decide to create a nuclear weapon within one to three years.[27] During the second half of the 1960s, a number of researchers believed that during that time, out of all the non-nuclear states, India was the closest to deciding to begin a military nuclear program and conducting nuclear tests and even could possess blueprints for a nuclear explosive device.[28]

As for Pakistan, India saw a number of threats connected with the acute confrontation between the two countries, which had led to armed conflicts on multiple occasions (in 1947 – 1948, 1965, 1971, and 1999). It also saw threats related to territorial disputes, terrorism, separatism, and, as many in India believed, the secret possession of nuclear weapons since the 1980s[29] and threats to use them. Indian leaders believed that Islamabad had voiced such threats at least twice: in 1986 – 1987 and in 1990.[30]

A letter that Atal Bihari Vajpayee, prime minister of India (1998 – 2004), sent to the leaders of foreign states after the nuclear tests in 1998 was a telling example. The letter justified the need to acquire nuclear weapons in terms of threats from India's neighbors, namely China, "an overt nuclear weapons

27 *Prospects for a Proliferation of Nuclear Weapons Over the Next Decade*, National Intelligence Estimate, Oct. 21, 1964, No. 4 – 2-64, p. 1, http://www.gwu.edu/~nsarchiv/nukevault/ebb401/docs/doc%203.pdf.
28 *See*, e.g. M. Edwardes, "India, Pakistan and Nuclear Weapons," *International Affairs* 43, No. 4 (Oct. 1967): 658, 661.
29 *Yadernye ispytaniya dlya obespecheniya natsional'noy bezopasnosti* [Nuclear tests to ensure national security]; A.B. Vajpayee, *Indiya na puti v buduschee: sbornik rechey i vystupleniy* [India's path to the future: compilation of speeches and statements] *(March 1998 – September 2001)*, compiled by Ye.Yu. Vanina et al., 24 – 26 (Moscow: Institute of Oriental Studies of the Russian Academy of Sciences, 2001).
30 K. Subrahmanyam, "Nuclear Deterrence in the Indian Context," Golden Jubilee Seminar on "The Role of Force in Strategic Affairs," (New Delhi: National Defence College, 2010), pp. 60 – 61.

state on our borders, a state which committed armed aggression against India in 1962," and Pakistan, a "covert nuclear weapons state," which had attacked India three times and was continuing to support terrorism in Kashmir.[31]

Close collaboration between Pakistan and China on various issues, including nuclear technologies, was seen as a separate threat to India. According to K. Subrahmanyam, the first head of India's National Security Advisory Board, by 1989 India had reliable information that China had helped Pakistan not only in the field of nuclear technologies, but in missile technologies as well. This made it possible for him to assert that in the 1980s the threats from China and Pakistan were not separate. Instead, there was one threat coming from China, which had proliferated nuclear weapons to Pakistan.[32] At present, according to Chitrapu Uday Bhaskar, former director of the New Delhi Institute for Defence Studies and Analyses, India is one of the vertices of the nuclear triangle, whose other vertices are comprised by China and Pakistan, who act in cooperation with one other.[33]

The main incentives for Pakistan to initiate a military nuclear program were the country's defeat in the Indo-Pakistani war of 1971 and the Indian nuclear tests of 1974 and 1998. In 1964, when there were already suspicions that India planned to create a nuclear weapon, Ishrat Hussain Usmani, head of the Pakistan Atomic Energy Commission, said, "If there will be a sixth nuclear weapon state, then there will be a seventh one."[34] According to the report prepared by the Bureau of Intelligence and Research of the U.S. State Department in June 1974, India's nuclear tests would provoke Pakistan to create a nuclear weapon, which, in turn, would cause India to expand its own nuclear program significantly.[35]

The imbalances in the South Asian rivals' defense budgets and armed forces were an important factor in Pakistan's work on military nuclear technologies. According to data cited by Feroz Khan, by the mid-1980s, the following relative proportions existed between India's and Pakistan's

31 Cited in: S. Talbott, *Engaging India: Diplomacy, Democracy, and the Bomb* (New Delhi: Penguin Books, 2004), p. 53.
32 Subrahmanyam, "Nuclear Deterrence in the Indian Context," pp. 60, 67.
33 C.U. Bhaskar, "Comparing Nuclear Pledges and Practice: The View From India," *The China-India Nuclear Crossroads*, ed. and transl. by L. Saalman, 36 (Washington: Carnegie Endowment for International Peace, 2012).
34 Cited in: Khan, *Eating Grass*, p. 50.
35 "India: Uncertainty over Nuclear Policy," *Intelligence Note: Science and Research* (June 13, 1974): p. 3, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB6/docs/doc19.pdf.

general-purpose forces: 2 to 1 in the two countries' respective armed forces personnel numbers, 2 to 1 in their numbers of tanks, 4 to 1 in their numbers of ships, and 3 to 1 in their numbers of fighter aircraft.[36]

The confidence of Pakistan's leaders that they made the right decision to develop a military nuclear program was also based on the threats that they sometimes felt from New Delhi. For example, after the Indian tests in 1998, Lal Krishna Advani, India's Minister of Home Affairs (1998—2004) and current opposition leader, said, "Islamabad should realize the change in the geo-strategic situation in the region and the world. It must roll back its anti-India policy especially with regard to Kashmir. Any other course will be futile and costly for Pakistan."[37]

This and similar statements by Indian politicians have given the Pakistanis a good opportunity to justify their development of military nuclear technologies on the basis of the need to defend the country from its neighbor. At a press conference on May 28, 1998, Pakistan's Prime Minister Nawaz Sharif (1997—1999) emphasized that "immediately after its nuclear tests, India has brazenly raised the demand that 'Islamabad should realize the change in the geo-strategic situation in the region' and threatened that 'India will deal firmly and strongly with Pakistan.' Our security, and peace and stability of the entire region was thus gravely threatened... Our hand was forced by the present Indian leadership's reckless actions... After due deliberations and a careful review of all options, we took the decision to restore the strategic balance... Our decision to exercise the nuclear option has been taken in the interest of national self-defense. These weapons are to deter aggression, whether nuclear or conventional."[38]

Technological Factors

Apathukatha Sivathanu Pillai, general director of the Russian-Indian joint

36 Khan, *Eating Grass*, p. 216. See also: A.H. Cordesman, *The Conventional Military Balance in South Asia: An Analytic Overview* (Washington: Center for Strategic and International Studies, 2000); R.W. Jones, "Conventional Military Imbalance and Strategic Stability in South Asia" (SASSU Research Paper, Mar., 2005); P.V. Topychkanov, "Nuclear Weapons and Strategic Security in South Asia" (Working Papers, No. 3, Moscow: Carnegie Moscow Center, 2011), pp. 9—12.
37 S. Inderjit, "Advani Tells Pakistan to Roll Back Its Anti-India Policy," *Times of India*, May 19, 1998.
38 Text of Prime Minister Muhammed Nawaz Sharif at a Press Conference on Pakistan Nuclear Tests, Islamabad, May 28, 1998, The Acronym Institute for Disarmament Diplomacy, http://www.acronym.org.uk/dd/dd26/26pak.htm.

venture BrahMos Aerospace, expressed the opinion in his study that technological embargoes are actually counterproductive, since the countries upon which an embargo is imposed develop technologies independently, and thereby become immune to embargoes.[39]

These words relate more to India and less to Pakistan. In India, a solid technological basis has been built for the country's nuclear program, which provided India with a certain degree of independence from external sources of technologies and materials. In Pakistan, the country's internal resources were insufficient, which forced it to take advantage of its contacts with foreign companies more actively.

In both cases, the restrictions that these states have confronted on the international nuclear technologies and materials market eventually forced them to seek a way out through both internal and external forces. Without involving external assistance, the path to nuclear weapons would have been longer and more costly, if it had been possible at all. This is evident in the role played by international cooperation for both India and Pakistan in creating a technological basis for their respective nuclear programs. There has been cooperation in three areas: education, nuclear energy, and the import of nuclear technologies and related technologies and materials.

In the field of education, the training and internships of students and researchers from India and Pakistan at Western universities, research institutes, and nuclear industry enterprises have played an important role. Thus, 1104 Indian specialists visited nuclear facilities in the United States from 1955 to 1974, and 263 underwent training at nuclear facilities in Canada.[40] During this period, Pakistan also sent students and specialists abroad to study and improve their qualifications in the field of nuclear and related technologies. In 1967, approximately 3000 students were studying in Pakistan and abroad in the field of nuclear technologies.[41] In essence, with the assistance of other countries, India and Pakistan provided their nuclear programs with the necessary human resources.

39 A.S. Pillai, *Technology leadership: a revolution in the making*, translated from English by B.A. Zagorulko and N.N. Samsonova, 13 – 14 (New Delhi: Pentagon Press, 2011).
40 M.V. Ramana, "Nuclear Power in India: Failed Past, Dubious Future," Gauging U.S.-Indian Strategic Cooperation, ed. H. Sokolski, 76 (Carlisle: Strategic Studies Institute, 2007).
41 Khan, *Eating Grass*, pp. 53, 57.

In the field of nuclear energy, India's and Pakistan's intent to take advantage of cooperation in peaceful nuclear power generation in order to obtain the technologies and materials required for military nuclear programs was obvious. For example, in 1954, India acquired a Canadian-produced heavy water reactor called CIRUS (Canadian-Indian Reactor, U.S.) for its research center in Trombay (since 1967 known as the Homi J. Bhabha Atomic Research Centre (BARC)). An enterprise was also created there for the chemical processing of spent nuclear fuel from that reactor. The enterprise was built on the basis of plans obtained from the United States.

In spite of the research-oriented character of the Trombay center, it immediately elicited suspicions that India had nuclear ambitions. Munir Ahmad Khan, chairman of Pakistan's Atomic Energy Commission, visited the facility in 1964. He concluded unambiguously that India was planning to create a nuclear weapon.[42] These suspicions became certainty after the test of a nuclear explosive device in 1974. The plutonium for the device had been processed in BARC.[43]

Pakistani Foreign Minister Zulfikar Ali Bhutto raised similar suspicions in 1965 with his request that 300 million rupees be allocated from Pakistan's budget for the acquisition of an enterprise from France that was similar to the one that India had in Trombay.[44] The request was officially justified on the basis of the need to process spent nuclear fuel from the Karachi Nuclear Power Plant (KANUPP), construction of which began in 1966. The power plant was commissioned in 1972.

However, Pakistan's intentions were obvious to other countries. In 1976, U.S. Secretary of State Henry Kissinger offered to sell 100 A-7 Strike Fighters to Pakistan in exchange for a repudiation of the transaction with France. After Islamabad rejected that proposal, Paris, under pressure from the United States, canceled the transaction and cut off all international cooperation with Pakistan related to nuclear technologies in 1978.[45]

This forced Pakistan to shift its attention from the development of a military nuclear program based on plutonium to a program based on uranium.

42 Ibid., p. 60.
43 Ramana, "Nuclear Power in India," p. 76.
44 Ibid, p. 61.
45 Betts, "Incentives for Nuclear Weapons," p. 1070.

In 1978, a pilot project was launched for the processing of uranium ore in Dera Ghazi Khan, Punjab, and in 1990 in Isakhel, Punjab. Since 1984, uranium enrichment was first achieved at Khan Research Laboratories (KRL, known as Engineering Research Laboratories before 1981, and before that as Project-706), located in Kahuta, Punjab. In 1983, Pakistan conducted its first cold nuclear test. As a whole, Pakistan conducted 25 such experiments from 1983 to 1995.[46]

As for the import of nuclear technologies and related technologies and materials, India and Pakistan have been compelled to be both proactive and inventive in order to find opportunities to obtain nuclear technologies and materials under conditions where national and international restrictions have been imposed on the export of such technologies and materials.

In the early 1980s, India, which was experiencing a deficit of heavy water for the pressurized heavy water reactors in Rawatbhata, Rajasthan, and Madras (now called Chennai, Tamil Nadu)[47] considered the possibility of importing it from Canada, China, the Soviet Union, and the United States. Out of these, only China did not demand that India promise not to use the heavy water for purposes connected with its military nuclear program. Therefore, in 1983 India imported 100 metric tons of Chinese heavy water, circumventing applicable restrictions.[48] India once again experienced an acute deficit of heavy water in 1985. By now, that problem has been resolved. India possesses six enterprises that produce heavy water.[49]

The history of Pakistan's participation in nuclear proliferation is well-established, as is the role of Abdul Qadeer Khan, who led the laboratory in Kahuta after working in the Urenco Group in 1972–1975.[50] However, the heightened attention to Khan sometimes overshadows the efforts of the representatives of Pakistan's bureaucratic, military, scientific, industrial, and business communities. Those efforts were aimed at obtaining the necessary elements for Pakistan's military nuclear program.

46 Khan, "Eating Grass," p. 185.
47 National Security Agency, *India's Heavy Water Shortages*, October 1982, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB187/IN32.pdf.
48 G. Milhollin, "Stopping the Indian Bomb," *American Journal of International Law* 81 (1987): pp. 596–597.
49 IAEA Nuclear Fuel Cycle Information System, *List of Nuclear Fuel Cycle Facilities*, http://infcis.iaea.org/NFCIS/Facilities/Facilities.
50 See, e.g. *Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks. A Net Assessment*, ed. M. Fitzpatrick (London: The International Institute for Strategic Studies, 2007).

Thus, the historical perspective makes it possible to see the main factors in India's and Pakistan's respective decisions to develop nuclear weapons.

- The growing influence of the proponents of nuclear weapons and their promotion to key state offices and, ultimately, the formation of a national consensus on the issue of building a nuclear arsenal.
- The maintenance of a high level of regional tension, a low level of trust between states, the experience of military conflicts between them, and the suspicions of one of those states that the other state likely was developing or already had nuclear weapons.
- The ability to allocate significant human, financial, technological, and industrial resources for a nuclear program in the absence of realistic plans to develop nuclear energy.
- The possibility of obtaining necessary nuclear technologies and materials from external sources within the framework of both open collaboration in the field of nuclear energy and various semi-legal and illegal mechanisms of nuclear proliferation. Such technologies include, but are not limited to, uranium enrichment, the construction of a heavy water reactor, the production of heavy water, and specific engineering areas.

A review of these factors makes it possible to see how India and Pakistan, under the influence of internal and external factors, became threshold states by the 1980s and nuclear states by the late 1990s. The situation in South Asia can be an example in considering non-nuclear states. If some of the factors indicated above are present in a certain country, that may provide the rationale for a careful study of that country's activities related to nuclear technologies. If all of the factors are present together, then there may be grounds for serious suspicions regarding that country's nuclear ambitions.


INTERNATIONAL
LUXEMBOURG
ON PREVENTING
NUCLEAR
CATASTROPHE

SESSION 4

CRITERIA FOR DETECTING NON-DECLARED PLANS FOR NUCLEAR WEAPONS DEVELOPMENT

Chairman –
Sergey OZNOBISHCHEV, Ph.D.

Director of the Institute for Strategic Assessments (Russia)

Criteria for the Assessment of Undeclared Nuclear Weapons Development

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Introduction

The realization that nuclear technology is, at its core, dual use in nature occurred early on in the nuclear age and has been fundamental to every effort to harness the positive potential widely (though by no means universally) believed to be inherent in nuclear technology, while minimizing its risks. Every plan unveiled since the mid-1940s to deal with the promotion of nuclear energy has in one way or another tried to address this complexity.

Yet over time this complex reality has only become more sobering. While it has long been recognized that multiple paths may lead to nuclear weapons acquisition, it is widely believed that the diversity of these paths has grown considerably over the years, largely as a result of the accumulation and dissemination of the nuclear knowledge, experience, and capabilities necessary to acquire nuclear weapons, as well as diminution of the costs associated with such a process. Alternative explanations for engaging in many activities indispensable for realizing nuclear weapons aspirations abound, be they in the conventional military domain, peaceful nuclear or scientific pursuits, or even other nuclear military realms (but not related to weapons). Furthermore, secrecy and deceit, common among countries harboring ambitions for developing nuclear weapons, make the challenge of observing and acting on encroachment on such a dividing line all the more challenging. Finally, making matters even worse is the tendency (readily observable in the majority of both past and even present nuclear weapons programs) for the final decision to convert latent weapons capability into actual weapons to come very late in the game, the Manhattan Project being very much an exception.

Taken together, the difficulty in credibly and reliably distinguishing between nuclear weapons programs and other applications (military and civilian alike) has greatly exacerbated the original difficulty inherent in the dual-use nature of nuclear technology. In practice it has made the challenge almost insurmountable, at least insofar as timely detection is involved. Yet an early distinction is of huge importance, because it greatly enhances the time and opportunities available and tools relevant to try to influence such developments, thereby also dramatically affecting the prospects of success in stopping the process generally, and employing peaceful means in particular.

