INTERNATIONAL LUXEMBOURG FORUM ON PREVENTING NUCLEAR CATASTROPHE

THE LIMITS OF SECURE NUCLEAR TOLERANCE

EDITED BY DR. VIATCHESLAV KANTOR

PRESIDENT OF THE INTERNATIONAL LUXEMBOURG FORUM
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In this book world renowned experts from different countries analyze the important issue of secure nuclear tolerance. They propose a set of criteria to identify the non-declared activity of states aimed at developing nuclear weapons. Those criteria may be potentially applied by the IAEA and the UN Security Council to determine the real nature and purposes of NPT Member States' nuclear programs. The expert study was initiated and conducted under the auspices of the International Luxembourg Forum on Preventing Nuclear Catastrophe.

The book is intended for specialists in international relations, arms control and security issues.

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GARETH EVANS
Member of the Supervisory Board, International Luxembourg Forum on Preventing Nuclear Catastrophe; Chancellor of the Australian National University (former Australian Senator and Member of Parliament, Minister of Foreign Affairs, Australia).

The Iran case has raised in the starkest possible way the question of how tolerant the international community can afford to be when it comes to non-nuclear countries developing capabilities that, while they may be capable of peaceful explanation, can all too readily be applied to building nuclear weapons and delivery systems. There is no question that this risk was not fully appreciated at the time of the negotiation of the Nuclear Non-Proliferation Treaty. Although there is a good argument that there is a "right to enrich" under that Treaty, that does not conclude the argument as to whether there *should* be now an unrestricted right to enrich, or the extent to which the wider international community should be tolerant of such claims and take no countermeasures.

The issues here are quite complex. It is not difficult to identify a set of objective criteria as to whether a given country has, or is acquiring, the *capability* to make a nuclear weapon. Crucial factors here are a capacity to produce or acquire fissile material, and evidence of certain research and development activities consistent with a nuclear weapons program. But, given the extent to which so much material, so many items, and so much research activity is dual use—consistent with other objectives than manufacturing nuclear weapons—it is very much harder to be confident on the question of *intent*.

That remains the case no matter how many further objective criteria or warning signs one adds to the list (for example, volatile strategic environment, perception of external threat, history of confrontation, absence of protecting ally). There are three basic kinds of nuclear latency. First, it may be *inadvertent*, when a state may have the basic capability to make nuclear weapons but have no intention to do so, or to persuade anyone else that it has that capacity. Second, it may be *deliberate but limited*—when a state consciously develops a demonstrable break-out capability but has no actual intent, at least for the foreseeable future, to weaponize: this is what might be called "hedging," and is arguably what Iran is doing. Third, it may be *deliberate and unlimited*—where the latent capability is simply a way station en route to weaponization. While it is only this third kind of latency that is really alarming, there is, of course, a risk with the second kind (deliberate hedging) that in the absence of international pushback other states will be provoked to seek equivalent capability.

The most difficult question of all in this area is how to translate analysis—that a state is at, or has passed, some threshold that justifies alarm bells being rung—into effective international action. While others like the Nuclear Suppliers Group or IAEA might have important roles in determining whether various criteria were satisfied, ultimately the responsibility for taking or authorizing appropriate countermeasures—whether these be in the form of admonitions, inspections, or coercive measures invoking Chapter VII of the UN Charter—would fall on the Security Council. And one would have to be a supreme optimist to believe that the Council would be able or willing for the indefinitely foreseeable future to take on such a generalized responsibility.

That said, if the Permanent Five members of the Security Council, in their capacity as the five NPT nuclear-weapon States, were to demonstrate real commitment to disarmament by further rolling back (or, in the case of China, at least capping) their own nuclear arsenals, their authority to impose nonproliferation obligations on others would be strengthened.

These various difficulties should not, however, inhibit debate on how best in the future to strengthen a nonproliferation system that badly needs such strengthening, any more than the technical and other difficulties standing in the way of ultimate elimination should stop us debating how to accelerate the disarmament process. This ground-breaking study by the Luxembourg Forum on Preventing Nuclear Catastrophe is a very important contribution to that debate.

IGOR IVANOV

Member of the Supervisory Board, International Luxembourg Forum on Preventing Nuclear Catastrophe; President of the Russian International Affairs Council and Professor at the Department of Global Political Processes at the Moscow State Institute for International Relations (MGIMO), Ministry of Foreign Affairs (former Russian Minister of Foreign Affairs, Secretary of the Security Council of the Russian Federation); Corresponding member RAS (Russia).

The Luxembourg Forum's new book addresses specific political, military, and technical issues related to enhancing the effectiveness of the Nuclear Non-Proliferation Treaty and the nuclear nonproliferation regime in general. Some of the book's assessments and proposals require more research and thinking. However, the goal of this intellectual effort is right and important.

During the almost half a century that has elapsed since the signing of the NPT in 1968, the world has changed dramatically due to tectonic geopolitical and ideological shifts, dynamic economic and technical developments, and a revolution in mass communications and information technology. These changes imply adequate adaptations of the NPT institutions and regimes: some have been made, but more are needed to cope with the new developments and threats. This has to be achieved without revising the principal provisions of the Treaty, but by the joint and well thought through elaboration of additional norms, institutions, and practical steps for enhancing the goals of the Treaty: encouraging the peaceful use of nuclear energy through international cooperation, while precluding the proliferation of nuclear weapons in the world. "Secure nuclear tolerance" implies the free realization of states' and businesses' rights to the former but stringent prohibition of the latter, taking a step beyond existing IAEA safeguards and nuclear suppliers' lists. This book is a first but valuable multinational experts' attempt to formalize this important purpose.

NIKOLAY LAVEROV

Member of the Supervisory Board, International Luxembourg Forum on Preventing Nuclear Catastrophe; Member of the Presidium, Russian Academy of Sciences (RAS, former Deputy Chairman of the Council of Ministers of the USSR, Chairman of the State Committee of the USSR Council of Ministers for Science and Technology); Academician RAS (Russia).

Given the current dead-end on the path to further reductions and limits on nuclear weapons, hampering reinforcement of the nonproliferation regime, breakthroughs in managing Syrian chemical weapons and the agreement on resolving the Iranian nuclear crisis represent a window of opportunity to further develop cooperation on nuclear energy and, more importantly, to continue nuclear disarmament negotiations.

On the whole, however, the situation regarding the proliferation of weapons of mass destruction—and, first and foremost, nuclear weapons—remains fragile and unstable. The efforts made by the international community to substantively bolster the nonproliferation regime since the opening of the Non-Proliferation Treaty for signature in 1968 have not succeeded.

In practice, it has proven extremely difficult to reinforce nonproliferation regimes. The present world economic and political situation, which is not conducive to resolving conflicts between countries, has seen these difficulties multiply.

Against this backdrop, the initiative of such an authoritative organization as the International Luxembourg Forum on Preventing Nuclear Catastrophe to seek new, innovative approaches to the reinforcement of the nonproliferation system as a whole is to be applauded. One such promising approach might be to draw up a set of additional criteria to clarify existing limits on nuclear proliferation and spell them out in greater detail. Finding these criteria and describing them in depth is also the object of this book, which was written with the involvement of prominent international experts.