From a policy perspective, the objective, technical challenge in drawing such a line between legitimate (if not necessarily explicitly sanctioned) activities under the NPT and those that violate at least its spirit (if not necessarily its letter) is significantly accentuated by intense political bickering over the interpretation of the NPT. This holds especially true regarding the linkage between the obligations contained therein pertaining to its three pillars: nuclear nonproliferation, disarmament, and peaceful development of nuclear energy, and most prominently the "inalienable rights" to nuclear energy enshrined in its Article IV. No international consensus presently exists on this dividing line between activities relevant to weapons or at the very least oriented toward them that ought to be proscribed for non-nuclear-weapon states (NWS) under the NPT (be it entirely or under certain circumstances) and those that ought to be permissible or at the very minimum tolerable. Yet making such a distinction in a generic, credible, and above all objective manner is indispensable if we are to create a common basis for promoting all three pillars of the NPT: define the outer boundaries of peaceful nuclear activities in the interest of facilitating peaceful applications of nuclear energy (especially in the domain of nuclear power) by states interested in them; use such a definition to delegitimize and curb nuclear ambitions crossing that line in the interest of nonproliferation; and finally also employ such delineation for the purpose of a disarmament process, in this case by suggesting the scope of the rollback necessary in existing nuclear weapons programs.

Obtaining Nuclear Weapons

Nuclear weapons might conceivably be imported in whole or in parts from the outside or deployed by external players on one's soil. But leaving those two possibilities aside, the indigenous development of nuclear weapons requires a hugely elaborate, time consuming, and expensive process, covering activities ranging from basic research and technical training, through recruitment of diversified personnel and procurement of facilities, equipment, materials facilities, and knowledge, to extensive research and development, design, testing, evaluation, production, and stockpiling in both the nuclear weapons and delivery vehicles domains, all the way to manufacturing and system integration. Above all, bringing such a domestic program to successful fruition calls for sustained commitment at the highest levels of government, typically spanning a decade or more, coordination, integration, and significant allocation of scare resources, all the more so when encountering internal or external efforts to derail such a program.

Detecting Nuclear Weapons Activity

Given the long and elaborate effort involved in indigenously procuring nuclear weapons, activities associated with the realization of such an ambition inevitably leave behind a salient footprint, one that is practically impossible to fully conceal. Detection of some or even many of the telltale signs of nuclear weapons oriented (or even relevant) activities is thus quite likely, especially for those tasked with professionally monitoring such developments nationally and/or internationally (the IAEA).

Yet the above-mentioned complexity associated with determining whether some or all of these activities are indeed designed to support a nuclear weapons program nevertheless stands in the way of easily translating detection into characterization of these indicators as reliable signs of an active nuclear weapons program. It is essential to debunk alternative explanations for such activities, be it those offered by the suspected state or otherwise envisaged by the analysts tracking the activities in question. Thus a combination of technical indicators over time pointing to a trajectory and contextual factors suggesting a possible intent is typically required in order to reach the conclusion that a clear enough pattern of nuclear weapons development has been identified. Furthermore, the technical activities ought to cover at least two domains: fissile material production capable of providing weapons-grade material in sufficient quantities as well as weaponization activity necessary to incorporate such material into a nuclear explosive device. Naturally, the availability of evidence on the development of delivery vehicles capable of carrying such nuclear weapons and work on the integration of nuclear payloads into such bombs or warheads is an important additional potential sign of nuclear weapons development.

Heuristically speaking, contextual factors play an important interpretive role only when technical activities of a relevant nature are present. Otherwise, they can at most serve the function of alerting those responsible for collecting and analyzing pertinent technical data to look for telltale signs of a nuclear program. Put differently, detection of technical activities, especially in the fuel cycle domain, is a necessary condition (even if insufficient by itself up to a very late development stage) for reaching the conclusion that a nuclear weapons development program is emerging. What this means in practice is that we are dealing with a checklist, or in fact two checklists (contextual, technical) of indicators of a possible nuclear weapons program. The more (and the more diverse) boxes on the list that are checked, and the more they occur in parallel in the contextual and technical

domains, the higher the confidence about the weapons intent. At the same time, these checklists may also serve as a basis for reassurance that the activities in question do not amount to nuclear weapons development.

What Should We Aim for?

The above analysis clearly points to some essential attributes that ought to be part of the efforts to develop, as the Luxembourg Forum professes to do, "secure tolerance criteria for the nuclear nonproliferation regime." Such a framework ought to be clear on where or at the very least when "rights" for the development of peaceful programs end and nuclear weapons programs begin. Given the inherently dual-use nature of so many nuclear applications, some activities of significant proliferation concern presently serving perfectly legitimate non-nuclear-weapon applications (such as those associated with naval propulsion and recycling spent nuclear fuel) will have to be modified or altogether stopped to widen the technical buffer between legitimate and illegitimate nuclear activities.

Then, the framework also ought to offer the most objective possible criteria for such determination and build broad support for this determination. At least in part, the latter mandates that such a framework be developed on a generic basis and be applied consistently across cases rather than (for reason of short-term political expediency) on a case by case basis. Finally, a framework of this nature inevitably has to be robust enough to withstand technical development that might otherwise suggest alternative paths toward nuclear weapons development. In practice this means that it might periodically be revisited and if need be amended in light of technological evolution and new revelations about heretofore unfamiliar practices identified to be part of nuclear weapons pursuits. Otherwise such a framework might ultimately prove counter-productive, serving to instill a false sense of confidence about observable behavior of concern.

Even this clearly daunting list of requirements will probably not suffice to make such a framework, even if and when successfully developed, into a broadly acceptable nonproliferation tool. It is highly likely that the political willingness to adopt such a framework for anything beyond eclectic national use (and especially by relevant international institutions) will hinge upon its application to *all three* pillars of the NPT: nuclear energy, nonproliferation, and disarmament. Naturally, this last requirement greatly complicates the already highly ambitious challenge at hand.

In practical terms, the development of such a framework imposes several additional requirements. It can hardly be envisaged without considerable contributions from diverse experts in relevant disciplines drawn from culturally diverse countries. It is also bound to run into both national and even P-5 security as well as proliferation concerns that it might turn into a roadmap for the development of nuclear weapons, or worse still, for offering a legitimate cover for such activity. Finally, the framework also has to factor in considerations pertaining to its possible applications, which in turn suggests that the framework will have to encompass verification and response aspects as well.

Assessing and Minimizing Proliferation Risk[51]

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INTRODUCTION

Proliferation challenges to date have been based on clandestine nuclear facilities with little or no direct link to declared, safeguarded civil programs. The current Iranian problem, however, shows that proliferation risk is not limited to clandestine programs. After having to bring under safeguards a nuclear program that it was developing in secret, Iran is now trying to legitimate this program, claiming the NPT gives any Party the right to develop any aspect of the nuclear fuel cycle.

Iran's actions raise the specter of *safeguarded proliferation* — that a "peaceful" nuclear program operated under safeguards could, if and when the state so decides, be used for break-out to nuclear weapons production. This possibility undermines international trust and confidence, and damages the credibility of the NPT and IAEA safeguards.

This paper approaches the topic *criteria for the assessment of non-declared nuclear weapons development* from the following perspectives:

51 The views in this paper are the author's and not necessarily those of NTI.

(a) in developing criteria for assessing "peaceful" nuclear programs, what risk factors should be taken into account?

(b) how might such criteria be applied?

In considering proliferation risk, the paper also looks at *nuclear latency* and *nuclear hedging*, issues of major concern underlying the development of national nuclear capabilities, and also the safeguards challenge presented by nuclear fuel cycle developments, in particular whether the safeguards system can meet the expectations reflected in the NPT.

PROLIFERATION RISK – TECHNICAL AND POLITICAL FACTORS

In order to develop criteria for assessing whether the purpose of a nominally peaceful nuclear program might really be nuclear weapons development, it is necessary to look at technical aspects, particularly *capability*, and political aspects, particularly *motivation*. Capability involves questions of fact and can readily be assessed on an objective basis. Motivation, while generally perceived as involving *subjective* considerations, is also open to factual analysis.

Capability to produce nuclear weapons

Broadly speaking, a nuclear weapon program will involve the following key elements:

a) Acquisition of fissile material

Fissile material is a convenient term for the nuclear materials required to produce nuclear weapons[52] — principally highly-enriched uranium (HEU) and separated plutonium. Production of fissile material requires:

(i) a uranium enrichment plant. There is no inherent technical barrier to producing HEU with enrichment technologies currently used for low-enriched uranium; or

(ii) a reprocessing plant, together with a source of suitable spent fuel (ideally, reactors that can readily produce low burn-up fuel — i.e. a low proportion of the isotope Pu-240).

52 The term used for IAEA safeguards purposes is "unirradiated direct-use material."

Historically nuclear weapon programs are based on a national capability to *produce* fissile material, but it should not be overlooked that fissile material may also be *imported*, by legitimate transfer (e.g. research reactor fuel, critical assembly fuel, or MOX fuel) or by illicit procurement (e.g. purchase on the black market or by theft/seizure). Some research facilities (reactors or critical assemblies) may have comparatively large inventories of fissile material, making them potentially attractive for diversion. There is a longstanding international program to reduce civil HEU inventories through repatriation to the originating states — to date, however, separated plutonium has not been given the same attention, and these inventories are increasing.

(b) Nuclear weaponization

Weaponization is a shorthand term for the range of activities, additional to acquisition of fissile material, necessary to produce a nuclear weapon. These include: nuclear weapon design and associated modeling and calculations; warhead re-entry vessel design and testing; high-explosive lenses and implosion testing; specialized high-energy electrical components; and high-flux neutron generators.

Many of these activities, items, and materials are *dual-use*, i.e. taken in isolation they do not necessarily indicate an intention to manufacture a nuclear weapon. Some, but not all, involve items on the Nuclear Suppliers Group (NSG) dual-use list. While the purpose of a single dual-use activity may be ambiguous, a combination of activities may more clearly indicate a nuclear weapon program.

An essential question, in assessing the significance of apparent weaponization activities, is whether the state is known to have fissile material, or the capability to produce it, but this is not necessarily conclusive. It is possible that weaponization activities may be the first indicator of an undeclared (and so far undetected) fissile material program.

(c) Nuclear-capable delivery system(s)

While nuclear weapons could be delivered by unconventional means, e.g. truck, boat, or shipping container, credible nuclear deterrence requires a delivery system that will perform reliably and has a high probability of avoiding interception. In view of the vulnerability of aircraft, ballistic missiles are the preferred delivery method. Hence, discovery that a state has a ballistic missile program will be a warning sign. Given the substantial costs and accuracy limits of ballistic missiles, development of such missiles may well indicate an intention to deploy highly destructive warheads.

An indication of relevant capabilities is given by the *Guidelines for Sensitive Missile-Relevant Transfers* under the Missile Technology Control Regime, i.e. missiles with a range exceeding 300 kilometers and a payload exceeding 500 kilograms. A state developing missiles exceeding these parameters is not necessarily seeking a nuclear capability (the stated reason may be space research), but such development will be grounds for suspicion, especially where other indicators are present, e.g. apparent weaponization activities, safeguards violations, etc.

Motivation to acquire nuclear weapons

Motivation reflects the circumstances of the state, a stimulus or incentive that induces a government to act in a certain way. These circumstances will have a factual basis, and hence can be identified and analyzed by objective means.

The principal indicator for motivation is the state's strategic environment, e.g. is the state located in a region of tension; is it under military, economic, cultural or religious threat; or is it involved in confrontation with others? The clearest example of a region of tension is the Middle East, and it is no coincidence that four of the six safeguards non-compliance cases have occurred there.[53] Other areas generally considered as regions of tension are the Korean Peninsula[54] and South Asia.

An important factor may be whether a state is involved in military alliances. Two examples of current relevance are South Korea and Japan. Their alliances with the United States are of critical importance in meeting threats presented by North Korea. Alliances can reduce the motivation, and also the opportunity, to pursue nuclear weapons.

NUCLEAR LATENCY AND NUCLEAR HEDGING

Nuclear latency refers to the situation where a state has established, under a peaceful nuclear program, dual-use capabilities that could be used for

53 Iraq, Iran, Libya, and Syria. Libya, while not part of the Middle East geographically, is closely involved politically. The other states found in safeguards non-compliance are Romania and North Korea.

54 And more broadly North Asia is looking increasingly fraught.

the production of nuclear weapons. Nuclear latency might be considered *inadvertent*: e.g. a state with uranium enrichment or reprocessing capabilities thereby has the basic capability to produce fissile material for nuclear weapons, though it may well have — at least in foreseeable circumstances — no intention of doing so.

Some commentators refer to such a state as a *virtual* nuclear-weapon state. The common example is Japan, sometimes described as being "just a screwdriver turn away" from having nuclear weapons. This is simplistic, overlooking the other capabilities required, such as weaponization and delivery systems,[55] as well as Japan's longstanding and strongly held commitment against nuclear weapons. Nonetheless, it illustrates the problem of enrichment and reprocessing capabilities being in national hands. Even a state as firmly committed to nonproliferation as Japan could change its position in the future — a concern reinforced by comments from Japanese political figures about the need to maintain fuel cycle capabilities to ensure a nuclear weapon option.[56]

The issue of nuclear latency is very much in the background in negotiations between the United States and South Korea for the renewal of their nuclear cooperation agreement, where South Korea is seeking consent to undertake enrichment and reprocessing. While no one is suggesting that South Korea's intentions are anything but peaceful, it cannot be overlooked that enrichment and reprocessing provide proliferation capabilities — and as in Japan, some South Korean political figures advocate a nuclear weapon option.[57]

Today, in addition to the five recognized nuclear-weapon states[58] and the other four nuclear-armed states,[59] there are at least eight states with demonstrated enrichment capability,[60] and four with demonstrated reprocessing capability,[61] ten in all (this number reflects that two states have both capabilities). Not all of these are perceived as *virtual* nuclear-armed states, but there

55 Some commentators point to Japan's space program as providing ballistic missile capabilities.

56 See e.g. remarks of Japan's defense minister, Satoshi Morimoto, prior to his appointment, reported in the *Japan Times*, September 6, 2012, http://info.japantimes.co.jp/text/nn20120906b4.html.

57 See e.g. speech by Chung Mong-joon to the April 2013 Carnegie International Nuclear Policy Conference, reported in the *New York Times*, http://www.nytimes.com/2013/04/10/world/asia/in-us-south-korean-makes-case-for-nuclear-arms.html?_r=1&.

58 The United States, Russia, the UK, France, and China.

59 India, Israel, Pakistan, and North Korea.

60 Argentina, Australia, Brazil, Germany, Iran, Japan, the Netherlands, and South Africa.

61 Belgium, Germany, Italy, and Japan.

is no doubt that the larger the number of states so perceived, the greater the potential destabilizing effect on the nonproliferation regime.

If nuclear latency is supposedly inadvertent, *nuclear hedging* refers to a deliberate national strategy of establishing the option of relatively rapid acquisition of nuclear weapons, based on an indigenous technical capacity to produce them within a relatively short time frame — ranging from several weeks to a few years.[62] Hedging could result in *virtual* arms races, with the risk of degenerating very quickly into real arms races, break-out from the NPT, and even nuclear war. Nuclear hedging is contrary to the NPT's objectives — the existence of hedging programs undermines the confidence and stability that the NPT is intended to promote.

Since the purpose of nuclear hedging is to be in a position to make nuclear weapons, it is essential to gain international recognition that nuclear hedging is *not a peaceful purpose* permitted by the NPT. The problem is how to determine the real intent of a state — how to distinguish between a genuinely peaceful program and a program whose purpose is to establish a nuclear weapon option, or worse, is part of a planned nuclear weapon break-out?

Some of the indicators that could point to an interest in nuclear weapons were outlined above. However, some of these indicators will be difficult to detect — so the apparent absence of indicators is not necessarily reassuring — and even if detected, the purpose could be ambiguous. The only visible indicator of hedging may well be an enrichment or reprocessing program that has no clear civil justification.

THE CHALLENGE FOR SAFEGUARDS

When the NPT was concluded, it was believed that IAEA safeguards would provide *timely warning* of any misuse of nuclear facilities, giving the international community opportunity to intervene before a proliferator has time to manufacture nuclear weapons. It was also believed proliferation risk would be limited, because only the nuclear-weapon states and a small number of advanced industrialized states would have enrichment and reprocessing capabilities.

62 Ariel Levite, "*Never Say Never Again*," *International Security* 27, No. 3: pp. 59–88.

Recent research has brought to light that during the NPT negotiations UK officials warned their U.S. counterparts that *centrifuge enrichment* presented a serious risk to the NPT's objectives.[63] Unfortunately this warning was not heeded, and the language in the draft NPT (Article IV) was not amended. The UK's warning proved prescient, as there has been a gradual spread of proliferation capabilities, particularly centrifuge enrichment technology, accelerated more recently by black market activities, notably involving the Pakistan-based A. Q. Khan network.

As the UK warned almost fifty years ago, centrifuge enrichment technology presents a serious challenge to the safeguards objective of providing timely warning — the relative ease of concealing centrifuge plants and the potential speed of break-out mean that in certain circumstances[64] *adequate warning time cannot be guaranteed*. Even if diversion of enriched uranium from safeguards, or use of a safeguarded facility for high enrichment,[65] is detected immediately, the time required for international deliberations could mean that practical intervention is not possible in the necessary timeframe.

Similar timeliness issues are raised where stocks of separated plutonium are held. The risks are exacerbated where *low burn-up* plutonium is involved, e.g. with fast breeder reactors or large "research" reactors.[66] There is a real possibility that if plutonium is diverted, and the state has made the necessary preparations in advance, the plutonium could be turned into nuclear weapons before effective intervention is possible.

DEVELOPING CRITERIA FOR ASSESSING NUCLEAR PROGRAMS

Some key indicators for assessing whether the underlying purpose of a nuclear program may be to produce nuclear weapons, or at least to provide a break-

63 John Krige, "The Proliferation Risks of Gas Centrifuge Enrichment at the Dawn of the NPT," *The Nonproliferation Review*, 19:2: 19–227, http://www.tandfonline.com/doi/abs/10.1080/10736700.2012.690961#.UYswj7VBO4I.

64 E.g. a state that has an industrial-scale enrichment facility, or the capability to establish undeclared enrichment facilities for upgrading LEU diverted from safeguards.

65 One problem here is that the production of HEU is not prohibited — if a state started to do this, vital time could be lost on legalistic arguments.

66 Such as Iran's Arak reactor.

out capability, are outlined as follows. Criteria could be formulated to reflect indicators such as these. The presence of any one of these indicators could be regarded as a warning that the purpose of a nuclear program is not peaceful. A combination of these indicators would be grounds for serious concern.

(a) Developing an enrichment and/or reprocessing program not commensurate with the scale of the state's nuclear power program

Enrichment There are limited opportunities for legitimate import of enrichment facilities, as the established technology holders (Urenco, Tenex) are very careful about who they supply and do so only on a *black box* basis. It is not likely they would provide an enrichment facility where the rationale was questionable.

It is expensive for a state to develop its own enrichment technology, and difficult to obtain the specialized components and materials needed. The main suppliers of enrichment-related equipment and materials are members of the Nuclear Suppliers Group (NSG), applying the NSG Guidelines. An alternative source may be the *black market*, but illicit procurement is a strong negative indicator, see (b) following.

Compared with buying enrichment services on the international market, few national enrichment projects could be justified economically. The general industry view is that an enrichment program will not be economically viable unless supplying at least *twenty reactors* — i.e. an enrichment capacity of around 3 million SWU/yr. Few states could make a convincing case for needing a national enrichment program.

Reprocessing Historically, civil reprocessing programs were developed because of technical necessity (to manage spent fuel not suitable for long-term storage) or in anticipation of the introduction of fast neutron reactors. Notwithstanding the claims of current reprocessing operators, reprocessing for plutonium recycle using thermal reactors is not economically viable, and the waste management benefits are marginal compared to the future possibility of recycling with fast reactors. It is difficult to make a convincing case for a new reprocessing project unless and until fast reactors are established.

(b) Illicit procurement of equipment or technology

Considering the costs and the consequences — international suspicion, reputational damage, etc. — legitimate civil nuclear programs are not based on illicit procurement. Illicit procurement is a strong indicator of undeclared nuclear activities.

(c) Establishment of facility types, or unusual facility operations, that could be of advantage in producing nuclear weapons

The question is whether there is anything unusual about the state's nuclear program or the way it is operated, compared with international practice. For example, large natural-uranium fueled research reactors are out of place in a modern civil program — if a state is establishing such a reactor, the question arises whether the purpose may be to optimize plutonium production. A related indicator is the presence of large hot cells. Another example is abnormal operation of power reactors (e.g. unscheduled fuel discharges for "technical" reasons), resulting in accumulation of low burn-up fuel.

(d) Safeguards problems and deficiencies

Serious safeguards violations, systematic violations, and lack of cooperation with the IAEA are obvious warning signs about whether a nuclear program is really peaceful.

An important criterion, applied by the NSG for sensitive nuclear exports, is whether the state has concluded an additional protocol with the IAEA. The IAEA has emphasized that absent an additional protocol it is unable to assure that a state has no undeclared nuclear activities. Even if the additional protocol is not considered mandatory,[67] there is no valid reason why a state in good nonproliferation standing, with nothing to hide, would refuse to accept this, the most effective form of safeguards.[68]

Other indicators, some of which are discussed above, include:

(e) Apparent weaponization activities;

(f) Development of nuclear-capable delivery systems;

(g) Location in a *region of tension*, or other strategic circumstances that could provide a motivation for pursuing nuclear weapons;

(h) Military involvement in the operation of a "civil" program.

67 See John Carlson, "Is the Additional Protocol 'Optional'?," *Trust and Verify*, VERTIC, Issue No. 132 (January-March 2011): pp. 6—9, http://www.vertic.org/media/assets/TV/TV132.pdf.

68 Currently the only NPT non-nuclear-weapon states with nuclear programs that have refused the additional protocol are Argentina, Brazil, Egypt, Syria, and Venezuela. Iran had an AP in force provisionally but "suspended" it. Algeria had an AP approved by the IAEA Board but has not signed it.

APPLYING THESE CRITERIA

If states or international bodies (e.g. the Security Council) apply criteria such as those discussed here and conclude that the purpose of a particular state's nuclear program is, or may be, nuclear weapons development, what could be done?

Current international arrangements are largely *reactive*, the main example being where a treaty violation, in particular non-compliance with a safeguards agreement, is involved. In this case the Security Council can take action, as it has done with Iran and North Korea.

Instead of reacting to a problem once it has arisen — when it may already be too late for effective intervention — it is preferable to be proactive, to take a *preventative* approach. At present the only established mechanism for this is in the rather limited area of export controls, where suppliers can decide to deny particular nuclear or dual-use transfers. For example, the NSG Guidelines contain special controls on sensitive exports,[69] which take into account some of the factors discussed above. Export denials, however, have inherent limitations — they can apply only to the particular items being sought and not to other parts of a state's nuclear program that may be of equal or greater concern, and they have little effect against a program that is not dependent on legitimate nuclear transfers.[70]

The current nonproliferation regime does not deal adequately with the issue of national activities involving proliferation-sensitive nuclear technologies. Today a significant number of states have the capability to produce fissile material, and if nothing changes, this number will increase. Iran's behavior has highlighted the dangers inherent in national enrichment and reprocessing programs — if a state decides to apply these technologies for military use, IAEA safeguards may not be able to provide adequate warning.

An international approval process? It may be necessary for the Security Council to consider some process for determining the acceptability, or otherwise, of national programs in areas such as enrichment and reprocessing. The Security Council could determine in advance, through the application of *appropriate criteria*, whether a program presented a threat, or potential threat, to international peace and security, and direct the discontinuation of such programs.

Even if this approach was agreed, however, there is the problem that a state's circumstances can change over time. A state that gains approval to proceed with an enrichment or reprocessing program may fail the criteria some years later, e.g. because its security environment has changed significantly, after the program has been running for many years. At that stage it will be very difficult to compel the state to close the program, and it may well be too late to prevent its misuse.

This is the latency/hedging dilemma. Every state wants energy security, but this does not necessitate national programs in sensitive technologies — and paradoxically these could jeopardize a state's broader security interests, e.g. due to the reactions of other states. A new international framework for the nuclear fuel cycle is needed, emphasizing international cooperation in place of national fuel cycle programs. Key elements in the new framework should include *multilateral fuel cycle centers*, international fuel supply guarantees, and fuel leasing.

CONCLUSION

Development of criteria for assessing whether nuclear programs are really for peaceful purposes will help guide governments and industry, contribute to establishing international norms, and may even become the basis for an international approval process for proliferation-sensitive stages of the fuel cycle. Ultimately however the only sure way of addressing latency and hedging is to gain international support for multilateral fuel cycle approaches.

69 INFCIRC/254/Rev.11/Part 1, paragraphs 6 and 7, http://www.nuclearsuppliersgroup.org/Leng/PDF/infcirc254r11p1.pdf.

70 Clandestine nuclear activities are often based on illicit procurement, but this is largely beyond the purview of export approval processes.

Comments on Indicators of Nuclear Weaponization[71]

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Comments on John Carlson's paper

John Carlson's paper on "Assessing and Minimizing Proliferation Risk," delivered in this session, expertly identifies the principal challenge today, which is that of identifying nuclear proliferation indicators — in particular, detection of undeclared nuclear weapon development activities in non-nuclear-weapon states party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

Carlson provides a useful capsule description of the sensitive parts of the nuclear fuel cycle for policy makers. His paper discusses the concept of "nuclear latency," which refers to a state developing a capability to produce weapon-usable nuclear material and advanced industrial knowhow and infrastructure. Carlson asserts that in some cases nuclear latency might be considered as *inadvertent*, i.e. a by-product of a civilian nuclear fuel cycle that includes uranium enrichment and/or plutonium reprocessing capability. I would argue that nuclear latency is a physical or technical capability that has been developed in states with advanced nuclear technology and such capability cannot be categorized as *inadvertent* — either the capability exists or it does not. Given the dual nature of the atom, i.e. that it can be used for both peaceful and military purposes, it has been recognized from the dawn of the nuclear age that developing the sensitive parts of the nuclear fuel cycle gives a state the capability to use nuclear technology and material for peaceful uses as well as for military or weapon purposes. The use of the technology is determined by the policy of the state and not by the technology itself. Thus, nuclear latency is the result of a technological capability developed by a state in the full knowledge of its dual use and cannot be inadvertent — rather it is the result of a deliberate policy decision.

Carlson is correct in noting that a state with a nuclear latency capability is limited only by a political decision whether or not to cross the threshold to nuclear weaponization. He refers to the example of Japan, which has developed a complete nuclear fuel cycle, including enrichment and reprocessing, but has a longstanding political commitment to nuclear non-proliferation, and it lacks weaponization and delivery systems. However, it must be noted that many experts are of the opinion that Japan could develop a nuclear weapon in short order should it decide to do, as it already has sizable stocks of separated Pu (albeit under safeguards), and it also has advanced dual-use industrial technology and know-how. While at present Japan does not deploy a ballistic missile, its extensive SLV (space launch vehicle) program puts it in a position to quickly convert the SLVs and deploy ballistic missiles in short order; furthermore it has tested the recovery of scientific payloads launched by an SLV, which also provides the potential for a re-entry vehicle (RV) capability (for a warhead). Such testing could provide useful experience for missile and warhead development. In addition, while Japan has implemented the Additional Protocol to its NPT safeguards agreement, its extensive plutonium reprocessing program and growing stocks of separated plutonium do in fact pose some potential verification and proliferation challenges. The Rakkosho reprocessing plant is difficult to safeguard. Despite this, at present there are no indications of

71 The views expressed in this paper are solely those of the author and do not represent the views of the IAEA or of any other entity.

a nuclear weapon development program in Japan — though contrary to its three non-nuclear principles enshrined in its Constitution, it has become clear that for several years the government turned a blind eye to the stationing of U.S. nuclear weapons at U.S. bases in Japan, contrary to its Constitutional provisions; and lately some senior officials have voiced interest in the possible development of nuclear weapons in response to North Korea's nuclear weapon program.

Carlson also refers to the case of South Korea in the context of nuclear latency and South Korea's interest in enrichment and reprocessing. It should be noted in this regard that enrichment and reprocessing is prohibited under the 1992 South-North Denuclearization Agreement, and South Korea is now eager to develop pyroprocessing, which the United States considers a form of reprocessing. One might recall that in 2004 the IAEA discovered that South Korea had engaged in undeclared nuclear activities involving sensitive nuclear material and had taken steps to conceal such activity from the IAEA. In its defense, South Korea claimed that fifteen scientists had misused a government facility and that the activities were not government sanctioned. South Korea later provided the required cooperation and access to the IAEA to resolve this matter.

Nuclear hedging is also described by Carlson — which is putting in place the capability to develop a nuclear weapon capability at a future date by breaking out of safeguards/the NPT. Some analysts categorize the advanced nuclear programs of Argentina, Brazil, Germany, Iran, Japan, South Korea, Switzerland, and Taiwan (China), among others, as being close to nuclear hedging.

Carlson also alludes to the dissemination of enrichment and reprocessing (E/R) technologies — a phenomenon highlighted by the IAEA Director General (DG) in October 2003 in his op-ed in *The Economist*, in which the DG noted that such technologies were now in too many hands and recommended that all sensitive parts of the nuclear fuel cycle henceforth be operated under multilateral auspices. Carlson recommends multilateral approaches to the nuclear fuel cycle as a way of addressing the proliferation concerns of the spread of sensitive nuclear fuel cycle technologies. This is an area where the IAEA has done much work since 2003. An approach proposed by the IAEA DG in 2003 was based on three pillars: (1) building new E/R facilities under multilateral auspices, not national ownership; (2) converting existing E/R facilities to multilateral operations; (3) eventually placing all E/R under multilateral arrangements, and supplementing this framework by a fissile material (cut-off) treaty (FMCT) banning the production of weapon-usable nuclear material and bringing existing stocks under nuclear material accountancy and international monitoring.

Unfortunately, the two new enrichment facilities under construction in the United States, plus the American Centrifuge facility, as well as the new French enrichment facility, are being built under national not multilateral auspices/operations; and Argentina, Australia, Brazil, Canada, Kazakhstan, South Africa, and Ukraine rejected giving up the national enrichment option, as did the NAM states. However, in 2010 the IAEA LEU Reserve in Angarsk (Russian Federation) was operational; in March 2011 the UK Nuclear Fuel Assurance (NFA) was approved by the IAEA Board of Governors (BoG); in December 2010 the IAEA BoG approved the establishment of an IAEA owned and operated LEU Bank (which will be set up in Ust Kamenogorsk in Kazakhstan); in 2008 the Russian Federation set up the International Uranium Enrichment Center (IUEC) at Angarsk in collaboration with Kazakhstan (Ukraine and Armenia joined later); and in 2012 the American Assured Fuel Supply was established, based on low-enriched uranium derived from down-blended high-enriched uranium from dismantled nuclear warheads. Despite these important steps toward assurances of the supply of nuclear fuel, thus far multilateral approaches to the nuclear fuel cycle have not been accepted by the advanced nuclear states, and the NAM states remain suspicious of such proposals.

Last, Carlson proposes a UN Security Council (UNSC) process for reviewing the establishment of E/R facilities based on "appropriate criteria," whether a program presented a threat, or potential threat. I cannot but oppose any such idea — not only would any such assessment be based on the P-5's subjective criteria, but more importantly the UN Security Council does not have the credibility to manage such an assessment program. Recent experience has shown how the UNSC can be manipulated by false and fabricated information, its decision-making can be circumscribed by the veto, and the Council is misplaced to assess technical matters regarding the nuclear fuel cycle or nuclear verification. Given P-5 politics in the Security Council, decisions or resolutions of the Council are hard to come by, and certain such decisions and resolutions are even harder to reverse or to be declared as successfully implemented. The Security Council increasingly is being (mis)-used by some of the P-5 as an instrumental body, deciding certain issues under the mandate of Chapter VII of the UN Charter, thus making such decisions mandatory for all UN member states but bypassing the traditional negotiating fora, such as the General Assembly, the UN Disarmament Commission, and the Conference on Disarmament. Recent Security Council resolutions, such as 1373 (2001), 1540 (2004), and 1887 (2009), were adopted by the Council pursuant to Chapter VII powers, thus being of mandatory nature even though these resolutions are unbalanced and drafted without the full involvement of the UN membership for which they are mandatory. The Security Council is increasingly viewed by the majority of the UN membership as being undemocratic and unrepresentative of the wider UN community of nations, as ineffective with regard to major issues of international peace and security, and as irrelevant in the context of the states possessing nuclear weapons. Thus, opening up nuclear fuel cycle issues, such as E/R, at the Security Council is bound to be counter-productive and a misuse of that body. Furthermore, the IAEA BoG (in 2009/2010/2011) as well as the 2010 NPT Review Conference have respectively affirmed to respect states' choices regarding their nuclear fuel cycle and also supported multilateral approaches to the nuclear fuel cycle — the UN Security Council has no mandate or authority to consider such multilateral treaty matters.