WILLIAM PERRY
Member of the Supervisory Board, International Luxembourg Forum on Preventing Nuclear Catastrophe; Professor, Stanford University (former Secretary of the U.S. Department of Defense).

During the Cold War, the world faced the prospect of a nuclear holocaust initiated by one of the superpowers that could have ended civilization. We had several very close calls: the Cuban missile crisis, which could have resulted in a nuclear war by miscalculation, and a number of false alarms that could have resulted in a nuclear war by accident. Partly by good management by Soviet and American leaders, but mostly by good luck, we avoided this catastrophe.

Now the Cold War is over, and the danger of a nuclear holocaust has greatly receded. Leaders of Russia and the United States have declared that a nuclear war cannot be won and should never be fought. Each country has dismantled thousands of nuclear weapons. But each country still maintains thousands of nuclear warheads, with many of these deployed on a prompt launch status. Additionally, the world is faced with a dangerous proliferation of these capabilities. India and Pakistan each have more than a hundred nuclear weapons, with many of these aimed at each other. Even more dangerous, both sides have developed and deployed "tactical" battlefield nuclear weapons, raising the probability that nuclear weapons could actually be used in any military confrontation. More recently North Korea, under the guise of a civil nuclear program, has developed and tested nuclear weapons, and it is possible that Iran may attempt to do the same with their civil nuclear program. International efforts to roll back North Korea's nuclear program have so far been unsuccessful. More progress has been made in international negotiations with Iran, but Iran is very close to having the capability to build nuclear bombs.

So while the existential dangers of total annihilation faced during the Cold War have receded, new dangers have arisen—the danger of a regional nuclear war, and the danger of nuclear terrorism. These new threats are exacerbated by the potential availability of nuclear weapons from the new nuclear powers as well as by the large number of nuclear weapons still possessed by Russia and the United States. These new dangers do not threaten the end of civilization, as nuclear weapons did during the Cold War, but still they could result in an unprecedented catastrophe. But there has been inadequate discussion of this danger. As a result, the likelihood of this catastrophe actually occurring is needlessly high, simply because it is not understood by most of our citizens and not acted on by our government leaders.

The Luxembourg Forum, founded in 2007, is an international group of security scholars, dedicated to promoting international understanding and tolerance, in order to lessen the danger that nuclear weapons pose to the world today. It has met a number of times these past few years to discuss current security problems in detail. This paper results from the meetings and studies of the Forum and puts its focus on the importance of "Secure Nuclear Tolerance." Our studies and conclusions do not represent the point of view of any specific nation or any specific political party. It is the objective view of security specialists from many nations who believe that the world today faces grave dangers from nuclear weapons and who seek to promote policies that can lessen those dangers.

INTRODUCTION

The concept of the limits of secure tolerance, formalized in a Model National Statute for the Promotion of Tolerance and elaborated with the participation of the International Luxembourg Forum on Preventing Nuclear Catastrophe, may be applied with due adjustments to nearly all aspects of the life of modern societies or activity of advanced states.

In this general philosophy the notion of secure limits of nuclear tolerance is of utmost importance for international security in the beginning of the twenty-first century. Nowadays the proliferation of nuclear weapons among states and the growing probability of their acquisition by terrorist organizations have become the greatest challenges, against which the traditional instruments of nuclear deterrence of the twentieth century do not work.

The norms of international law designed to cope with this threat that were initiated and implemented in the last century will not be sufficient in the foreseeable future either. These norms are mainly based on the provisions of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which was signed in 1968 and entered into force in 1970. This highly important document establishes a number of key general obligations, which slowed down nuclear proliferation in the past and in some cases helped to reverse it (i.e., the Republic of South Africa in 1991 to 1992). At the same time, at present and in the foreseeable future the NPT does not cover the full range of states' cooperative or nuclear activities that have evolved over the forty-six years since the initiation of the Treaty against a backdrop of colossal geopolitical, economic, and technological (including informational) changes in the world.

The International Atomic Energy Agency (IAEA) has played a crucial role in the implementation of the NPT but is lacking the necessary expertise and legal rights to deal with the many routes of nuclear weapons design and development or concurrent technological projects and the accumulation of nuclear materials and technological capacities (i.e. uranium enrichment facilities), which permit nations to tacitly move to the threshold of obtaining nuclear weapons or even secretly cross this threshold.

Hence, there is presently an acute necessity to elaborate some additional norms, institutions, and practical methods of enhancing the goals of the Treaty.

In the opinion of the well-known experts who are the authors of this book, the concept of the limits of secure nuclear tolerance should involve an effective monitoring of states' atomic energy-related activities in terms of their compliance not only directly with the provisions of the NPT or IAEA safeguards; it is also necessary to monitor and impartially analyze the entire range of nuclear energy and scientific activities and the development of concurrent technological projects that may indirectly indicate proliferation intentions. An agreement among leaders of the most influential states on an evidence-based system of signs (indicators or criteria) of various activities related to nuclear and concurrent non-nuclear research and development might be an important new step in this direction.

The criteria of the limits of secure tolerance may also be applied to other state functions: the military use of outer space, the development of conventional high-precision arms or missile defense systems, biotechnological progress, the creation of arms based on new physical principles, and the foreign sales of weapons and military equipment. However, these subjects are beyond the scope of the present book, which is dedicated to the broadly defined area of contemporary nuclear weapons proliferation.

PART I.

GENERAL CHALLENGES OF SECURE NUCLEAR TOLERANCE

Chapter 1.1.
CONSTRUCTING A SECURE NUCLEAR TOLERANCE SYSTEM

Viatcheslav Kantor[1]

A system of secure nuclear tolerance is an integral part of the general concept of secure tolerance. Such a system functions in such a way so that states, social groups, and individuals have a broad set of inalienable rights and freedoms, but the exercise of those rights and freedoms should not serve to cover up ulterior motives and threaten other states, societies, and citizens ("The freedom of my fist ends where my fellow man's nose begins").

Such a concept was initially built into the Model National Statute for the Promotion of Tolerance developed by a group of experts in Heidelberg in December 2011 under the aegis of the European Council on Tolerance and Reconciliation. The Model Statute is designed for adoption by the legislative bodies of all world states.

The Model National Statute for the Promotion of Tolerance consists of nine sections that touch upon nearly all aspects of the activity of modern states (including the defense of rights and freedoms, national and international security, social policy and morality, health care, immigration policy, criminal liability, education, mass media, and others).

The limits of secure tolerance amount to agreed-upon, justified, and, where necessary, coercive restrictions on those activities for the sake of the common good, including in the areas of immigration policy and the creation of insular ethnic enclaves. In this sense, the concept of secure tolerance is applicable to socioeconomic and cultural policy as well as to states' nuclear activities that can subvert regional and global security. The Model Statute includes a section that limits states' rights in international relations in situations when a state's intentions and actions can lead to a security breach on either the regional or global level. "Tolerance should not be used as... a defense for those who aim to undermine peace and stability on the national or international level."

Secure nuclear tolerance is a supremely important link in the general concept of secure tolerance, since the unrestricted proliferation of nuclear weapons and nuclear materials will inevitably lead to a nuclear catastrophe, not just on the regional level, but on the global level as well.