Instead of the Security Council, the IAEA BoG could be the suitable venue where states embarking on E/R programs could voluntarily provide information as a measure of openness and transparency in accordance with the provisions of the IAEA Statute and the Agency's safeguards system. In any case, pursuant to the modified Code 3.1 of the comprehensive safeguards agreement, a non-nuclear-weapon state is obligated to provide early design information as soon as consideration is undertaken to construct a new nuclear facility or to modify an existing nuclear facility. Furthermore, the Additional Protocol in conjunction with a comprehensive safeguards agreement (CSA) should be recognized as the verification standard for NPT non-nuclear-weapon states. In addition, the Additional Protocol itself needs to be updated, as it is based on pre-1997 verification methodologies.

Finally, as proposed by the IAEA Director General in 2003, and as affirmed in 2005 by the independent Expert Group on Multilateral Approaches to the Nuclear Fuel Cycle commissioned by the IAEA Director General,[72] the sensitive parts of the nuclear fuel cycle — uranium enrichment and reprocessing of plutonium — should no longer be solely under national control but placed under multilateral auspices with the involvement of the IAEA and arrangements to prevent technology spread. Multilateral nuclear approaches (MNAs), when properly established, can provide both "assurance of nonproliferation" and "assurance of supply and services of nuclear fuel." Thus, MNAs can assure peaceful uses of nuclear energy while minimizing proliferation risks.

Indicators of Nuclear Weaponization

One of the greatest challenges in the current nuclear nonproliferation regime is the lack of technologies to detect clandestine production of nuclear-weapon usable materials, i.e. highly-enriched uranium (HEU) and plutonium (Pu). As a result, accusations of hidden nuclear weapon ambitions, actual clandestine efforts to acquire a stockpile of relevant materials, and international uncertainty about such efforts have repeatedly lead to a considerable increase in regional and international crises in the past decades, not to mention an unnecessary war in 2003 and threats of military attack and cyber warfare more recently.

IAEA safeguards

In 2005, the IAEA Board of Governors established an Advisory Committee on Safeguards and Verification within the Framework of the IAEA Statute to review further safeguards strengthening measures. Despite the

72 INFCIRC/640, Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report submitted to the Director General of the International Atomic Energy Agency, February 22, 2005, for which the author served as the Scientific Secretary, http://www.iaea.org/Publications/Documents/Infcircs/2005/infcirc640.pdf.

eagerness of some states to establish this advisory committee, no technical proposals were presented by member states; as such the IAEA Secretariat produced several technical papers covering new monitoring technologies, expanded an innovative use of existing technologies, and sought approval for additional verification tools. The Committee was wound up at the end of its two-year mandate with no agreement.

The IAEA is implementing the state-level concept for the implementation and evaluation of safeguards. In the state-level concept, safeguards implementation and the evaluation of that implementation are based on a state-level approach (SLA), developed for each state. SLAs are developed on a non-discriminatory basis using safeguards verification objectives that are common to all states with comprehensive safeguards agreements (CSAs). They also enable state-specific features, such as the state's nuclear fuel cycle and the effectiveness of its state system of accounting for and control of nuclear material (SSAC), to be factored in. The IAEA also is obtaining information on the procurement and supply of sensitive nuclear technology, which enables the Agency to increase its understanding of covert nuclear trade activities, on a transnational basis, for safeguards purposes.

Thus, the IAEA is increasing its capabilities to detect clandestine nuclear weapon programs; however, it is hampered in this effort by lack of consensus among its member states, paucity of funding, lack of access to the most advanced technologies, and lack of experienced inspectors with direct experience in the nuclear-weapon cycle.

Clandestine nuclear weapon development

With regard to clandestine nuclear weapon development, there is no simple or definitive way to discern the capabilities and time required to develop and manufacture nuclear weapons. General factors to be considered include, for example, technology diffusion and the NPT regime. Specific factors include national motivation, level of technological development, external assistance, and technological options, such as nuclear material production, warhead design, weaponization, and nuclear testing; as well as the strategic requirements and defense roles for nuclear weapons, arsenal size and deployment, delivery systems, and doctrine. Despite the diffusion of technology and

the existence of clandestine supply networks, any state pursuing a nuclear weapon development option necessarily will need to overcome a series of challenges — financial, technological, diplomatic, and military.

Special Nuclear Materials Production

Special nuclear material (SNM) production always has been and remains today the major obstacle to nuclear-weapon development. The production of special nuclear material — plutonium (Pu) and highly-enriched uranium (HEU) — requires specialized equipment, facilities, and expertise. The material production process is indicative of a timeline only in abstract terms for nuclear-weapon development. The estimated construction/operation time is based on the production of a significant quantity of Pu or HEU sufficient for a weapon, which according to the IAEA safeguards glossary is 8 kg of plutonium and 25 kg of HEU. On this basis, if one assumes a parallel weaponization track, the estimated time for material production also provides an estimate of the time necessary to develop nuclear weapons. According to the IAEA, the time required for detection and conversion of a significant quantity of nuclear material to an explosive is one month for "Un-irradiated Direct-use Material" and three months for "Irradiated Direct-use Material."

In reality though, concerning the quantity of SNM a state would require, the state's technological capability and related elements would need to be considered. States with advanced nuclear power programs, particularly if they include the sensitive parts of the nuclear fuel cycle — enrichment and reprocessing — already possess the technological know-how and facilities for producing weapon-usable materials, and in some cases they may even hold large stocks of SNM, thus giving them a ready-to-go capability should they decide to break out of the NPT and IAEA safeguards.

If a state is initiating a nuclear weapon program from inception, it is generally believed that a plutonium path would require less time and technological capability compared to uranium enrichment to manufacture the SNM required for a weapon. Pu production and reprocessing, as compared to uranium enrichment, results in higher radiation signatures. A small production reactor and reprocessing facility (which may even be a hot cell) can be more easily camouflaged than a gaseous diffusion plant for enriching uranium, but a small gas centrifuge facility can easily be hidden. Since detection of HEU production at a small gas centrifuge facility would be difficult, nowadays this is considered to be the preferred path to clandestine SNM acquisition.

The design and manufacture of a plutonium weapon would pose a greater challenge than a gun-type weapon using HEU, but this would be of a lesser order of magnitude than producing the SNM.

The diffusion of gas centrifuge technology has reduced but not eliminated the differences between acquiring Pu and HEU with regard to the length of time and expertise needed for a newcomer state to develop a nuclear weapon. Such differences, however, would be marginal for states with advanced nuclear technology. Nonetheless, despite external assistance, significant challenges may remain with regard to the acquisition of SNM.

The best indicator for plutonium production is atmospheric krypton-85, which is emitted during the reprocessing of spent nuclear fuel. The most promising new sensor technology is the ultra-sensitive trace analysis of this radioactive noble gas isotope. The International Monitoring System (IMS) of the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) has been carrying out atmospheric sampling and transport modeling, but the IAEA has not yet been given this capability by its member states — opposition from some NWS, NAM, and developed states is the obstacle.

The major environmental signatures of uranium enrichment result from the gaseous uranium hexafluoride (UF_6), which escapes during the various process steps. This unstable gas quickly reacts with atmospheric humidity to form UO_2F_2 and HF. Other reaction products also occur such as (HF) n, and $UF_2(OH)_2$. These are the remote indicators for uranium enrichment. The uranium could be at any enrichment level in the production process. For any type of uranium enrichment technology, these signatures are very weak, and it will be a real challenge to devise a measurement technology with sufficiently high sensitivity that permits detection of any trace gases in the environment. Thus far, little research work has been carried out in this field. To date, no clandestine enrichment facilities have been discovered or identified using environmental modeling — the experience thus far results from war (Iraq 1991) and intelligence information (Iran 2002 and 2009).

Procurement of Specialized Equipment and Materials

Specialized, often dual-use equipment, including precision milling, electronics, exploding bridge-wire, diagnostic equipment, and single-use equipment, such as neutron generators, is required for nuclear weapon development. Non-nuclear materials, such as energetic high explosives, are necessary, as are beryllium and related materials. For some designs deuterium and tritium may be required. The difficulty in dealing with such equipment and materials is that only small quantities may be required, with limited and ambiguous observable characteristics.

Weaponization

Weaponization comprises a series of nuclear weapon development activities, from device design to component engineering to non-nuclear testing, which together provide assurance that the nuclear explosive will perform as intended. These activities may be more or less demanding, depending on the type of weapon and the level of technological development of the state. Those states with advanced chemical munitions capabilities are better placed in this regard. The challenges to states today are no longer basic science but nuclear engineering, and such challenges can be enormous and not easily overcome. Increasingly, while weaponization will require time, the time to acquire the SNM generally will be longer.

Nuclear Testing

Nuclear explosive testing may or may not be necessary for new nuclear weapons, depending upon the type chosen, technical factors, and the risks a state is willing to assume. In those rare instances where a single, relatively unsophisticated weapon is sought and envisaged as a means to intimidate adversaries, testing may not be a technical necessity. South Africa, which developed gun-type fission weapons using HEU, would appear not to have needed to test on technical grounds — however, South Africa reportedly was making preparations to carry out an underground test but was discovered and pressured by the United States to cancel. India carried out an initial single test in 1974 and only twenty-four years later detonated additional devices. Nuclear explosive testing can be viewed as politically useful to prove capability, as in the case of all ten states that have carried out test explosions.

With regard to sophisticated weapon designs that would be fully developed and deployed in standing forces, states very likely would resort to explosive testing to assure reliability and quality. Thus, tests carried out by India in 1974 and 1998, by Pakistan in 1998, and by North Korea in 2006, 2008, and 2013, certainly had both political and technical drivers. Explosive testing campaigns, where required technically, add considerable time — ranging from months to years — to deploy combat ready weapons.

Weapon Production

Serial weapon production requires a viable production infrastructure, including resources, manpower, and technological know-how and engineering skills. The size and technical sophistication of the arsenal will drive the requirements for SNM, non-nuclear materials, infrastructure, and production/assembly lines. Such time lines can be drawn out and are unlikely to be compressed.

Delivery Systems

The capabilities of delivery systems drive the parameters for warheads in terms of size and weight. Manned aircraft as delivery systems are acquired relatively easily, but these systems are vulnerable to interception by an adversary's defensive forces. Greater reliability in delivery systems comes from air-breathing (cruise) missiles and from ballistic missiles; the latter can easily be adapted from a space launch vehicle capability. Ballistic missiles, however, require extensive testing and engineering even when acquired from an external source.

Overall Assessment

Despite significant variations in real-world cases, the record of proliferation beyond the original proliferators — i.e. the five nuclear-weapon states: the United States, the Soviet Union, the United Kingdom, France, and China — in Israel, South Africa, India, Pakistan, and North Korea, suggests that each case is unique and sui generis. Thus, much of the discussion of the indicators, capabilities, and time lines for nuclear weapon acquisition from initial development to testing to serial production to deployment on delivery vehicles tends to reflect an over-simplification of the complexities involved. The key independent variable is the resources/time required to acquire the relevant SNM. The dependent variables include technology, resources, manpower, and infrastructure. In fact, the total number and types of weapons being pursued, as well as their delivery systems, nuclear posture, and doctrine, are by and large irrelevant.

In the real world, each state's requirements and capabilities are different and should be generalized. This leads to different requirements and capabilities, different time lines and acquisition paths. Nonetheless, three categories of states can be identified: (1) for states with no or minimal nuclear activities, indicators could include any nuclear activity beyond the medical and industrial isotopes, and possible weaponization development, such as high-explosive testing. These types of activities could be expected to consume a decade or more, though the timeframe could be significantly altered by imports and other factors; (2) for states with some level of nuclear activities, key indicators could include attempts to develop large research reactors, sensitive fuel cycle facilities including E/R, weaponization, and delivery systems; and (3) for advanced industrial states, such as Germany, Japan, or South Korea, indicators of nuclear weapon development (virtual or actual) may include decisions to shorten lead-times for capabilities to develop and produce nuclear weapons, or the acquisition or development of military assets to deploy tactical or strategic nuclear forces. Thus, states with a capable nuclear fuel cycle and strong industrial base already possess a latent or virtual capability, which could be converted to weapons within months, should a priority national decision be adopted. Such capability is not inadvertent and provides a hedging option.

Conclusion

The single most significant obstacle to nuclear weapon development remains acquisition of SNM — highly-enriched uranium and weapon-usable plutonium. Development of a production capability for SNM cannot be achieved without a number of observable indicators as discussed above and requires time, as well as overcoming considerable obstacles. With advances in safeguards methodologies and practices, the ubiquitous availability of satellite imagery, national technical means, and related capabilities, the clandestine production of SNM runs an unacceptably high risk of detection — Iran and North Korea are cases in point. Thus, with a strengthened IAEA safeguards system, supplemented by additional information and data sources, the probability of detecting the clandestine production of SNM is high. In addition, removing existing SNM production facilities from national control and placing them under multilateral auspices with IAEA involvement further strengthens the nuclear nonproliferation system and provides additional confidence in the assurance of nonproliferation. Finally, if a state is determined to develop or has achieved a break-out capability or nuclear latency — as have several advanced non-nuclear-weapon states — there is no absolute guarantee or system to prevent break-out; this is the enduring dilemma of nuclear technology.

Final Document of the Conference of the International Luxembourg Forum on Preventing Nuclear Catastrophe

“Secure Tolerance Criteria for the Nuclear Nonproliferation Regime”

(May 21–22, 2013, Montreux, Switzerland)

The members of the International Advisory Council of the International Luxembourg Forum express their gratitude to the Geneva Centre for Security Policy for its cooperation in holding a session on “Secure Tolerance Criteria for the Nuclear Nonproliferation Regime.”

The members of the International Advisory Council of the International Luxembourg Forum express their concern over the present state of the nuclear nonproliferation regime. They believe that the Treaty on the Non-Proliferation of Nuclear Weapons continues to be the cornerstone of prevention of the further proliferation of nuclear weapons and furtherance of nuclear disarmament, which are fundamental elements of international security at global and regional levels.

Nonetheless, the nonproliferation regime is in need of enhancement and refinement. Equally important is building consensus among the great powers and other responsible states on such steps and their priority for ensuring the efficacy of the nonproliferation regime and its norms and institutions.

The need for such measures is demonstrated by the prolonged crises over the nuclear programs of North Korea and Iran, as well as a number of other violations and deviations from NPT norms and procedures by other states.

The participants of the Conference of the International Luxembourg Forum paid special attention to the following technical, operational, strategic, economic, and political aspects and tipping points of nuclear weapons development. These issues should be the focus of monitoring and, if necessary, of actions by the international community in order to enhance the nonproliferation regime:

1. Foremost, the technical aspects of nuclear weapons, their delivery systems, and nuclear force deployments of various scales were analyzed.

2. Special attention was given to the scientific, technical, and industrial potential of states relevant to nuclear weapons development.

3. Besides analyzing the experience of the five nuclear-weapon states, the participants of the Conference gave thorough consideration to the specifics of nuclear weapons development in the regions of Northeast Asia, the Middle East, and South Asia.

4 The International Luxembourg Forum experts started the process of defining criteria for non-declared weapons development that could be used by the IAEA and the UN Security Council to make a judgment about the nature and goals of the nuclear programs of NPT parties. Such criteria may serve for the initiation of appropriate actions by the IAEA and the UN Security Council in order to prevent violations or break-out of parties from the Non-Proliferation Treaty.

5 The participants proposed the establishment of an International Expert Center as a subsidiary organ of the UN Security Council under the auspices of the IAEA with the task of analyzing and monitoring the possible development of nuclear explosive devices and their delivery means by non-nuclear-weapon states. This Center would receive relevant information from the national technical means of states and from other sources.

6. Conference participants decided to create a Working Group for the elaboration of criteria and to propose a general structure of academic, public, and official organizations that would be assigned the task of producing policy guidance and instruments to prevent misuse of nuclear energy in order to promote secure nuclear tolerance.

Elaboration of such assessment methods and criteria should define the limits of secure tolerance within the nuclear nonproliferation regime. Participants agreed that continuation of this analytical effort would be essential for presenting concrete proposals to the IAEA and the UN Security Council.

The context of this endeavor is to create an environment that facilitates the peaceful development of nuclear energy while minimizing the risks of its potential misuse and to conduct work beneficial to peaceful uses of nuclear energy, disarmament, and nonproliferation.

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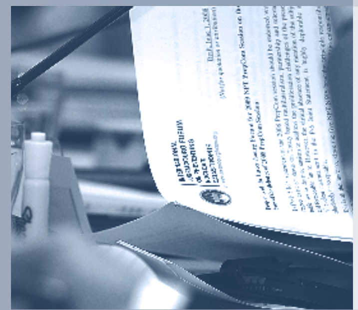
11. **Sergey OZNOBISHCHEV** — Director of the Institute for Strategic Assessments; Professor of the MGIMO (former Chief of the Organizational Analytic Division, RAS); Ph.D.; Full Member of the Russian Academy of Cosmonautics (Russia).

12. **Tariq RAUF** — President, "Global Nuclear Solutions" (former Head, Verification and Security Policy Coordination, Office of External Relations and Policy Coordination of the IAEA); Ph.D. (Austria).

13. **Roald SAGDEEV** — Distinguished University Professor, Department of Physics at the University of Maryland; Director Emeritus of the Russian Space Research Institute; Member of the Supervisory Council of the International Luxembourg Forum; Academician RAS (Russia/United States).

14. **Fred TANNER** — Director of the Geneva Centre for Security Policy; Ambassador (Switzerland).



APPENDICES

APPENDIX 1

Normative Documents on Nuclear Nonproliferation

1.1. United Nations Security Council Resolution 2094 (North Korea), March 7, 2013; New-York

The Security Council,

Recalling its previous relevant resolutions, including resolution 825 (1993), resolution 1540 (2004), resolution 1695 (2006), resolution 1718 (2006), resolution 1874 (2009), resolution 1887 (2009) and resolution 2087 (2013), as well as the statements of its President of 6 October 2006 (S/PRST/2006/41), 13 April 2009 (S/PRST/2009/7) and 1 6 April 2012 (S/PRST/2012/13),

Reaffirming that proliferation of nuclear, chemical and biological weapons, as well as their means of delivery, constitutes a threat to international peace and security,

Underlining once again the importance that the DPRK respond to other security and humanitarian concerns of the international community,

Expressing the gravest concern at the nuclear test conducted by the Democratic People's Republic of Korea ("the DPRK") on 12 February 2013 (local time) in violation of resolutions 1718 (2006), 1874 (2009) and resolution 2087 (2013), and at the challenge such a test constitutes to the Treaty on Non-Proliferation of Nuclear Weapons ("the NPT") and to international efforts aimed at strengthening the global regime of non-proliferation of nuclear weapons, and the danger it poses to peace and stability in the region and beyond,

Concerned that the DPRK is abusing the privileges and immunities accorded under the Vienna Convention on Diplomatic and Consular Relations,

Welcoming the Financial Action Task Force's (FATF) new Recommendation 7 on targeted financial sanctions related to proliferation, and *urging* Member States to apply FATF's Interpretative Note to Recommendation 7 and related guidance papers for effective implementation of targeted financial sanctions related to proliferation,

Expressing its gravest concern that the DPRK's ongoing nuclear and ballistic missile-related activities have further generated increased tension in the region and beyond, and *determining* that there continues to exist a clear threat to international peace and security,

Acting under Chapter VII of the Charter of the United Nations, and taking measures under its Article 41,

1. *Condemns* in the strongest terms the nuclear test conducted by the DPRK on 12 February 2013 (local time) in violation and flagrant disregard of the Council's relevant resolutions;
2. *Decides* that the DPRK shall not conduct any further launches that use ballistic missile technology, nuclear tests or any other provocation;
3. *Demands* that the DPRK immediately retract its announcement of withdrawal from the NPT;
4. *Demands further* that the DPRK return at an early date to the NPT and International Atomic Energy Agency (IAEA) safeguards, bearing in mind the rights and obligations of States parties to the NPT, and underlines the need for all States parties to the NPT to continue to comply with their Treaty obligations;
5. *Condemns* all the DPRK's ongoing nuclear activities, including its uranium enrichment, *notes* that all such activities are in violation of resolutions 1718 (2006), 1874 (2009) and 2087 (2013), *reaffirms* its decision that the DPRK shall abandon all nuclear weapons and existing nuclear programmes, in a complete, verifiable and irreversible manner and immediately cease all related activities and shall act strictly in accordance with the obligations applicable to parties under the NPT and the terms and conditions of the IAEA Safeguards Agreement (IAEA INFCIRC/403);
6. *Reaffirms* its decision that the DPRK shall abandon all other existing weapons of mass destruction and ballistic missile programmes in a complete, verifiable and irreversible manner;
7. *Reaffirms* that the measures imposed in paragraph 8 (c) of resolution 1718 (2006) apply to items prohibited by paragraphs 8 (a) (i), 8 (a) (ii) of resolution 1718 (2006) and paragraphs 9 and 10 of resolution 1874 (2009), *decides* that the measures imposed in paragraph 8 (c) of resolution 1718 (2006) also apply to paragraphs 20 and 22 of this resolution, and *notes* that these measures apply also to brokering or other intermediary services, including when arranging for the provision, maintenance or use of prohibited items in other States or the supply, sale or transfer to or exports from other States;
8. *Decides further* that measures specified in paragraph 8 (d) of resolution 1718 (2006) shall apply also to the individuals and entities listed in annexes I and II of this resolution and to any individuals or entities acting on their behalf or at their direction, and to entities owned or controlled by them, including through illicit means, and *decides further* that the measures specified in paragraph 8 (d) ofresolution 1718 (2006) shall apply to any individuals or entities acting on the behalf or at the direction of the individuals and entities that have already been designated, to entities owned or controlled by them, including through illicit means;
9. *Decides* that the measures specified in paragraph 8 (e) of resolution 1718 (2006) shall also apply to the individuals listed in annex I of this resolution and to individuals acting on their behalf or at their direction;

10. *Decides* that the measures specified in paragraph 8 (e) of resolution 1718 (2006) and the exemptions set forth in paragraph 10 of resolution 1718 (2006) shall also apply to any individual whom a State determines is working on behalf or at the direction of a designated individual or entity or individuals assisting the evasion of sanctions or violating the provisions of resolutions 1718 (2006), 1874 (2009), 2087 (2013), and this resolution, and further *decides* that, if such an individual is a DPRK national, then States shall expel the individual from their territories for the purpose of repatriation to the DPRK consistent with applicable national and international law, unless the presence of an individual is required for fulfillment of a judicial process or exclusively for medical, safety or other humanitarian purposes, provided that nothing in this paragraph shall impede the transit of representatives of the Government of the DPRK to the United Nations Headquarters to conduct United Nations business;

11. *Decides* that Member States shall, in addition to implementing their obligations pursuant to paragraphs 8 (d) and (e) of resolution 1718 (2006), prevent the provision of financial services or the transfer to, through, or from their territory, or to or by their nationals or entities organized under their laws (including branches abroad), or persons or financial institutions in their territory, of any financial or other assets or resources, including bulk cash, that could contribute to the DPRK's nuclear or ballistic missile programmes, or other activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, or to the evasion of measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, including by freezing any financial or other assets or resources on their territories or that hereafter come within their territories, or that are subject to their jurisdiction or that hereafter become subject to their jurisdiction, that are associated with such programmes or activities and applying enhanced monitoring to prevent all such transactions in accordance with their national authorities and legislation;

12. *Calls upon* States to take appropriate measures to prohibit in their territories the opening of new branches, subsidiaries, or representative offices of DPRK banks, and also *calls upon* States to prohibit DPRK banks from establishing new joint ventures and from taking an ownership interest in or establishing or maintaining correspondent relationships with banks in their jurisdiction to prevent the provision of financial services if they have information that provides reasonable grounds to believe that these activities could contribute to the DPRK's nuclear or ballistic missile programmes, or other activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), and this resolution, or to the evasion of measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution;

13. *Calls upon* States to take appropriate measures to prohibit financial institutions within their territories or under their jurisdiction from opening representative offices or subsidiaries or banking accounts in the DPRK if they have information that provides reasonable grounds to believe that such financial services could contribute to the DPRK's nuclear or ballistic missile programmes, and other activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), and this resolution;

14. *Expresses* concern that transfers to the DPRK of bulk cash may be used to evade the measures imposed in resolutions 1718 (2006), 1874 (2009), 2087 (2013), and this resolution, and *clarifies* that all States shall apply the measures set forth in paragraph 11 of this resolution to the transfers of cash, including through cash couriers, transiting to and from the DPRK so as to ensure such transfers of bulk cash do not contribute to the DPRK's nuclear or ballistic missile programmes, or other activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, or to the evasion of measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution;

15. *Decides* that all Member States shall not provide public financial support for trade with the DPRK (including the granting of export credits, guarantees or insurance to their nationals or entities involved in such trade) where such financial support could contribute to the DPRK's nuclear or ballistic missile programmes, or other activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, or to the evasion of measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution;

16. *Decides* that all States shall inspect all cargo within or transiting through their territory that has originated in the DPRK, or that is destined for the DPRK, or has been brokered or facilitated by the DPRK or its nationals, or by individuals or entities acting on their behalf, if the State concerned has credible information that provides reasonable grounds to believe the cargo contains items the supply, sale, transfer, or export of which is prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, for the purpose of ensuring strict implementation of those provisions;

17. *Decides* that, if any vessel has refused to allow an inspection after such an inspection has been authorized by the vessel's flag State, or if any DPRK-flagged vessel has refused to be inspected pursuant to paragraph 12 of resolution 1874 (2009), all States shall deny such a vessel entry to their ports, unless entry is required for the purpose of an inspection, in the case of emergency or in the case of return to its port of origination, and *decides* further that any State that has been refused by a vessel to allow an inspection shall promptly report the incident to the Committee;

18. *Calls upon* States to deny permission to any aircraft to take off from, land in or overfly their territory, if they have information that provides reasonable grounds to believe that the aircraft contains items the supply, sale, transfer or export of which is prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, except in the case of an emergency landing;

19. *Requests* all States to communicate to the Committee any information available on transfers of DPRK aircraft or vessels to other companies that may have been undertaken in order to evade the sanctions or in violating the provisions of resolution 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, including renaming or re-registering of aircraft, vessels or ships, and *requests* the Committee to make that information widely available;

20. *Decides* that the measures imposed in paragraphs 8 (a) and 8 (b) of resolution 1718 (2006) shall also apply to the items, materials, equipment, goods and technology listed in annex III of this resolution;

21. *Directs* the Committee to review and update the items contained in the lists specified in paragraph 5 (b) of resolution 2087 (2013) no later than twelve months from the adoption of this resolution and on an annual basis thereafter, and *decides* that,

if the Committee has not acted to update this information by then, the Security Council will complete action to update within an additional thirty days;

22. *Calls upon* and allows all States to prevent the direct or indirect supply, sale or transfer to or from the DPRK or its nationals, through their territories or by their nationals, or using their flag vessels or aircraft, and whether or not originating in their territories of any item if the State determines that such item could contribute to the DPRK's nuclear or ballistic missile programmes, activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, or to the evasion of measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, and *directs* the Committee to issue an Implementation Assistance Notice regarding the proper implementation of this provision;

23. *Reaffirms* the measures imposed in paragraph 8 (a) (iii) of resolution 1718 (2006) regarding luxury goods, and *clarifies* that the term "luxury goods" includes, but is not limited to, the items specified in annex IV of this resolution;

24. *Calls upon* States to exercise enhanced vigilance over DPRK diplomatic personnel so as to prevent such individuals from contributing to the DPRK's nuclear or ballistic missile programmes, or other activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), and this resolution, or to the evasion of measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution;

25. *Calls upon* all States to report to the Security Council within ninety days of the adoption of this resolution, and thereafter upon request by the Committee, on concrete measures they have taken in order to implement effectively the provisions of this resolution, and *requests* the Panel of Experts established pursuant to resolution 1874 (2009), in cooperation with other UN sanctions monitoring groups, to continue its efforts to assist States in preparing and submitting such reports in a timely manner;

26. *Calls upon* all States to supply information at their disposal regarding non-compliance with the measures imposed in resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution;

27. *Directs* the Committee to respond effectively to violations of the measures decided in resolutions 1718 (2006), 1874 (2009), 2087 (2013), and this resolution, *directs* the Committee to designate additional individuals and entities to be subject to the measures imposed in resolutions 1718 (2006), 1874 (2009), 2087 (2013), and this resolution, and *decides* that the Committee may designate any individuals for measures under paragraphs 8 (d) and 8 (e) of resolution 1718 (2006) and entities for measures under paragraph 8 (d) of resolution 1718 (2006) that have contributed to the DPRK's nuclear or ballistic missile programmes, or other activities prohibited by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, or to the evasion of measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution;

28. *Decides* that the mandate of the Committee, as set out in paragraph 12 of resolution 1718 (2006), shall apply with respect to the measures imposed in resolution 1874 (2009) and this resolution;

29. *Recalls* the creation, pursuant to paragraph 26 of resolution 1874 (2009), of a Panel of Experts, under the direction of the Committee, to carry out the tasks provided for by that paragraph, *decides* to extend until 7 April 2014 the Panel's mandate, as renewed by resolution 2050 (2012), *decides further* that this mandate shall apply with respect to the measures imposed in this resolution, *expresses its intent* to review the mandate and take appropriate action regarding further extension no later than twelve months from the adoption of this resolution, *requests* the Secretary-General to create a group of up to eight experts and to take the necessary administrative measures to this effect, and *requests* the Committee, in consultation with the Panel, to adjust the Panel's schedule of reporting;

30 *Emphasizes* the importance of all States, including the DPRK, taking the necessary measures to ensure that no claim shall lie at the instance of the DPRK, or of any person or entity in the DPRK, or of persons or entities designated for measures set forth in resolutions 1718 (2006), 1874 (2009), 2087 (2013), or this resolution, or any person claiming through or for the benefit of any such person or entity, in connection with any contract or other transaction where its performance was prevented by reason of the measures imposed by this resolution or previous resolutions;

31. *Underlines* that measures imposed by resolutions 1718 (2006), 1874 (2009), 2087 (2013) and this resolution are not intended to have adverse humanitarian consequences for the civilian population of the DPRK;

32. *Emphasizes* that all Member States should comply with the provisions of paragraphs 8 (a) (iii) and 8 (d) of resolution 1718 (2006) without prejudice to the activities of diplomatic missions in the DPRK pursuant to the Vienna Convention on Diplomatic Relations;

33. *Expresses* its commitment to a peaceful, diplomatic and political solution to the situation and welcomes efforts by Council members as well as other States to facilitate a peaceful and comprehensive solution through dialogue and to refrain from any actions that might aggravate tensions;

34. *Reaffirms* its support to the Six-Party Talks, *calls for* their resumption, *urges* all the participants to intensify their efforts on the full and expeditious implementation of the 19 September 2005 Joint Statement issued by China, the DPRK, Japan, the Republic of Korea, the Russian Federation and the United States, with a view to achieving the verifiable denuclearization of the Korean Peninsula in a peaceful manner and to maintaining peace and stability on the Korean Peninsula and in north-east Asia;

35. *Reiterates* the importance of maintaining peace and stability on the Korean Peninsula and in north-east Asia at large;

36. *Affirms* that it shall keep the DPRK's actions under continuous review and is prepared to strengthen, modify, suspend or lift the measures as may be needed in light of the DPRK's compliance, and, in this regard, *expresses its determination* to take further significant measures in the event of a further DPRK launch or nuclear test;

37. *Decides* to remain seized of the matter.

ANNEX I

Travel ban/asset freeze

1. YO'N CHO'NG NAM

(a) Description: Chief Representative for the Korea Mining Development Trading Corporation (KOMID). The KOMID was designated by the Committee in April 2009 and is the DPRK's primary arms dealer and main exporter of goods and equipment related to ballistic missiles and conventional weapons.

2. KO CH'O'L-CHAE

(a) Description: Deputy Chief Representative for the Korea Mining Development Trading Corporation (KOMID). The KOMID was designated by the Committee in April 2009 and is the DPRK's primary arms dealer and main exporter of goods and equipment related to ballistic missiles and conventional weapons.

3. MUN CHO'NG-CH'O'L

(a) Description: Mun Cho'ng-Ch'o'l is a TCB official. In this capacity he has facilitated transactions for TCB. Tanchon was designated by the Committee in April 2009 and is the main DPRK financial entity for sales of conventional arms, ballistic missiles, and goods related to the assembly and manufacture of such weapons.

ANNEX II

Asset freeze

1. SECOND ACADEMY OF NATURAL SCIENCES

(a) Description: The Second Academy of Natural Sciences is a national-level organization responsible for research and development of the DPRK's advanced weapons systems, including missiles and probably nuclear weapons. The Second Academy of Natural Sciences uses a number of subordinate organizations to obtain technology, equipment, and information from overseas, including Tangun Trading Corporation, for use in the DPRK's missile and probably nuclear weapons programmes. Tangun Trading Corporation was designated by the Committee in July 2009 and is primarily responsible for the procurement of commodities and technologies to support DPRK's defence research and development programmes, including, but not limited to, weapons of mass destruction and delivery system programmes and procurement, including materials that are controlled or prohibited under relevant multilateral control regimes.