Diplomats and experts agree that the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) establishes very general obligations for the five nuclear-weapon States not to transfer nuclear weapons to other countries (Article I of the NPT). It also obligates non-nuclear States not to acquire nuclear weapons (Article II); encourages cooperation among States in the development of peaceful atomic energy and science (Article IV); and obligates the IAEA to guarantee that the fruits of such collaboration will be used exclusively for peaceful ends (Article III).

At the same time, the NPT does not cover the full range of States' nuclear activities and collaboration that have developed over the forty-five years since the execution of the Treaty against a backdrop of colossal geopolitical, technological, and informational changes. The experience of preceding decades has shown that non-nuclear-weapon countries can come all the way to the verge of creating nuclear weapons without formally violating the Treaty and then withdraw from the NPT under a contrived pretext with only three months' notification (per Article X.1) and create a nuclear weapon in a short span of time (as North Korea did in 2003—2006). This experience also demonstrated that IAEA safeguards are insufficiently effective in relation to States that did not accede to the Additional Protocol of 1997. In light of the expected growth of atomic energy internationally (the volume of which will double by 2040) and the expansion of international cooperation in this area, the danger of further proliferation of nuclear

[1] Viatcheslav Kantor is President of the International Luxembourg Forum on Preventing Nuclear Catastrophe; Ph.D. (Russia).

weapons and of those weapons falling into the hands of terrorists may grow exponentially.

In this connection, the concept of secure nuclear tolerance should involve the need for effective monitoring of States' atomic energy-related activities in terms of their compliance, not only with the terms of the NPT, but also with the entire nuclear nonproliferation regime, including the requirements of the Additional Protocol of 1997 and the modified Code 3.1, activities of the Zangger Committee and the Nuclear Suppliers Group in coordinating lists of equipment and permissible nuclear export materials, agreements on export control standards, and other components. And of course, international and national legal measures are needed to respond to identified breaches of the nuclear nonproliferation regime.

The peculiar features of these problems require expanded monitoring and analysis of adjacent subject matter such as regional characteristics, foreign and military policy, economics, the development of potential delivery vehicles for nuclear weapons, etc.

Note that the requirements of secure tolerance can be applied to other state functions such as the military use of outer space, the development of conventional high-precision arms, the creation of missile defense systems, biotechnological progress, the development of weapons based on new physical principles, and the supply of weapons to illegal military formations.

At present, an increasing number of NPT Member States, encouraged by North Korea's actions and disagreements among the great powers in the UN Security Council over sanctions against Iran, are conducting suspicious activities that cannot be justified in terms of peaceful ends and bring them closer to the nuclear threshold while they maintain formal membership in the NPT.

For example, *Japan* has decided to increase its capabilities for the separation of plutonium (an effective weapon material) from spent nuclear fuel from its 54 reactors. *South Korea* periodically engages in actions and its politicians make statements that are incompatible with nuclear nonproliferation.

Saudi Arabia has shown interest in atomic energy, although it supplies hydrocarbon fuel both for itself and for the rest of the world. The same goes for the Arab countries of the Persian Gulf and Indonesia.

Brazil is reactivating its atomic energy program, including plans for production of highly-enriched uranium allegedly for the purpose of fabricating fuel for nuclear submarine reactors. Yet it is impossible to imagine Brazil under a seaborne threat that would justify such expensive and menacing weapons (diesel submarines and guard ships would be sufficient to defend that country's coast).

Iran is building a large uranium enrichment complex in Natanz (where 13,000 centrifuges are currently in operation, with plans to bring that number up to 54,000), although it has no appropriate industrial nuclear reactors. Iran so far has just one old research reactor in Tehran; a power reactor has been commissioned at the nuclear power plant in Bushehr; a research reactor is being built in Arak; and two energy reactors are being built in Darkhovin. But, according to a treaty with Russia, certified fuel for the most powerful (1 gigawatt) Bushehr reactor is to be supplied exclusively by Rosatom. The claim of Iran's former president that there are plans to build ten or more enrichment plants is all the more absurd (even Russia has only four such plants). Although Iran has announced plans to build sixteen reactors in fifteen years, it is an utterly impossible project in any case and rather a matter of the distant future.

The Fordow enrichment complex evokes even greater suspicions. It is built at an eighty-meter depth in hard rock. There are no reasons for such underground structures, and therefore for the tremendous additional expenses, if, as Tehran claims, they are designed for peaceful atomic energy. Iran's invocation of Israeli threats to strike by air are unconvincing. If Iran's enemies wish to impede the development of peaceful, and not military, atomic energy in Iran, then they will still be able to destroy all of the other elements of the nuclear industry there.

There are only two examples of similar underground atomic energy projects in world history. The USSR created an underground nuclear power plant called Atomgrad near Krasnoyarsk for the production of weapons-grade plutonium, while North Korea appears to be building a uranium enrichment complex within mountain masses. Both projects unquestionably have military purposes, viz. the production of weapons-grade nuclear materials even in case of war and in spite of air strikes.

All of the other eleven countries that possess declared uranium enrichment facilities or already are nuclear-weapon States (the "nuclear nine," not counting Israel and North Korea) have also created such complexes for military purposes in the past or they have a highly-developed atomic energy infrastructure as a lawful consumer of enriched uranium fuel. Those non-nuclear-weapon countries are Japan (54 reactors), Germany (eighteen reactors), and the Netherlands (four reactors). Moreover, the latter two countries have enrichment plants within the framework of the multilateral URENCO campaign (in which the United Kingdom and United States also participate). Another state with enrichment technology is Brazil, which initially created such facilities for military purposes, but later disavowed them.

It is impossible to change the letter of the NPT, since that would require the agreement of all Member States, including those involved in suspicious activities. Any attempt to make the articles of the NPT stricter by introducing amendments or new articles would cause the Treaty to fall apart and would obliterate this principal, albeit presently imperfect and insufficiently effective, barrier to the proliferation of nuclear weapons.

In this connection, additional steps are needed to fortify the entire nuclear nonproliferation regime, which is based upon the NPT, without amending the articles of that Treaty but by supplementing them with other agreements and mutual understandings as has previously taken place (the improvement of IAEA safeguards in stages, the execution of the Additional Protocol of 1997 and the modified Code 3.1, the activities of the Zangger Committee and the Nuclear Suppliers Group in coordinating lists of equipment and permissible nuclear export materials, agreements on export control standards, and others).

The development by experts and agreement among leading states of an evidence-based system of signs (indicators or criteria) of state activities can be an important new step in this direction. Those criteria will make it possible to conclude with sufficient reliability whether a State is approaching a threshold designated as the "red line," i.e. the creation of nuclear weapons by wrongfully using the materials and technologies of peaceful atomic energy even without formally violating the NPT and before announcing intent to withdraw from the Treaty under its Article X.1.

Taken as a whole, those signs would indicate the limits of acceptable nuclear tolerance.

The following could be seen as signs of such actions:

- A State's failure to accede to the Additional Protocol of 1997 to IAEA safeguards (which expands the scope of information to be submitted to the IAEA and permits the IAEA to search for States' undeclared nuclear activities);
- Creation of elements of the nuclear fuel cycle (including uranium enrichment facilities) despite a small number of active and realistically expected nuclear reactors, making such production economically infeasible for peaceful purposes;
- Creation of other elements of the nuclear fuel cycle (including separation of plutonium from spent nuclear fuel) in the absence of reactors that operate on mixed uranium-plutonium fuel (i.e. MOX fuel);
- Refusal to engage the services of foreign national and multilateral centers for the supply of enriched uranium and nuclear fuel, despite a low number of active nuclear reactors;
- Accumulation of significant reserves of enriched uranium (and especially highly-enriched uranium) that do not correspond to available nuclear reactors that are capable of using such fuel or when available reactors are required by international agreements to use certified foreign-produced fuel only;
- Creation of highly protected (underground) nuclear industry facilities, especially when those facilities involve dual-purpose technologies that can be used to create weapons-grade nuclear materials;
- Development and testing of delivery vehicles designed to be fitted with nuclear warheads;
- Research and experiments associated with the creation of nuclear explosive devices and nuclear warheads (including conversion of fissile materials into a metallic state and specific shaping of those materials, and experiments with various non-nuclear elements of nuclear explosive devices and materials including beryllium, polonium, tritium, and gallium);
- Production of highly-enriched uranium (with over 20 percent uranium-235 content) under the pretext of providing fuel for naval nuclear

reactors in the absence of a realistic need for a nuclear-powered navy; production of highly-enriched uranium for research and medical needs in volumes that exceed those necessary to satisfy those needs;
- Construction of facilities that have the features of facilities for the conduct of in-situ nuclear tests;
- International cooperation outside of IAEA safeguards for the transmission of nuclear technologies and materials, including with countries that are not members of the NPT;
- Interference with the IAEA's inspection activities;
- Announcement of intentions to withdraw from the NPT or withdrawal from the NPT in the absence of "circumstances" that would threaten the "supreme interests" of the country in question (per Article X.1). The presence of such circumstances should not be determined by each country at its own discretion, but rather should be subject to review by a conference of NPT Member States and/or the UN Security Council.

The analysis and assessment of these signs and the conclusions made thereupon should be connected with the governments of the states under suspicion, their possible connections with terrorist organizations that could obtain nuclear materials, and the general political and socioeconomic situation in the region.

There is a separate task of defining a critical set of indicators (signs) of suspected states approaching the "red line," which by no means must necessarily include all of the indicators listed above. It is expedient to have an expanded team of experts perform that task.

If leading states and the Nuclear Suppliers Group agree on a critical set of indicators of suspicious activity, and the IAEA, as well as possible new, legitimate international organizations, discovers signs that a State is approaching the "red line" or is in the process of crossing that line (which can take years, as in the case of North Korea in 2003—2006), the UN Security Council may make decisions on appropriate countermeasures, from admonitions and demands for additional inspections and investigations all the way up to the imposition of sanctions under Articles 41 and 42 of the UN Charter. At the same time, the particular features of the State's political system and its status in the region must be taken into account.

It should be noted that the IAEA's current capacities and rights are insufficient for collecting and analyzing the entire range of signs of suspicious activities of non-nuclear-weapon Member States of the NPT (for example, for monitoring the development and testing of potential nuclear weapon delivery vehicles, the acquisition of dual-purpose technologies and materials used in nuclear warhead assemblies, and the preparation of potential sites for nuclear tests, as well as for interviewing specialists and obtaining relevant documentation). Other indicators are entirely beyond the IAEA's designated powers (for example, the relative proportions of uranium enrichment and the number and type of planned nuclear power plants or the creation of highly-enriched uranium for naval reactors as compared with the navy's real needs).

In this connection, it becomes increasingly important to monitor more broadly the activities of non-nuclear-weapon NPT Member States that can bring them closer to the "red line," and to prevent actions in a timely manner that are incompatible with the nuclear nonproliferation regime but do not directly relate to the goals and competences of the IAEA and the Nuclear Suppliers Group.

Under these conditions, it is expedient to consider the possibility of forming a special Center (or Agency) to monitor not just the processes of nuclear weapons creation but also the processes of the development of nuclear weapons delivery vehicles.

The prospects for the UN Security Council to make effective decisions when a country is approaching the "red line" depend on a number of problems that still remain unresolved. Those problems relate to leading states' differing attitudes and political preferences in identifying real threats of nuclear weapons proliferation.

In this connection, it is necessary to develop international and national legal initiatives that can become the legitimate basis for imposing coordinated sanctions on a state that advances its nuclear programs toward the "red line." Such initiatives must undergo mandatory expert review in the academic community and in civil society. And it will be very important that there will be a public component in the process of discussing these initiatives. Otherwise, the value of the results obtained will be significantly lower.

It should be emphasized that the process itself is absolutely critical, since leading states' political leaders, in making decisions on sanctions even before coordinating and adopting respective laws, will base their actions on the conclusions of the expert community.

In conclusion, it must be noted that in order to further develop the theoretical and practical aspects of forming the critical set of indicators that will confirm that suspected states aim to create nuclear weapons, i.e. that they are approaching the "red line," and in order to create a legal basis that will make it possible to prevent that, a working group has been created under the aegis of the International Luxembourg Forum on the Prevention of Nuclear Catastrophe, the Institute of World Economy and International Relations of the Russian Academy of Sciences in Russia, and Georgetown University in the United States.

Chapter 1.2.

THE ROLE OF THE SECURITY COUNCIL AND THE IAEA IN THE STRENGTHENING OF NUCLEAR NONPROLIFERATION

Rolf Ekéus[2]

The IAEA Safeguards and Their Shortcomings

The undertaking by each of the non-nuclear-weapon States Party to the Non-Proliferation Treaty to enter into a safeguards agreement with the IAEA and to accept safeguards for the purpose of verification constitutes a foundation of the verification of the implementation of the Treaty. The explicit details of a verification system for this very purpose have been developed in the context of the operations of the IAEA.

The obligation of a non-nuclear-weapon State Party to the Treaty is to make a comprehensive safeguards agreement that requires the State to declare all nuclear material and facilities to the IAEA, and even to maintain nuclear accounting records and to report all relevant changes. In addition to site visits, the verification activities can include camera surveillance and environmental sampling of the declared facilities and nuclear material.

The fundamental point in this context is that a comprehensive safeguards agreement is no more comprehensive than that it is limited to declared facilities only. The considerations, when the Treaty was negotiated and drafted, that nuclear fuel cycle development outside declared facilities would not be realizable, turned out to be wrong, as was shown with the case of Iraq. Thus, when the Security Council-mandated verification activities

[2] Rolf Ekéus is Ambassador (former High Commissioner on National Minorities at the OSCE, Chairman of the Governing Board, SIPRI; Sweden).

(under its resolution 687) were applied by UNSCOM/IAEA in Iraq, inspections disclosed a wide range of activities including different approaches to enrichment of nuclear fuel and some quantities of plutonium separation. None of this had been registered in the comprehensive safeguards inspections. Even violations of safeguards agreements by Iran, Libya, and Syria have gradually confirmed that comprehensive safeguards verifications are not designed to detect deliberate violations of the nonproliferation regime.

These experiences regrettably demonstrate that, as regards weapons of mass destruction norms, the principle of "Pacta Sunt Servanda" (treaties shall be respected and executed) does not always apply.