(b) AKA: 2ND ACADEMY OF NATURAL SCIENCES; CHE 2 CHAYON KWAHAKWON; ACADEMY OF NATURAL SCIENCES; CHAYON KWAHAK-WON; NATIONAL DEFENSE ACADEMY; KUKPANG KWAHAK-WON; SECOND ACADEMY OF NATURAL SCIENCES RESEARCH INSTITUTE; SANSRI

(c) Location: Pyongyang, DPRK

2. KOREA COMPLEX EQUIPMENT IMPORT CORPORATION

(a) Description: Korea Ryonbong General Corporation is the parent company of Korea Complex Equipment Import Corporation. Korea Ryonbong General Corporation was designated by the Committee in April 2009 and is a defence conglomerate specializing in acquisition for DPRK defence industries and support to that country's military-related sales.

(b) Location: Rakwon-dong, Pothonggang District, Pyongyang, DPRK

ANNEX III

Items, materials, equipment, goods and technology Nuclear items

1. Perfluorinated Lubricants

— They can be used for lubricating vacuum pump and compressor bearings. They have a low vapour pressure, are resistant to uranium hexafluoride (UF_6), the gaseous uranium compound used in the gas centrifuge process, and are used for pumping fluorine.

2. UF_6 Corrosion Resistant Bellow-sealed Valves

— They can be used in uranium enrichment facilities (such as gas centrifuge and gaseous diffusion plants), in facilities that produce uranium hexafluoride (UF_6), the gaseous uranium compound used in the gas centrifuge process, in fuel fabrication facilities and in facilities handling tritium.

Missile items

1. Special corrosion resistant steels — limited to steels resistant to Inhibited Red Fuming Nitric Acid (IRFNA) or nitric acid, such as nitrogen stabilized duplex stainless steel (N-DSS).

2. Ultra high-temperature ceramic composite materials in solid form (i.e. blocks, cylinders, tubes or ingots) in any of the following form factors:

(a) Cylinders having a diameter of 120 mm or greater and a length of 50 mm or greater;

(b) Tubes having an inner diameter of 65 mm or greater and a wall thickness of 25 mm or greater and a length of 50 mm or greater; or

(c) Blocks having a size of 120 mm x 120 mm x 50 mm or greater.

3. Pyrotechnically Actuated Valves.

4. Measurement and control equipment usable for wind tunnels (balance, thermal stream measurement, flow control).

5. Sodium Perchlorate.

Chemical weapons list

1. Vacuum pumps with a manufacturer's specified maximum flow-rate greater than 1 m3/h (under standard temperature and pressure conditions), casings (pump bodies), preformed casing-liners, impellers, rotors, and jet pump nozzles designed for such pumps, in which all surfaces that come into direct contact with the chemicals being processed are made from controlled materials.

ANNEX IV

Luxury goods

1. Jewelry:

(a) Jewelry with pearls;

(b) Gems;

(c) Precious and semi-precious stones (including diamonds, sapphires, rubies, and emeralds);

(d) Jewelry of precious metal or of metal clad with precious metal.

2. Transportation items, as follows:

(a) Yachts;

(b) Luxury automobiles (and motor vehicles): automobiles and other motor vehicles to transport people (other than public transport), including station wagons;

(c) Racing cars.

Source: United Nations Security Council Resolution 2094/ United Nations' official site// http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2094(2013).

1.2. Priorities for Russia-U.S. Relations: a Statement by Former Ambassadors to Washington and Moscow, April 12, 2013; Moscow

Last week, we former ambassadors to Washington and Moscow from Russia and the United States gathered in Moscow to discuss and consider fundamental questions concerning our countries' bilateral relations and the international context in which they exist. When we last met two years ago in Washington, we welcomed the concrete steps our governments had taken to redirect relations toward a constructive path but noted that much remained to be done.

In our current talks, we welcomed further significant accomplishments by our two governments that have put in place a strong foundation for cooperation in the future. The new strategic arms agreement is being implemented and continuing to reduce the nuclear arsenals of both countries. The 123 agreement is in force and expanding our civilian nuclear cooperation. With strong U.S. support, Russia completed its formal entry into the World Trade Organization, and the level of mutual trade and investment is increasing. Russian-U.S. cooperation on Afghanistan has made the fight against terrorism and narcotics in that country more effective. And the signature of a major agreement on visas has made it easier for the citizens of both countries to visit and do business with each other.

Against that backdrop of real achievement, we took a sober view of the strains that continue to complicate today's relations. We agreed that the level of hard rhetoric and the high degree of mistrust that were once the norm in our relations have diminished, and the heads of our countries have expressed a desire to build a stable modus vivendi that takes into account the interests and national security of each state and its allies as well as world peace.

On the other hand, we noted that the experience of the recent past shows that serious irritants and differences still can disrupt our bilateral relations. We agreed that these issues often stem from failure to conduct our relations in ways consistent with principles of equality and mutual respect. In discussing the global context for our relations, we stressed the reality of rapid change, and we agreed that one of the pressing tasks for us today is to coordinate better mutual bilateral and multilateral steps as we address the problems of a changing and complex global environment.

Cooperation is essential as both nations face today's challenges. The consequences of the global economic crisis linger. Shifting balances of economic, political, and military power reshape the international environment in unpredictable ways. The upheaval in the Arab Middle East has suddenly made that region a source of unpredictable and rapid change. Global problems—terrorism, climate change, and transnational crime—demand coordinated multilateral action. Nuclear proliferation and the uncertainties of dependence on increasingly complex technologies present familiar and new challenges to the status quo and global stability.

In these circumstances, our discussions focused on how our two governments can build on the positive foundation for cooperation that has been created over the last several years and bring focus to an agenda that can address productively the challenges both our countries now face. The full agenda we confront is the result of a mutual acknowledgement that stability and predictability in our countries' relations and progress on mutually beneficial steps will benefit both of our peoples as well as global peace and security.

Our long experience working in each other's countries came largely during the era when questions of strategic stability and arms control constituted the center of gravity in affairs between us. Today, we welcome the fact that a healthy and fundamental shift is taking place in which questions of trade, investment, and economic cooperation are becoming central. We agreed that the sustainable, long-term improvement in relations that our people seek must be built on a strong foundation of growing commercial interaction. Russia's accession to the World Trade Organization is a vital component of this, and the long-overdue repeal of the Jackson-Vanik Amendment allows American business to take full advantage of new opportunities for trade and investment.

But far too many obstacles to doing business still exist in both countries, and we need to do a better job of breaking down the barriers that prevent the enhancement of our scientific and technological cooperation. Although bilateral trade balances hit record levels since our last meeting, we are dismayed to see what a small fraction they still constitute of our foreign trade levels overall. We call on the governments and business communities in both countries to work together on a set of ambitious, concrete goals aimed at tripling our trade and investment over the next five years. We also support greater U.S. and Russian mutual involvement in trans-Atlantic and trans-Pacific trade and investment mechanisms.

The world is no longer hostage to tense relations between Moscow and Washington, but the global community is still concerned to see these relations put on a stable foundation. Our two countries hold a special and unique responsibility for maintaining strategic stability in a changing global threat environment. The development of a reliable foundation for a regime of nuclear nonproliferation and nonproliferation of other weapons of mass destruction depends to a large degree on how Russia and the United States interact.

We considered in detail existing disagreements in the search for compromise on ballistic missile defense, and we agreed that efforts to find a mutually acceptable formula must be intensified. We believe that with the U.S. decision to restructure its missile defense posture in Europe, our two sides should urgently take advantage of the opportunity to end the division ballistic missile defense has brought to relations for more than a decade. Our nations should set as a goal achieving the highest level of cooperation sufficient to assure that these systems will not undermine deterrence and strategic stability but will retain the capacity to deal with limited ballistic missile threats from proliferating states with the appropriate level of interceptors.

We are greatly encouraged by the mutual steps taken by our governments over the last several years to continue the trend of strategic arms reduction begun almost three decades ago. The habits of cooperation built through such negotiations and verification regimes pay dividends beyond the actual reductions. This process must continue, and we believe that setting a lower number of operational warheads and delivery vehicles for each side would build further on the momentum toward the lower levels achieved in New START.

One of the pressing tasks for us today is to strive to coordinate the bilateral and multilateral steps we must take to manage challenges to international peace and security. Few international problems are manageable without cooperation among the major powers. We agreed that further cooperation is essential to ensure that the leadership in both Iran and North Korea understands our joint view on the imperative of compliance with international norms and agreements regarding the nuclear programs in both countries and to avoid precipitation of conflict by accident or miscalculation.

On Syria, we believe invigorated joint efforts toward political settlement to permit early necessary steps at negotiations without preconditions or linkage could prove critical in moving toward peace. Russia and the United States should work together along with others to: develop negotiations without preconditions or linkage of one measure to another; seek an immediate humanitarian ceasefire monitored by the United Nations; assure protection for all minorities in Syria; and establish a representative, transitional government.

We took note as well of the impending change in the role of the U.S. and allied forces in Afghanistan and the transfer to Afghan authority of responsibility for their own security. Cooperation on Afghanistan has been a strong positive element in U.S.-Russian cooperation over the last years. It will be important now for our two governments to continue discussions and joint work to ensure a future of peace and stability for this region.

In discussing bilateral relations, we found disturbing the recent deterioration in the atmosphere of relations and the growing trend toward a focus on issues that divide us. Some legislation enacted in both countries does not help the desirable expansion of contacts and engagement between our two societies. We believe this matter requires urgent attention, and we call for a renewed level of parliamentary exchange between Moscow and Washington involving both members and senior staff.

We noted the positive contribution the Bilateral Presidential Commission has made to expanding contacts and cooperation, giving impetus to more effective work among the agencies of the two governments and stimulating broader exchanges among the Russian and American people in education, science, sports, and the arts. Modernizing this mechanism further by upgrading the leadership and moving in the direction of a more active search for joint projects in areas of mutual self-interest will add an important element to the structure of Russian-American stability.

We believe that our two countries are on the threshold of an important new period in relations. Two decades after the Cold War and the great changes that have reshaped the economic, political, and security maps of the Euro-Atlantic region, new opportunities exist to create a more stable, productive, and secure future. Creative professional diplomacy is a reliable instrument for achieving these goals and making the most from these possibilities. The character of the coming era will largely depend on it. But in the end, ambassadors, diplomats, and decisionmakers must recognize that all of our work aimed at making relations between Russia and the United States more constructive and more productive depends increasingly on active and informed support from our societies as a whole.

John Beyrle	**Alexander A. Bessmertnykh**
James Collins	**Yury V. Dubinin**
Jack Matlock	**Viktor G. Komplektov**
Tom Pickering	**Vladimir P. Lukin**

Source: Priorities for Russia-U.S. Relations: a Statement by Former Ambassadors to Washington and Moscow / Site of the Carnegie Endowment for International Peace // http://carnegieendowment.org/2013/04/12/priorities-for-russia-u.s.-relations-statement-by-former-ambassadors-to-washington-and-moscow/fza1.

1.3. Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran, February 21, 2013; Vienna

A report of the International Atomic Energy Agency Director General

A. Introduction

1. This report of the Director General to the Board of Governors and, in parallel, to the Security Council, is on the implementation of the NPT Safeguards Agreement[73] and relevant provisions of Security Council resolutions in the Islamic Republic of Iran (Iran).

2. The Security Council has affirmed that the steps required by the Board of Governors in its resolutions[74] are binding on Iran.[75] The relevant provisions of the aforementioned Security Council resolutions[76] were adopted under Chapter VII of the United Nations Charter, and are mandatory, in accordance with the terms of those resolutions.[77]

73 The Agreement between Iran and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/214), which entered into force on 15 May 1974.

74 The Board of Governors has adopted 12 resolutions in connection with the implementation of safeguards in Iran: GOV/2003/69 (12 September 2003); GOV/2003/81 (26 November 2003); GOV/2004/21 (13 March 2004); GOV/2004/49 (18 June 2004); GOV/2004/79 (18 September 2004); GOV/2004/90 (29 November 2004); GOV/2005/64 (11 August 2005); GOV/2005/77 (24 September 2005); GOV/2006/14 (4 February 2006); GOV/2009/82 (27 November 2009); GOV/2011/69 (18 November 2011); and GOV/2012/50 (13 September 2012).

75 In resolution 1929 (2010), the Security Council: affirmed, inter alia, that Iran shall, without further delay, take the steps required by the Board in GOV/2006/14 and GOV/2009/82; reaffirmed Iran's obligation to cooperate fully with the IAEA on all outstanding issues, particularly those which give rise to concerns about the possible military dimensions of the Iranian nuclear programme; decided that Iran shall, without delay, comply fully and without qualification with its Safeguards Agreement, including through the application of modified Code 3.1 of the Subsidiary Arrangements; and called upon Iran to act strictly in accordance with the provisions of its Additional Protocol and to ratify it promptly (paras 1–6).

76 The United Nations Security Council has adopted the following resolutions on Iran: 1696 (2006); 1737 (2006); 1747 (2007); 1803 (2008); 1835 (2008); and 1929 (2010).

77 By virtue of its Relationship Agreement with the United Nations (INFCIRC/11, Part I.A), the Agency is required to cooperate with the Security Council in the exercise of the Council's responsibility for the maintenance or restoration of international peace and security. All Member States of the United Nations agree to accept and carry out the decisions of the Security Council and, in this respect, to take actions which are consistent with their obligations under the United Nations Charter.

3. This report addresses developments since the Director General's previous report (GOV/2012/55, 16 November 2012), as well as issues of longer standing. It focuses on those areas where Iran has not fully implemented its binding obligations, as the full implementation of these obligations is needed to establish international confidence in the exclusively peaceful nature of Iran's nuclear programme.

B. Clarification of Unresolved Issues

4. In November 2011, the Board adopted resolution GOV/2011/69, in which, inter alia, it stressed that it was essential for Iran and the Agency to intensify their dialogue aimed at the urgent resolution of all outstanding substantive issues for the purpose of providing clarifications regarding those issues, including access to all relevant information, documentation, sites, material and personnel in Iran. In that resolution, the Board also called on Iran to engage seriously and without preconditions in talks aimed at restoring international confidence in the exclusively peaceful nature of Iran's nuclear programme. In light of this, between January and the beginning of September 2012, Agency and Iranian officials held six rounds of talks in Vienna and Tehran, including during a visit by the Director General to Tehran in May 2012. However, no concrete results were achieved.[78]

5. On 13 September 2012, the Board adopted resolution GOV/2012/50, in which, inter alia, it decided that Iranian cooperation with Agency requests aimed at the resolution of all outstanding issues was essential and urgent in order to restore international confidence in the exclusively peaceful nature of Iran's nuclear programme. The Board also stressed that it was essential for Iran to immediately conclude and implement a structured approach for resolving outstanding issues related to possible military dimensions to its nuclear programme, including, as a first step, providing the Agency with the access it had requested to relevant sites. Immediately following the adoption of that resolution, the Agency took steps to engage Iran in further talks.[79]

6. Since the Director General's November 2012 report, Agency and Iranian officials have held three further rounds of talks in Tehran – on 13 December 2012, 16 and 17 January 2013 and 13 February 2013 – aimed at finalizing the structured approach document.[80] While the Secretariat's commitment to continued dialogue is unwavering, it has not been possible to reach agreement with Iran on the structured approach or to begin substantive work on the outstanding issues, including those related to possible military dimensions to Iran's nuclear programme.

C. Facilities Declared under Iran's Safeguards Agreement

7. Under its Safeguards Agreement, Iran has declared to the Agency 16 nuclear facilities and nine locations outside facilities where nuclear material is customarily used (LOFs).[81] Notwithstanding that certain of the activities being undertaken by Iran at some of the facilities are contrary to the relevant resolutions of the Board of Governors and the Security Council, as indicated below, the Agency continues to verify the non-diversion of

78 GOV/2012/37, para. 8.

79 GOV/2012/55, para. 6.

80 The current focus of the document is on the issues outlined in the Annex to the Director General's November 2011 report. The other outstanding issues will need to be addressed separately.

81 All of the LOFs are situated within hospitals.

declared material at these facilities and LOFs.

D. Enrichment Related Activities

8. Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran has not suspended its enrichment related activities in the declared facilities referred to below. All of these activities are under Agency safeguards, and all of the nuclear material, installed cascades and the feed and withdrawal stations at those facilities are subject to Agency containment and surveillance.[82]

9. Iran has stated that the purpose of enriching UF_6 up to 5% U-235 is the production of fuel for its nuclear facilities[83] and that the purpose of enriching UF_6 up to 20% U-235 is the manufacture of fuel for research reactors.[84]

10. Since Iran began enriching uranium at its declared facilities, it has produced at those facilities:

– 8271 kg (+660 kg since the Director General's previous report) of UF_6 enriched up to 5% U-235, of which 5974 kg remain in the form of UF_6 enriched up to 5% U-235[85] and the rest has been further processed (as detailed in paras 19 and 25–27 below); and

– 280 kg (+47 kg since the Director General's previous report) of UF_6 enriched up to 20% U-235, of which 167 kg remain in the form of UF_6 enriched up to 20% U-235[86] and the rest has been further processed (as detailed in para. 45 below).