The Ronald Reagan dictum "Trust but verify" would be more suitable. The limitation of the comprehensive safeguards verification to declared facilities does not exclude the possibility that Member States can assist in capacity building by providing the IAEA safeguards department with detection technologies, including satellite imagery and national technical means (intelligence data).

However, after the experience of the failure of the IAEA safeguards system in the case of Iraq, it has become a broadly acceptable view that a verification system limited to declared facilities and activities only must be strengthened. The IAEA Model Additional Protocol introduced in 1997 as a voluntary legal instrument could draw extensively from the experiences of the IAEA/UNSCOM inspections acting under the authority of the Security Council to also inspect non-declared facilities. What was new with the Additional Protocol was to make it possible for the IAEA to access more extensive information on nuclear-related activity in manufacturing, exports, and imports, and more importantly, to provide inspectors with broader rights to visit and investigate nuclear sites and nuclear-related locations.

At the present time, most non-nuclear-weapon States (105), including many with wide nuclear programs, have signed the Additional Protocol. However, six States with significant nuclear activities—Argentina, Brazil, Egypt, North Korea, Syria and Venezuela—have not adopted the Additional Protocol. Iran, having adopted the Protocol in 2003, stated in February 2007 that it would no longer act in accordance with the provisions of the Protocol.

In the case of Iran, the Geneva talks in 2014 between Iran and six States (the five permanent Security Council Member States and Germany) have reached preliminary agreement giving the IAEA opportunities and rights to investigate the whole range of possible nuclear activities that are necessary for the manufacture of nuclear weapons or explosive devices, like converting fissile material into metallic form and the development and acquisition of high-explosive lenses or of high-energy electrical components.

A complicating factor is the question whether the IAEA has the expertise and competence to deal with weapons design and weapons development in addition to its high quality work in verifying nuclear material. Furthermore, it is questionable from a nonproliferation point of view whether weapons development and production know-how should be made easily available to a multilateral organization like the IAEA. The risks are obvious that such highly sensitive knowledge could be dispersed internationally, causing serious harm to the international nonproliferation regime.

Fundamentally, the problem with the Additional Protocol is that States engaged in advanced nuclear-related activities refuse to adhere to it. The motivations differ from political to technical. The outliers deeply dislike the discriminating character of the nonproliferation regime in favor of nuclear-weapon States and cannot accept the addition of further obligations for the non-nuclear-weapon States. Proposals that the Nuclear Suppliers Group (NSG) of States should limit their exports of nuclear material only to States having adopted the Additional Protocol open up serious international tensions and could be counterproductive. On the other hand, proposals that the nuclear-weapon States should also take on new responsibilities, e.g. in the form of increased transparency as regards their weapons programs, as recently demonstrated by the U.S. administration, are welcome, but are considered far from sufficient in redressing the imbalances or modifying the perceived imbalances in the implementation of the NPT.

Improving the Political Support for the IAEA

Short of substantial reductions of nuclear weapons arsenals implicating the launching of processes toward the elimination of nuclear weapons, little could satisfy the non-aligned States outside the U.S. nuclear guarantees, the "non-umbrella" States. That does not exclude the possibility that reform proposals as regards the role of the IAEA and the UN could be well received if they indicate a shared concern about the dangers of a world not free of nuclear weapons.

One such proposal was the initiative by former IAEA Director General Mohammed ElBaradei aiming at a multilateralized nuclear fuel cycle to diminish the quest for national fuel cycles and to guarantee that states considering developing peaceful nuclear energy programs would have safe supplies of civilian nuclear reactor technology and reactor fuel. Supportive of this is the nuclear fuel bank, as originally proposed by the Nuclear Threat Initiative (NTI). The bank should stand as a guarantor of nuclear fuel supplies to civilian nuclear energy projects. The financing of the system is based upon a grant by the NTI and by contributions from the U.S. government, the European Union, and others. The nuclear fuel bank is now operational as a part of an IAEA-related organizational set-up. The non-aligned States have accepted this system but have emphasized that the existence of the bank should not be allowed to call into question the rights of the States Party to the NPT to develop their own national enrichment capability for peaceful purposes. This position does not mean that these States are necessarily endorsing Director General ElBaradei's plan for a multilateral nuclear fuel cycle. Alternatively, nuclear-weapon States, e.g., Russia and the United States, offer certain assurances about delivery of LEU for peaceful purposes, but the major non-aligned non-nuclear-weapon States appear not to be impressed.

The Role of the Security Council: the Iraqi Experience

In 1991 the Security Council took the initiative to create its own verification disarmament unit with its resolution 687, constituting the ceasefire after the 1991 Kuwait War. This unit, the Special Commission (UNSCOM) became the first subsidiary organ of the Council. It was tasked with supervising the removal and destruction of Iraq's weapons of mass destruction and relevant delivery systems and with taking measures to prevent their reconstitution. Concerning specifically the nuclear weapons dimension of the decision by

the Security Council, the Director General of the IAEA was given responsibility regarding supervision. Thus, it was not formally the IAEA organization, with its institutional structures and decision-making bodies, which was to carry out the task of supervising the destruction and elimination of the proscribed nuclear-related items.

To fulfill his obligations, the Director General set up an Action Team with the necessary expertise, but independent of the IAEA formal structures. Through the Action Team, the Director General could carry out his task of verifying and accounting for the nuclear facilities and capabilities declared by Iraq. UNSCOM had to provide for the financing of the Action Team's operations. Regarding corresponding non-declared locations relevant for nuclear verification and supervision, it was left to the Executive Chairman of UNSCOM to designate locations for inspections by the Action Team, which had to carry out its operations with the assistance and cooperation of UNSCOM.

Two points regarding principle should be made in this context:

1. To give the IAEA, a Specialized Agency within the UN family, a highly intrusive task with complex political and security dimensions was considered not suitable for the Agency's institutional set up and decision-making structure (the General Conference and the Board of Governors), which could not be adapted to the kind of systematic operational activities that were expected for the verification and disarmament task ahead. Another problem in this context was that the verification task was not only limited to the field of the IAEA's competence in nuclear fuel matters, but it could be expected to relate to weapons technology and weapons design, with potential weapons proliferation significance.

2. The fact that the Security Council did not authorize the Director General of the IAEA to act with regard to non-declared facilities and activities, without an UNSCOM designation, was an expression of the principle established in the preambular part of the cease-fire resolution, namely, the commitment to the sovereignty, territorial integrity, and political independence of Iraq. The Security Council was thus not ready to farm out to the IAEA or its Director General rights that could challenge the territorial integrity of Iraq. Instead, it was the Council's own subsidiary organ,

UNSCOM, that, under the Council's supervision, was to be responsible for handling and judging such sensitive issues as the designation of non-declared locations for investigation.

The creation of UNSCOM and the related institutional structure is unique in contemporary history. The earlier historical example is the Control Commission tasked with disarming Germany after World War I. In contrast to the Control Commission, the UNSCOM/DGIAEA (later called the UNSCOM/IAEA) operation turned out to be a remarkable success. Stiff resistance by the Iraqi authorities with regard to weapons declarations and access for inspectors, along with generally obstructive practices, challenged the inspectors in the implementation of their task. However, a united Security Council gave constant and continuous political support with strong statements and sometimes threatening language. With that solid political backing the UNSCOM operations continued effectively until 1998, when the U.S. bombing of Iraq made continued work impossible and the UNSCOM/IAEA was forced to terminate inspection and verification activities in the country.