D.1. Natanz

11. **Fuel Enrichment Plant:** FEP is a centrifuge enrichment plant for the production of low enriched uranium (LEU) enriched up to 5% U-235, which was first brought into operation in 2007. The plant is divided into Production Hall A and Production Hall B. According to design information submitted by Iran, eight units are planned for Production Hall A, with 18 cascades in each unit, which totals approximately 25 000 centrifuges in 144 cascades. Iran has yet to provide the corresponding design information for Production Hall B.

12. As of 19 February 2013, Iran had fully installed 74 cascades in Production Hall A, partially installed three other cascades and completed preparatory installation work for the other 67 cascades.[87] On that date, Iran declared that it was feeding 53 of the fully installed cascades with natural UF_6.

13. In a letter dated 23 January 2013, Iran informed the Agency that IR-2m centrifuges "will be used" in one of the units of Production Hall A.[88] At the request of the Agency, Iran, in a letter dated 6 February 2013, provided additional information on the planned cascade configuration for the unit that would comprise IR-2m centrifuges and provided other related technical information. On 6 February 2013, the Agency observed that Iran had started the installation of IR-2m centrifuges and empty centrifuge casings. This is the first time that centrifuges more advanced than the IR-1 have been installed in FEP.

14. As a result of the physical inventory verification (PIV) carried out by the Agency at FEP between 20 October 2012 and 11 November 2012, the Agency verified, within measurement uncertainties normally associated with such a facility, the inventory of nuclear material as declared by Iran on 21 October 2012.

15. The Agency has confirmed that, as of 21 October 2012, 85 644 kg of natural UF_6 had been fed into the cascades since production began in February 2007, and a total of 7451 kg of UF_6 enriched up to 5% U-235 had been produced. Iran has estimated that, between 22 October 2012 and 3 February 2013, a total of 9106 kg of natural UF_6 was fed into the cascades and a total of approximately 820 kg of UF_6 enriched up to 5% U-235 was produced, which would result in a total production of 8271 kg of UF_6 enriched up to 5% U-235 since production began.

16. Based on the results of the analysis of environmental samples taken at FEP since February 2007,[89] and other verification activities, the Agency has concluded that the facility has operated as declared by Iran in the relevant design information questionnaire (DIQ).

17. **Pilot Fuel Enrichment Plant:** PFEP is a research and development (R&D) facility, and a pilot LEU production facility, which was first brought into operation in October 2003. It has a cascade hall that can accommodate six cascades, and is divided between an area designated by Iran for the production of UF_6 enriched up to 20% U-235 (Cascades 1 and 6) and an area designated by Iran for R&D (Cascades 2, 3, 4 and 5).

18. *Production area:* As of 12 February 2013, Iran was continuing to feed low enriched UF_6 into two interconnected cascades (Cascades 1 and 6) containing a total of 328 IR-1 centrifuges.

19. As previously reported,[90] the Agency has verified that, as of 15 September 2012, 1119.6 kg of UF_6 enriched up to 5% U-235 produced at FEP had been fed into the cascades in the production area since production began in February 2010, and that a total of 129.1 kg of UF_6 enriched up to 20% U-235 had been produced. Iran has estimated that, between 16 September 2012 and 12 February 2013, a total of 145.5 kg of UF_6 enriched up to 5% U-235 produced at FEP was fed into the cascades in the production area and that approximately 20.8 kg of UF_6 enriched up to 20% U-235 were produced. This would result in a total production of 149.9 kg of UF_6 enriched up to 20% U-235 at PFEP since production began.

20. **R&D area:** Since the Director General's previous report, Iran has installed two new types of centrifuge (IR-6 and IR-6s) and has been intermittently feeding natural UF_6 into them as single machines. Iran has also been intermittently feeding natural UF_6 into IR-2m and IR-4 centrifuges, sometimes into single machines and sometimes into cascades of various sizes.[91]

82 In line with normal safeguards practice, small amounts of nuclear material (e.g. some waste and samples) may not be subject to containment and surveillance.
83 As declared in Iran's design information questionnaires (DIQs) for the Fuel Enrichment Plant (FEP) at Natanz.
84 GOV/2010/10, para. 8; as declared in the DIQ for the Fuel Plate Fabrication Plant (FPFP).
85 This comprises nuclear material in storage, as well as nuclear material in the cold traps and still inside cylinders attached to the enrichment process.
86 This comprises nuclear material in storage, nuclear material in the cold traps and still inside cylinders attached to the enrichment process, and nuclear material in cylinders attached to the conversion process.
87 As of 19 February 2013, 12 669 IR-1 centrifuges (+2255 since the Director General's previous report) and, in two cascades, 180 IR-2m centrifuges and empty centrifuge casings were installed in FEP.
88 GOV/INF/2013/3, 30 January 2013.
89 Results are available to the Agency for samples taken up to 7 August 2012.
90 GOV/2012/55, para. 18.
91 On 19 February 2013, there were 29 IR-4 centrifuges, six IR-6 centrifuges and two IR-6s centrifuges installed in Cascade 2, nine IR-2m centrifuges and two IR-1 centrifuges installed in Cascade 3, 164 IR-4 centrifuges installed in Cascade 4 and 162 IR-2m centrifuges installed in Cascade 5.

21. Between 12 November 2012 and 12 February 2013, a total of approximately 469.2 kg of natural UF_6 was fed into centrifuges in the R&D area, but no LEU was withdrawn as the product and the tails were recombined at the end of the process.

22. In an updated DIQ dated 6 February 2013, Iran informed the Agency that it planned to start withdrawing from Cascades 4 and 5 the product and the tails separately, rather than recombining them at the end of the process as it had done previously. The Agency and Iran are discussing how safeguards measures will need to be modified as a result of the changes in the operation of these cascades. Iran has agreed not to start operations until such safeguards measures are in place.

23. Based on the results of the analysis of the environmental samples taken at PFEP,[92] and other verification activities, the Agency has concluded that the facility has operated as declared by Iran in the relevant DIQ.

D.2. Fordow

24. **Fordow Fuel Enrichment Plant:** FFEP is, according to the DIQ of 18 January 2012, a centrifuge enrichment plant for the production of UF_6 enriched up to 20% U-235 and the production of UF_6 enriched up to 5% U-235. Additional information from Iran is still needed in connection with this facility, particularly in light of the difference between the original stated purpose of the facility and the purpose for which it is now being used.[93]

92 Results are available to the Agency for samples taken up to 22 October 2012.

93 GOV/2009/74, paras 7 and 14; GOV/2012/9, para. 24. To date, Iran has provided the Agency with an initial DIQ and three revised DIQs. Each of the DIQs has stated a different purpose for the facility.

The facility, which was first brought into operation in 2011, is designed to contain up to 2976 centrifuges in 16 cascades, divided between Unit 1 and Unit 2. To date, all of the centrifuges installed are IR-1 machines.[94] Iran has yet to inform the Agency which of the cascades are to be used for enrichment up to 5% U-235 and/or for enrichment up to 20% U-235.[95]

25. As of 17 February 2013, Iran was continuing to feed four cascades (configured in two sets of two interconnected cascades) of Unit 2 with UF_6 enriched up to 5% U-235;[96] none of the other 12 cascades had been fed with UF_6.[97]

26. Between 17 November 2012 and 3 December 2012, the Agency conducted a PIV at FFEP and verified that, as of 17 November 2012, a total of 769 kg of UF_6 enriched up to 5% U-235 produced at FEP had been fed into cascades at FFEP since production began in December 2011, and that 101.2 kg of UF_6 enriched up to 20% U-235 had been produced. As a result of this PIV, the Agency verified, within measurement uncertainties normally associated with such a facility, the inventory of nuclear material as declared by Iran on 17 November 2012.

27. Iran has estimated that between 18 November 2012 and 10 February 2013, a total of 210.1 kg of UF_6 enriched up to 5% U-235 was fed into cascades at FFEP, and

94 As of 17 February 2013, 2710 centrifuges were installed at FFEP (−74 since the Director General's previous report).

95 In a letter to the Agency dated 23 May 2012, Iran stated that the Agency would be notified about the production level of the cascades prior to their operation (GOV/2012/23, para. 25).

96 The number of centrifuges being fed (696) remains unchanged from that reflected in the Director General's previous report (GOV/2012/55, para. 23).

97 As of 17 February 2013, all eight cascades in Unit 1, and three of the four remaining cascades in Unit 2, had been subjected to vacuum testing and made ready for feeding with UF_6. The fourth cascade in Unit 2 was incomplete.

that approximately 28.7 kg of UF_6 enriched up to 20% U-235 were produced. This would result in a total production of 129.9 kg of UF_6 enriched up to 20% U-235 since production began, 125.3 kg of which have been withdrawn from the process and verified by the Agency.

28. Based on the results of the analysis of environmental samples taken at FFEP,[98] and other verification activities, the Agency has concluded that the facility has operated as declared by Iran in its most recent DIQ for FFEP.

D.3. Other Enrichment Related Activities

29. Iran has not provided a substantive response to Agency requests for further information in relation to announcements made by Iran concerning the construction of ten new uranium enrichment facilities, the sites for five of which, according to Iran, have been decided.[99] Nor has Iran provided information, as requested by the Agency, in connection with its announcement on 7 February 2010 that it possessed laser enrichment technology.[100] As a result of Iran's lack of cooperation on those issues, the Agency is unable to verify and report fully on these matters.

E. Reprocessing Activities

30. Pursuant to the relevant resolutions of the Board of Governors and the Security Council, Iran is obliged to suspend its reprocessing activities, including R&D.[101]

98 Results are available to the Agency for samples taken up to 28 October 2012.

99 Iran Specifies Location for 10 New Enrichment Sites', Fars News Agency, 16 August 2010.

100 Cited on the website of the Presidency of the Islamic Republic of Iran, 7 February 2010, at http://www.president.ir/en/?ArtID=20255.

101 S/RES/1696 (2006), para. 2; S/RES/1737 (2006), para. 2; S/RES/1747 (2007), para. 1; S/RES/1803 (2008), para. 1; S/RES/1835 (2008), para. 4; S/RES/1929 (2010), para. 2.

Iran has stated that it "does not have reprocessing activities".[102]

31. The Agency has continued to monitor the use of hot cells at the Tehran Research Reactor (TRR)[103] and the Molybdenum, Iodine and Xenon Radioisotope Production (MIX) Facility.[104] The Agency carried out an inspection and design information verification (DIV) at TRR on 12 February 2013, and a DIV at the MIX Facility on 13 February 2013. It is only with respect to TRR, the MIX Facility and the other facilities to which the Agency has access that the Agency can confirm that there are no ongoing reprocessing related activities in Iran.

F. Heavy Water Related Projects

32. Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran has not suspended work on all heavy water related projects, including the ongoing construction of the heavy water moderated research reactor at Arak, the Iran Nuclear Research Reactor (IR-40 Reactor), which is under Agency safeguards.[105]

33. On 11 February 2013, the Agency carried out a DIV at the IR-40 Reactor at Arak and observed that the installation of cooling and moderator circuit piping was almost complete. As previously reported, Iran has stated that the operation of the IR-40 Reactor is expected to commence in the first quarter of 2014.[106]

102 Letter to the Agency dated 15 February 2008.

103 TRR is a 5 MW reactor which operates with 20% U-235 enriched fuel and is used for the irradiation of different types of targets and for research and training purposes.

104 The MIX Facility is a hot cell complex for the separation of radiopharmaceutical isotopes from targets, including uranium, irradiated at TRR. The MIX Facility is not currently processing any uranium targets.

105 S/RES/1737 (2006), para. 2; S/RES/1747 (2007), para. 1; S/RES/1803 (2008), para. 1; S/RES/1835 (2008), para. 4; S/RES/1929 (2010), para. 2.

106 GOV/2012/55, para. 29.

34. Since its visit to the Heavy Water Production Plant (HWPP) on 17 August 2011, the Agency has not been provided with further access to the plant. As a result, the Agency is again relying only on satellite imagery to monitor the status of HWPP. Based on recent images, the plant appears to continue to be in operation. To date, Iran has not permitted the Agency to take samples of the heavy water stored at the Uranium Conversion Facility (UCF).[107] Since the Director General's previous report, the Agency has reiterated its requests to Iran for access to HWPP and for the taking of samples of the aforementioned heavy water. Iran has again not provided the requested access.

G. Uranium Conversion and Fuel Fabrication

35. Although Iran is obliged to suspend all enrichment related activities and heavy water related projects, it is conducting a number of activities at UCF, the Fuel Manufacturing Plant (FMP) and the Fuel Plate Fabrication Plant (FPFP) at Esfahan, as indicated below, which are in contravention of those obligations, notwithstanding that the facilities are under Agency safeguards.

36. Since Iran began conversion and fuel fabrication at its declared facilities, it has, inter alia:

– Produced 550 tonnes of natural UF_6 at UCF,[108] of which 107 tonnes have been transferred to FEP;

– Fed into the R&D conversion process at UCF 53 kg of UF_6 enriched up to 3.34% U-235 and produced 24 kg of uranium in the form of UO_2;[109]

– Fed into the conversion process at FPFP 111 kg of UF_6 enriched up to 20% U-235 (+28.3 kg since the Director General's previous report) and produced 50 kg of uranium in the form of U_3O_8; and

– Transferred to TRR five fuel assemblies containing uranium enriched up to 20% U-235 and two fuel assemblies containing uranium enriched to 3.34% U-235.

37. **Uranium Conversion Facility:** As a result of the PIV carried out by the Agency at UCF in March 2012 and following the receipt of further information from Iran,[110] the Agency verified, within measurement uncertainties normally associated with such a facility, the inventory of nuclear material as declared by Iran on 2 March 2012.

38. Since the previous report, Iran has informed the Agency that it intends to conduct R&D conversion activities involving the use of natural UF_6 for the production of UO_2.[111]

39. According to Iran, as of 3 February 2013, it had produced 9056 kg of natural uranium in the form of UO_2 through the conversion of uranium ore concentrate. As of 5 February 2013, the Agency had verified that Iran had transferred 3823 kg of this UO_2 to FMP.

40. Since the Director General's previous report, Iran has informed the Agency that it has recovered — in the form of liquid scrap, sludge and solid waste — the majority of the nuclear material that spilled onto the floor of the facility when a storage tank ruptured last year.[112] The Agency is currently assessing Iran's declaration.

107 GOV/2010/10, paras 20 and 21.
108 GOV/2012/37, para. 33.
109 GOV/2012/55, para. 35.
110 GOV/2012/55, para. 33.
111 Iran had previously conducted similar R&D conversion activities using UF_6 enriched up to 3.34% U-235 (GOV/2012/55, para. 35).
112 GOV/2012/55, para. 36.

41. **Fuel Manufacturing Plant:** As a result of the PIV carried out by the Agency at FMP between 4 and 6 September 2012, the Agency verified, within measurement uncertainties normally associated with such a facility, the inventory of nuclear material as declared by Iran on 4 September 2012.

42. On 26 November 2012, the Agency verified a prototype IR-40 natural uranium fuel assembly before its transfer to TRR for irradiation testing.

43. On 9 and 11 February 2013, the Agency carried out an inspection and a DIV at FMP and confirmed that the manufacture of pellets for the IR-40 Reactor using natural UO_2 was ongoing.

44. **Fuel Plate Fabrication Plant:** As a result of the PIV carried out by the Agency at FPFP on 29 September 2012, the Agency verified, within measurement uncertainties normally associated with such a facility, the inventory of nuclear material as declared by Iran on that date.

45. On 27 September 2012, Iran suspended converting UF_6 enriched up to 20% U-235 into U_3O_8 at FPFP. Iran has estimated that, between 2 December 2012, when it resumed such conversion activities, and 11 February 2013, 28.3 kg of UF_6 enriched up to 20% U-235 were fed into the conversion process at FPFP and 12 kg of uranium were produced in the form of U_3O_8. This would bring the total amount of UF_6 enriched up to 20% U-235 which had been fed into the conversion process to 111 kg and the total amount of uranium in the form of U_3O_8 which had been produced to 50 kg.[113]

46. On 12 and 13 February 2013, the Agency verified seven fuel assemblies and 95 fuel plates present at the facility.

H. Possible Military Dimensions

47. Previous reports by the Director General have identified outstanding issues related to possible military dimensions to Iran's nuclear programme and actions required of Iran to resolve these.[114] Since 2002, the Agency has become increasingly concerned about the possible existence in Iran of undisclosed nuclear related activities involving military related organizations, including activities related to the development of a nuclear payload for a missile. Iran has dismissed the Agency's concerns, largely on the grounds that Iran considers them to be based on unfounded allegations.[115]

48. The Annex to the Director General's November 2011 report (GOV/2011/65) provided a detailed analysis of the information available to the Agency, indicating that Iran has carried out activities that are relevant to the development of a nuclear explosive device. This information is assessed by the Agency to be, overall, credible.[116] Since November 2011, the Agency has obtained more information which further corroborates the analysis contained in the aforementioned Annex.