The UNSCOM/IAEA inspections combined a "search and destroy" mission with a monitoring verification system, the OMV, constructed by the UNSCOM and the Action Team, and approved by the Security Council in resolution 715, which in addition to site inspections encompassed document searches, interviews, air sampling, overhead photography from U2 flight surveillance, sampling equipment, satellite imagery, ground-penetrating radar, and intelligence provided by governments. The monitoring applied no-notice inspections at locations where activities suspected of involving the development, production, or storage of prohibited items could take place. The special strength of the system was that inspections as a rule were led by seasoned experts in their field of activities: nuclear, chemical, biological, and missile technology.

The definitive evaluation of the quality and efficiency of the UNSCOM/IAEA verification and inspection work in Iraq from 1991 to 1998 could not be accomplished until the end of the 2003 Iraq War, when the United States and allied troops had occupied the country. The final assessment of the post-war evaluation carried out by the American-Iraqi Survey Group led

to the conclusion that back in 1997 the UNSCOM/IAEA had already accomplished its task fully in accordance with cease-fire resolution 687 and subsequent resolutions 707 and 715. In other words, all prohibited items, facilities, and capabilities had been identified and destroyed and a fully operational monitoring system had been in place until the end of 1998.

The UNMOVIC inspection system, which was to replace UNSCOM (dissolved in the context of the break-up of the earlier seven years of the Council's unified support), was set up by the Security Council in 1999. As it was proven later, UNMOVIC had no prohibited items to look for. Its operations in Iraq immediately before the outbreak of the Iraq War in 2003 were also limited to four months only (compared to UNSCOM's eight years).

A Permanent Subsidiary Organ of the Security Council

As a consequence of the indisputable success and accomplishments of the control and verification systems set up by the Security Council for Iraq, a number of proposals have been launched. The common denominator for these proposals has been that the Security Council should consider the establishment of a subsidiary organ on a permanent basis for the verification and supervision of suspect nuclear proliferation events. The focus should be on nuclear weapons, weaponization, and weapons production. Thus, there should not be a duplication of IAEA activities and responsibilities as regards nuclear fuel, HEU, and plutonium. Like the UNSCOM-IAEA cooperation, the subsidiary organ could address the questions of inspections or site visits by IAEA inspectors to non-declared facilities. Such decisions should take into account the principles of national sovereignty and territorial integrity. The subsidiary organ should base its authority upon decisions by the Security Council. At the same time, the subsidiary organ should be able and have the competence and authority to carry out weapons inspections and to alert the Security Council to possible threats of proliferation and related events. It should address developments both as regards States Party to the NPT and non-States Party to the Treaty, as well as non-state actors.

The subsidiary organ should closely follow the development as regards nuclear weapons proliferation through analyzing and assembling information from governments and research institutions and by following and evaluating trade patterns and tendencies. The nuclear weapons competence of the subsidiary organ must be carefully protected when selecting staff and by the handling of incoming sensitive data. The staffing of the unit would follow the UNSCOM model of recruiting both seasoned scientific experts and personnel with operational experience and training for the inspection activities. Weapons analysts should be stationed at the organ's headquarters, reachable by the Security Council. A roster of weapons inspectors, regularly trained and updated, should be kept ready in their home countries, to be summoned on short notice.

The subsidiary organ should report directly to the Security Council on a regular basis regarding the state of proliferation of nuclear weapons and the technologies and delivery systems associated with these weapons. This would be in full harmony with the responsibilities of the Security Council under the UN Charter and in practical terms be an expression of the Council's obligations to provide early warning and preventive diplomacy.

Chapter 1.3.

CRITERIA FOR THE ASSESSMENT OF UNDECLARED NUCLEAR WEAPONS DEVELOPMENT

Ariel Levite[3]

The realization that nuclear technology is, at its core, dual-use in nature occurred early on in the nuclear age, and it 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 the diminution of the costs associated with such processes. 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 nuclear military realms other than weapons. Furthermore, secrecy and deceit, common among countries harboring ambitions for developing nuclear weapons, make the challenge of observing and acting on an encroachment on such a dividing line all the more challenging. Finally, making

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matters even worse is the tendency (readily observable in the majority of both past and even present nuclear weapons programs) for final decision-making 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 weapons relevant or at the very least oriented activities 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 to the creation of 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, 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 over a decade or more, coordination, integration, and the significant allocation of scarce 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 easy translation of detection into characterization of these indicators as reliable signs of an active nuclear weapons program, because it is essential to debunk alternative explanations for such activities, be they 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 weapon development.

Heuristically speaking, the 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 the technical activities, especially in the fuel cycle domain, is a necessary (if up to a very late development stage by itself insufficient) condition 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, "safety tolerance criteria for nuclear nonproliferation regimes." Such framework ought to be clear on where or at the very least when "rights" for the development of peaceful use end and a nuclear weapons program begins. 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 the recycling of 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 to the largest possible extent objective criteria for such determination and build broad support for this determination. The latter at least in part mandates that such framework be developed on a generic basis and be applied consistently across the 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, which in practice 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 counterproductive, 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 contribution 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, worse still for offering a legitimate cover for such activity. Finally, the framework has to factor in further considerations pertaining to its possible applications, which in turn suggests that the framework will have to encompass verification and response aspects as well.

Chapter 1.4. ASSESSING AND MINIMIZING PROLIFERATION RISK[4]

John Carlson[5]

Introduction

This paper discusses some of the issues involved in assessing the risk of proliferation from national nuclear programs, particularly the idea of criteria for assessing whether an ostensibly "peaceful" program is really aimed at developing nuclear weapons. Amongst the issues considered are:

(a) the risk factors to be taken into account in developing criteria for assessing "peaceful" nuclear programs;
(b) how such criteria might be applied;
(c) whether a criteria approach is sufficient to deal with proliferation risk.

The paper also addresses major underlying themes, in particular the boundaries of "peaceful uses" permitted by the Nuclear Non-Proliferation Treaty (NPT), and the closely related issues of nuclear latency and nuclear hedging. The paper also looks at the safeguards challenges presented by national nuclear fuel cycle developments, and the effect of these on the ability of the International Atomic Energy Agency (IAEA) safeguards system to meet the expectations reflected in the NPT.

The very fact of discussing criteria for assessing the peacefulness of nuclear programs illustrates a critical change in the dynamics of proliferation.

[4] The views in this paper are the author's and not necessarily those of NTI.
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Until recent years the proliferation challenges that have arisen from States within the NPT have been based on clandestine (undeclared) nuclear programs with little or no direct link to declared, safeguarded civil programs. Criteria would have limited utility in addressing secret programs. However, the current Iranian nuclear problem shows that circumstances are changing—proliferation risk is no longer limited to clandestine programs. Iran, having been forced to bring under safeguards a nuclear program that it was developing in secret, is now seeking to legitimate this program, arguing that 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 IAEA safeguards could, if and when the State so decides, be used for break-out to nuclear weapons production. If States believe this is the underlying reason for the nuclear programs of other States, international trust and confidence will be undermined, and the credibility of the NPT and IAEA safeguards will be damaged. As will be discussed, the development of criteria could help define the limits of international tolerance for what is acceptable in national nuclear programs.

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. While motivation is commonly perceived as involving *subjective* considerations, this too can be analyzed objectively based on factual indicators.

A) Capability to produce nuclear weapons

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

(i) Acquisition of fissile material

Fissile material is a convenient term for the nuclear materials required to produce nuclear weapons[6]—principally highly-enriched uranium (HEU) and separated plutonium. Production of fissile material requires:

(a) a uranium enrichment plant. While the reason a state gives for acquiring an enrichment plant may be production of low-enriched uranium (LEU) fuel, there is no inherent technical barrier to using any of the currently established enrichment technologies to produce HEU. Centrifuge facilities in particular are readily adaptable for HEU; or

(b) a reprocessing plant, together with a source of suitable spent fuel. If a state intends to establish a nuclear weapon option, it will install reactors that can be readily used to produce low burn-up fuel (i.e. fuel in which the plutonium predominantly comprises the isotope Pu-239[7]), such as on-load refueling reactors, large "research" reactors, or fast breeder reactors.

<u>Acquisition by transfer.</u> While historically nuclear weapon programs have been based on a national capability to produce fissile material, it should not be overlooked that fissile material may also be *imported*:

(a) by legitimate transfer, e.g., research reactor fuel, critical assembly fuel, or MOX (mixed-oxide) fuel; or

(b) 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 an attractive source of nuclear material for weapons. This risk has been recognized for HEU, and 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 inventories of separated plutonium are increasing in several states (not only reprocessing states).

[6] The term used for IAEA safeguards purposes is unirradiated direct-use material.

[7] Weapons-grade plutonium is commonly defined as comprising 93 percent or more Pu-239; plutonium in spent fuel from the normal operation of a power reactor typically comprises around 55 percent Pu-239.

(ii) 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; high-explosive lenses and implosion testing; specialized high-energy electrical components; high-flux neutron generators; and design and testing of warhead re-entry vehicles.

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, however, a combination of such activities may more clearly indicate the existence of 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 in itself this is not necessarily conclusive. It is possible that detection of weaponization activities may be the first indicator that a state already has an undeclared (and so far undetected) program to produce fissile material—or weaponization activities may indicate that a state intends to divert safeguarded fissile material in the future.

(iii) Nuclear-capable delivery system(s)

While nuclear weapons could be delivered by unconventional means, e.g., truck, fishing boat, or shipping container, these are really only of terrorist interest. 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 (e.g., it may say it is engaged in *space research*), but such development will be grounds for suspicion, especially where other indicators are present, e.g., apparent weaponization activities, safeguards violations, and so on.

B) Motivation to acquire nuclear weapons

There are several reasons why states might pursue nuclear weapons, including notions of prestige and national pride, the desire to exert influence over other states, or the need for a military deterrent. While these are political sentiments, they can be given tangible form through statements made, actions taken, and so on. In analytical terms, 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 factual manifestations; therefore, they can be identified and assessed by objective means.

The principal indicator for motivation is the state's strategic environment, e.g.:

(a) is the state located in a region of tension?;

(b) is it—or does it consider itself to be—under military, economic, cultural, or religious threat?;

(c) is it involved in military or political confrontation with other states?

The clearest example of a region of tension is the Middle East, and it is no coincidence that of the six safeguards non-compliance cases that have occurred to date, four have involved states in the Middle East.[8] Other areas generally considered as regions of tension are the Korean Peninsula[9] and South Asia.

An important factor may be whether a state is involved in military alliances. Two examples of current relevance are the Republic of Korea (ROK) and Japan. Their alliances with the United States are of critical importance in meeting threats presented by the Democratic People's Republic of Korea (DPRK). Alliances can reduce the motivation to pursue nuclear weapons—and also, through oversight by the alliance partner, can reduce the opportunity to do so.

[8] Iran, Iraq, 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 (former regime) and the DPRK.

[9] And North Asia more broadly is looking increasingly fraught.

Peaceful Uses under the NPT

The use of nuclear energy for peaceful purposes is one of the three fundamental pillars of the NPT, together with nuclear disarmament and nonproliferation. A key objective of the NPT is to ensure that nuclear energy is indeed used only for peaceful purposes and does not contribute to the proliferation of nuclear weapons. Accordingly, Article IV of the NPT affirms the right of States to use nuclear energy for peaceful purposes, provided this is in conformity with the nonproliferation obligations of the Treaty and IAEA safeguards are applied to verify fulfilment of these obligations.

It is notable that the NPT does not define *peaceful purposes* and *peaceful uses*. The Treaty contemplates three categories of nuclear activity:

(a) the manufacture or other acquisition of nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices;

(b) non-proscribed non-peaceful purposes, i.e. non-explosive military purposes such as naval propulsion reactors—these activities are not mentioned expressly but are implicit in the wording of the safeguards article (Article III);

(c) peaceful uses and peaceful purposes—these would appear to encompass anything outside (a) and (b).

Iran in particular has been very vocal in asserting that Article IV gives it a right to undertake enrichment or any other fuel cycle activity. Article IV, however, does not refer to any specific technology, but rather, more broadly, to the use of *nuclear energy*. As noted above, this right is not unqualified, but must be exercised in conformity with the Treaty, and for *peaceful purposes*.

The lack of a clear definition of *peaceful purposes* leaves a grey area with respect to nuclear latency and nuclear hedging, problems that were neither adequately foreseen nor appropriately addressed at the time the NPT was negotiated. As will be discussed, international efforts to minimize proliferation risk must include careful consideration of how the NPT should be applied in contemporary circumstances.

Nuclear Latency and Nuclear Hedging

A) Nuclear latency

Nuclear latency refers to the situation where a state has established, under a peaceful nuclear program, dual-use capabilities that *could* be used for the production of nuclear weapons. Nuclear latency might be *inadvertent*: e.g., while a state with uranium enrichment and/or reprocessing capabilities thereby has the basic capability to produce fissile material for nuclear weapons, it may well have (at least in foreseeable circumstances) no intention of doing so.

On the other hand, nuclear latency could also be *deliberate*—a state could establish enrichment or reprocessing capabilities with an eye to having an essential component for a nuclear weapon option should its strategic circumstances change at some future time. The problem is that it's difficult to tell what the state's intentions may be. From a nonproliferation perspective, the fewer national programs there are in enrichment and reprocessing, the better, and vice versa—the more widespread these capabilities become, the greater the risk of proliferation.

While the greatest concern with respect to latency is the establishment of enrichment or reprocessing, it should not be overlooked that there are other pathways to nuclear latency. One is producing and stockpiling low burn-up fuel, e.g., through operating on-load refueling reactors, large research reactors, or fast breeder reactors. Compared with the difficulty of developing uranium enrichment, building a small plutonium extraction plant in the future (e.g., in the form of large hot cells) would not be a major technical challenge.