49. In resolution 1929 (2010), the Security Council reaffirmed Iran's obligations to take the steps required by the Board of Governors in its resolutions GOV/2006/14 and GOV/2009/82, and to cooperate fully with the Agency on all outstanding issues, particularly those

113 GOV/2012/55, para. 38. In addition, approximately 1.6 kg of UF_6 enriched up to 20% U-235 have been blended with natural UF_6 at PFEP (GOV/2012/23, para. 19).
114 See, for example: GOV/2011/65, paras 38–45 and Annex; GOV/2011/29, para. 35; GOV/2011/7, Attachment; GOV/2010/10, paras 40–45; GOV/2009/55, paras 18–25; GOV/2008/38, paras 14–21; GOV/2008/15, paras 14–25 and Annex; GOV/2008/4, paras 35–42.
115 GOV/2012/9, para. 8.
116 GOV/2011/65, Annex, Section B.

which give rise to concerns about the possible military dimensions to Iran's nuclear programme, including by providing access without delay to all sites, equipment, persons and documents requested by the Agency.[117] As indicated in Section B above, since the publication of the Director General's November 2011 report, although the Board has adopted two resolutions addressing the urgent need to resolve outstanding issues regarding the Iranian nuclear programme, including those which need to be clarified to exclude the existence of possible military dimensions, it has not been possible to finalize the structured approach document or to begin substantive work in this regard.

50. Parchin: As stated in the Annex to the Director General's November 2011 report,[118] information provided to the Agency by Member States indicates that Iran constructed a large explosives containment vessel in which to conduct hydrodynamic experiments;[119] such experiments would be strong indicators of possible nuclear weapon development. The information also indicates that the containment vessel was installed at the Parchin site in 2000. The location at the Parchin site of the vessel was only identified in March 2011, and the Agency notified Iran of that location in January 2012.

51. As previously reported, satellite imagery available to the Agency for the period from February 2005 to January 2012 shows virtually no activity at or near the building housing the containment vessel (chamber building). Since the Agency's first request for access to this location, however, satellite imagery shows that extensive activities and resultant changes have taken place at this location.[120] The Agency has reiterated during each round of talks with Iran its request for access to the location at the Parchin site, but Iran has not acceded to that request.

52. Among the most significant developments observed by the Agency at this location since the Director General's report in November 2012 are:

- Reinstatement of some of the chamber building's features (e.g. wall panels and exhaust piping);
- Alterations to the roofs of the chamber building and the other large building;
- Dismantlement and reconstruction of the annex to the other large building;
- Construction of one small building at the same place where a building of similar size had previously been demolished;
- Spreading, levelling and compacting of another layer of material over a large area; and
- Installation of a fence that divides the location into two areas.

53. As previously reported, Iran has stated that the allegation of nuclear activities at the Parchin site is "baseless" and that "the recent activities claimed to be conducted in the vicinity of the location of interest to the Agency, has nothing to do with specified location by the Agency".[121] To date, Iran has only provided an explanation for the soil displacement by trucks, which it stated was "due to constructing the Parchin new road".[122]

117 S/RES/1929, paras 2 and 3.
118 GOV/2011/65, Annex, para. 49.
119 GOV/2011/65, Annex, para. 47.
120 For a list of the most significant developments observed by the Agency at this location between February 2012 and the publication of the Director General's November 2012 report, see GOV/2012/55, para. 44.
121 GOV/2012/37, para. 43.
122 INFCIRC/847, 20 December 2012, para. 58.

54. In light of the extensive activities that have been, and continue to be, undertaken by Iran at the aforementioned location on the Parchin site, when the Agency gains access to the location, its ability to conduct effective verification will have been seriously undermined. While the Agency continues to assess that it is necessary to have access to this location without further delay, it is essential that Iran also provide without further delay substantive answers to the Agency's detailed questions regarding the Parchin site and the foreign expert,[123] as requested by the Agency in February 2012.[124]

I. Design Information

55. Contrary to its Safeguards Agreement and relevant resolutions of the Board of Governors and the Security Council, Iran is not implementing the provisions of the modified Code 3.1 of the Subsidiary Arrangements General Part to Iran's Safeguards Agreement.[125] It is important to note that the absence of such early information reduces the time available for the Agency to plan the necessary safeguards arrangements, especially for new facilities, and reduces the level of confidence in the absence of other nuclear facilities.[126]

56. Contrary to Iran's obligations under the modified Code 3.1, Iran has not provided the Agency with an updated DIQ for the IR-40 Reactor since 2006. The lack of up-to-date information is having an adverse impact on the Agency's ability to effectively verify the design of the facility and to implement an effective safeguards approach.[127]

57. Iran's response to Agency requests that Iran confirm, or provide further information regarding, its stated intention to construct new nuclear facilities is that it would provide the Agency with the required information in "due time" rather than as required by the modified Code 3.1 of the Subsidiary Arrangements General Part to its Safeguards Agreement.[128]

J. Additional Protocol

58. Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran is not implementing its Additional Protocol. The Agency will not be in a position to provide credible assurance about the absence of undeclared nuclear material and activities in Iran unless and until Iran provides the necessary cooperation with the Agency, including by implementing its Additional Protocol.[129]

K. Other Matters

59. The Agency and Iran continue to discuss the discrepancy between the amount of nuclear material declared by the operator and that measured by the Agency in connection with conversion experiments

123 GOV/2011/65, Annex, para. 44.
124 GOV/2012/9, para. 8.
125 In accordance with Article 39 of Iran's Safeguards Agreement, agreed Subsidiary Arrangements cannot be changed unilaterally; nor is there a mechanism in the Safeguards Agreement for the suspension of provisions agreed to in the Subsidiary Arrangements. Therefore, as previously explained in the Director General's reports (see, for example, GOV/2007/22, 23 May 2007), the modified Code 3.1, as agreed to by Iran in 2003, remains in force. Iran is further bound by operative paragraph 5 of Security Council resolution 1929 (2010) to "comply fully and without qualification with its IAEA Safeguards Agreement, including through the application of modified Code 3.1".
126 GOV/2010/10, para. 35.
127 GOV/2012/37, para. 46.
128 GOV/2011/29, para. 37; GOV/2012/23, para. 29.
129 Iran's Additional Protocol was approved by the Board on 21 November 2003 and signed by Iran on 18 December 2003, although it has not been brought into force. Iran provisionally implemented its Additional Protocol between December 2003 and February 2006.

carried out by Iran at the Jabr Ibn Hayan Multipurpose Research Laboratory (JHL) between 1995 and 2002.[130]

60. On 12 February 2013, three fuel assemblies that had been produced in Iran and which contain nuclear material that was enriched in Iran up to 3.5% and up to 20% U-235 were in the core of TRR.[131]

61. On 26 and 27 November 2012, the Agency conducted a PIV at the Bushehr Nuclear Power Plant (BNPP) and verified that the fuel assemblies that previously had been transferred to the spent fuel pond had since been reloaded into the reactor core.[132] During an inspection conducted by the Agency at BNPP on 16 and 17 February 2013, Iran informed the Agency that the reactor was shut down.

L. Summary

62. While the Agency continues to verify the non-diversion of declared nuclear material at the nuclear facilities and LOFs declared by Iran under its Safeguards Agreement, as Iran is not providing the necessary cooperation, including by not implementing its Additional Protocol, the Agency is unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran is in peaceful activities.[133]

63. Iran has started the installation of more advanced centrifuges (IR-2m) at FEP for the first time.

64. Contrary to the Board resolutions of November 2011 and September 2012 and despite the intensified dialogue between the Agency and Iran since January 2012 in nine rounds of talks, it has not been possible to agree on the structured approach. The Director General is unable to report any progress on the clarification of outstanding issues, including those relating to possible military dimensions to Iran's nuclear programme.

65. It is a matter of concern that the extensive and significant activities which have taken place since February 2012 at the location within the Parchin site to which the Agency has repeatedly requested access will have seriously undermined the Agency's ability to undertake effective verification. The Agency reiterates its request that Iran, without further delay, provide both access to that location and substantive answers to the Agency's detailed questions regarding the Parchin site and the foreign expert.

66. Given the nature and extent of credible information available, the Agency continues to consider it essential for Iran to engage with the Agency without further delay on the substance of the Agency's concerns. In the absence of such engagement, the Agency will not be able to resolve concerns about issues regarding the Iranian nuclear programme, including those which need to be clarified to exclude the existence of possible military dimensions to Iran's nuclear programme.

67. The Director General continues to urge Iran to take steps towards the full implementation of its Safeguards Agreement and its other obligations and to engage with the Agency to achieve concrete results on all outstanding substantive issues, as required in the binding resolutions of the Board of Governors and the mandatory Security Council resolutions.

68. The Director General will continue to report as appropriate.

Source: Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran// Site of the Institute for Science and International Security // http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Safeguards_report_--_21_Feb_2013.pdf.

130 GOV/2003/75, paras 20–25 and Annex 1; GOV/2004/34, para. 32, and Annex, paras 10–12; GOV/2004/60, para. 33, and Annex, paras 1–7; GOV/2011/65, para. 49.

131 On 12 February 2013, the core of TRR comprised a total of 33 fuel assemblies.

132 GOV/2012/55, para. 52.

133 The Board has confirmed on numerous occasions, since as early as 1992, that paragraph 2 of INFCIRC/153 (Corr.), which corresponds to Article 2 of Iran's Safeguards Agreement, authorizes and requires the Agency to seek to verify both the non-diversion of nuclear material from declared activities (i.e. correctness) and the absence of undeclared nuclear activities in the State (i.e. completeness) (see, for example, GOV/OR.864, para. 49 and GOV/OR.865, paras. 53–54).

APPENDIX 2

Acronyms

ABM	anti-ballistic missile
BMD	ballistic missile defense
BTWC/BWC	Biological and Toxin Weapons Convention (Biological Weapons Convention, BWC)
BWC	Biological Weapons Convention
CIA	Central Intelligence Agency (United States)
CTBT	Comprehensive Nuclear Test Ban Treaty
CTC	Counter-Terrorist Committee
CTR	Cooperative Threat Reduction, Nunn-Lugar Program
CW	chemical weapon/warfare
CWC	Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and their Destruction
DoD	Department of Defense (United States)
DoE	Department of Energy (United States)
DPRK	Democratic People's Republic of Korea
FATF	Financial Action Task Force on Money Laundering
FMCT	Fissile Material Cut-Off Treaty
G8	Group of Eight
GDP	gross domestic product
GNEP	Global Nuclear Energy Partnership
HEU	highly-enriched uranium
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Organization
ICJ	International Court of Justice
IMEMO	Institute for World Economy and International Relations (Russia)
IMO	International Maritime Organization
INF	intermediate-range nuclear forces
INFCE	International Nuclear Fuel Cycle Estimation
LEU	low-enriched uranium

LNG	liquefied natural gas
MAD	mutual assured destruction
MIT	Massachusetts Institute of Technology (United States)
MTCR	Missile Technology Control Regime
NATO	North Atlantic Treaty Organization
NGO	non-governmental organization
NNWS	non-nuclear-weapon state
NORAD	North American Aerospace Defense Command
NPT	Treaty on the Non-Proliferation of Nuclear Weapons (Nuclear Non-Proliferation Treaty)
NSG	Nuclear Suppliers Group
NTI	Nuclear Threat Initiative
OPCW	Organization for the Prohibition of Chemical Weapons
OSCE	Organization for Security and Cooperation in Europe
P5	five permanent members of the UN Security Council
PSI	Proliferation Security Initiative
RAS	Russian Academy of Sciences
R&D	research and development
SDI	Strategic Defense Initiative
START	Strategic Arms Reduction Treaty
TNT	trinitrotoluol
UAV	unmanned aerial vehicles
UNMOVIC	United Nations Monitoring, Verification and Inspection Commission
UNODC	United Nations Office on Drugs and Crime
UNSCOM	UN Special Commission (Iraq)
USEC	United States Enrichment Corporation
WCO	World Customs Organization
WHO	World Health Organization
WMD	weapon of mass destruction
WMDC	Weapons of Mass Destruction Com

APPENDIX 3

List of Participants in the Conference

1.	**Viatcheslav KANTOR**	President of the International Luxembourg Forum on Preventing Nuclear Catastrophe; Ph.D. (Russia).
2.	**Alexei ARBATOV**	Head of the Center for International Security of the IMEMO RAS; Scholar-in-Residence of the Carnegie Moscow Center (former Deputy Chairman of the Defense Committee of the State Duma, Federal Assembly — Russian Parliament); Academician RAS (Russia).
3.	**David ATWOOD**	Associate Fellow of the Geneva Centre for Security Policy (former Director of the Quaker United Nations Office in Geneva); Ph.D. (United States).
4.	**John CARLSON**	Counselor to the Nuclear Threat Initiative; Visiting Fellow at the Lowy Institute for International Policy in Sidney (former Director General of the Australian Safeguards and Non-proliferation Office, Chairman of the IAEA's Standing Advisory Group on Safeguards Implementation, Australia).
5.	**Anatoliy DIAKOV**	Researcher (former Director), Center for Arms Control, Energy and Environmental Studies; Ph.D. (Russia).
6.	**Vladimir DVORKIN**	Chairman of the Organizing Committee, International Luxembourg Forum; Principal Researcher at the Center for International Security, IMEMO RAS; Professor; Major-General, ret. (Russia).
7.	**Rolf EKEUS**	Ambassador; Member of the Supervisory Council of the International Luxembourg Forum (former High Commissioner on National Minorities at the OSCE; Chairman of the Governing Board, SIPRI; Sweden).

8. **Vladimir EVSEEV** — Head of the Research Planning Division of the Russian Academy of Sciences; Senior Associate at the Center for International Security, IMEMO RAS; Ph.D. (Russia).

9. **Marc FINAUD** — Senior Programme Advisor, Emerging Security Challenges Programme; Course Co-Director, New Issues in Security Course, Geneva Centre for Security Policy (former Head of the Information Department, French Ministry of Foreign Affairs, France).

10. **Mark FITZPATRICK** — Director of the Non-proliferation and Disarmament Programme, International Institute for Strategic Studies in London (United States).

11. **Vladimir IAKOVLEV** — Principal Researcher at the Center for International Security, IMEMO RAS (former Director of the General Staff Academy of the Armed Forces of the Russian Federation, Commander-in-Chief of the Strategic Rocket Forces); General of the Army, ret. (Russia).

12. **Anton KHLOPKOV** — Director of the Center for Energy and Security Studies (Russia).

13. **Ariel LEVITE** — Nonresident Senior Associate at the Carnegie Endowment for International Peace (former Deputy National Security Advisor (Defense Policy) and Head of the Bureau of International Security at the Israeli Ministry of Defense); Ph.D. (Israel).

14. **Gustav LINDSTROM** — Head of the Euro-Atlantic Security Programme, Director of the European Training Course in Security Policy, Geneva Centre for Security Policy; Ph.D. (Sweden).

15. **Sergey OZNOBISHCHEV** — Director of the Institute for Strategic Assessments; Professor of the MGIMO (former Chief of the Organizational Analytic Division, RAS); Ph.D.; Full Member of the Russian Academy of Cosmonautics (Russia).

16. **Jean-Daniel PRAZ** — Deputy Head, Arms Control, Disarmament and Non-proliferation, Division for Security Policy, Directorate of Political Affairs, Swiss Federal Department of Foreign Affairs (Switzerland).

17. **Tariq RAUF** — President, "Global Nuclear Solutions" (former Head, Verification and Security Policy Coordination, Office of External Relations and Policy Coordination of the IAEA); Ph.D. (Austria).

18. **Roald SAGDEEV** — Distinguished University Professor, Department of Physics at the University of Maryland; Director Emeritus of the Russian Space Research Institute; Member of the Supervisory Council of the International Luxembourg Forum; Academician RAS (Russia/United States).

19. **Jarmo SAREVA** — Deputy Secretary-General of the Conference on Disarmament and Director of the Office for Disarmament Affairs, United Nations Office at Geneva (Finland).

20. **Fred TANNER** — Director of the Geneva Centre for Security Policy; Ambassador (Switzerland).

21. **Alexandra TOKAREVA** — Programme Coordinator for the Security and Law Programme, Geneva Centre for Security Policy (Switzerland).

22. **Petr TOPYCHKANOV** — Senior Associate at the Center for International Security, IMEMO RAS; Associate, Nonproliferation Program at the Carnegie Moscow Center; Ph.D. (Russia).