Some commentators refer to a state with enrichment or reprocessing 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 suitable delivery systems,[10] as well as Japan's longstanding and strongly held commitment against nuclear weapons. Nonetheless, it illustrates the problem of having enrichment and

[10] Some commentators point to Japan's space program as providing ballistic missile capabilities.

reprocessing capabilities in national hands. Even a state as firmly committed to nonproliferation as Japan could change its position in the future. Concern this *could* happen is reinforced by comments from some Japanese political figures about the need to maintain fuel cycle capabilities to ensure a nuclear weapon option.[11]

The issue of nuclear latency is very much in the background in negotiations between the United States and the ROK for the renewal of their nuclear cooperation agreement, where the ROK is seeking consent to undertake enrichment and reprocessing. While there is no serious suggestion that the ROK's intentions are anything but peaceful, it cannot be overlooked that enrichment and reprocessing provide proliferation capabilities—and as with Japan, in the ROK some political figures advocate a nuclear weapon option.[12]

Today, in addition to the five recognized nuclear-weapon states[13] and the other four nuclear-armed states,[14] there are at least eight other states with demonstrated enrichment capability,[15] and four with demonstrated reprocessing capability,[16] ten in all (this total reflects the fact that two of these states have both capabilities). Not all of these are perceived as armed states, but there is no doubt that the larger the number of states so perceived, the greater the potential destabilizing effect on the nonproliferation regime.

As will be discussed, the principal difference between nuclear latency and nuclear hedging, apart from questions of intention, is the timeframe. Nuclear latency refers to the possibility of proliferation some years in the future. However, if there are indications that the state is taking steps to reduce this period, e.g., through weaponization activities or developing nuclear-capable delivery systems, then the state may be approaching—or have crossed—the line between latency and hedging.

[11] 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.

[12] 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&.

[13] The United States, Russia, UK, France, and China.

[14] India, Israel, Pakistan, and North Korea.

[15] Argentina, Australia, Brazil, Germany, Iran, Japan, the Netherlands, and South Africa.

[16] Belgium, Germany, Italy, and Japan.

B) Nuclear hedging

If nuclear latency might be an unintended consequence of having certain technologies, nuclear hedging refers to a deliberate national strategy of establishing the option of acquiring nuclear weapons within a relatively short timeframe. Compared with latency, nuclear hedging has a much shorter time horizon—ranging from several weeks to at most a few years.[17] The shorter timeframe reflects the level of preparation—hedging implies that the state not only has fissile material production capacity, but it is also undertaking at least some weaponization activities and developing or acquiring nuclear-capable delivery systems.

If a number of states engaged in hedging, this 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. 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 earlier. However, some of these indicators will be difficult to detect—so an apparent absence of indicators is not necessarily reassuring—and even if detected, the purpose could be ambiguous. The only visible indicator that a state is hedging may well be that it is pursuing an enrichment or reprocessing program that has no clear civil justification.

The Challenge for the NPT and 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 the 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.

Recent research has brought to light that during the NPT negotiations UK officials warned their U.S. counterparts that *centrifuge enrichment*

[17] Ariel Levite, "Never Say Never Again," *International Security* 27, No. 3 (Winter 2002/03): pp. 59—88.

presented a serious risk to the NPT's objectives.[18] 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 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[19] *adequate warning time cannot be guaranteed*. Even if the diversion of enriched uranium from safeguards or the use of a *safeguarded* facility for high enrichment[20] is detected immediately, the time taken 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.[21] There is a real possibility that if a state diverts plutonium and has made the necessary preparations in advance, it could fabricate the plutonium into nuclear weapons before effective international intervention is possible.

It can now be seen that the problem of the spread of enrichment and reprocessing was not well anticipated in the language of the NPT. This makes it all the more important for the international community to focus on how the NPT should be applied in today's circumstances.

One traditional view is that whatever is not specifically prohibited by the NPT is permitted. This view is reflected in the argument by Iran and others that the NPT permits a party to pursue *any* fuel cycle activity so long as this is under safeguards (Iran conveniently overlooks that it has violated this safeguards condition). This position may have seemed reasonable in

[18] John Krige, "The Proliferation Risks of Gas Centrifuge Enrichment at the Dawn of the NPT," *Nonproliferation Review*, 19:2, 219—227, http://www.tandfonline.com/doi/abs/10.1080/10736700.2012.690961#.UYswj7VBO4I.

[19] For example, a state that has an industrial-scale enrichment facility, or the capability to establish undeclared enrichment facilities for upgrading LEU diverted from safeguards.

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

[21] Such as Iran's Arak reactor.

the past, when it was assumed safeguards *could* provide timely warning of misuse of nuclear programs, but it is not appropriate today, when it is clear that in certain situations this assumption is no longer valid.

This brings us to the issue of nuclear hedging. Since the purpose of hedging is to be able to make nuclear weapons, it is essential to gain international recognition that nuclear hedging is *not a peaceful purpose* permitted by the NPT. Nuclear hedging is contrary to the NPT's objectives—the existence of hedging programs will undermine the confidence and stability that the NPT is intended to promote.

At one time the draft NPT contained language that was helpful on this point—the Soviet draft of September 24, 1965, included the following:

Parties to the Treaty not possessing nuclear weapons undertake not to create, manufacture or prepare for the manufacture of nuclear weapons either independently or together with other States, in their own territory or in the territory of other States.

Hedging is clearly *preparing for* the manufacture of nuclear weapons. Regrettably this language did not make it into the final text, but the prohibition on non-nuclear-weapon States "not to manufacture... nuclear weapons" (Article II) should be interpreted as including not to prepare to manufacture nuclear weapons. To "manufacture" cannot be interpreted so narrowly that there is no violation of Article II until a nuclear weapon is fully assembled—this would undermine the practical value of the NPT. Where a State is pursuing enrichment or reprocessing without a clear civil justification, or beyond the scale of its demonstrated civil requirements, there could be good reason to regard this as a step in the manufacture of nuclear weapons, hence beyond the scope of the NPT even if the activity is being carried out (at least for the time being) under safeguards.

Criteria for Assessing the "Peacefulness" of 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-out capability (whether as long-term latency or shorter-term hedging), are outlined in the following discussion. 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.

(i) The state is developing an enrichment and/or reprocessing program that is not commensurate with the scale of its nuclear power program.

Enrichment. There are limited opportunities for a state to legitimately import 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 host state's rationale for the facility was questionable.

If a state seeks to develop its own enrichment technology, this will be very expensive, and it will be difficult for the state to obtain the specialized components and materials needed. The main suppliers of enrichment-related equipment and materials are members of the NSG, applying the NSG Guidelines. An alternative source may be the *black market*, but illicit procurement is a strong negative indicator, see (iii) 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 *20 reactors*—i.e., an enrichment capacity of around 3 million SWU/yr.[22] 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 recycle and transmutation using fast reactors. It is difficult to make a convincing case for a new reprocessing project unless and until fast reactors are established.

[22] SWU is separative work unit, a unit for measuring enrichment effort.

(ii) The state is stockpiling materials of strategic significance, in excess of demonstrated civil requirements.

Examples would be stockpiling of LEU in the form of UF_6 (uranium hexafluoride) in excess of actual fuel requirements (the concern about LEU is its potential use as feedstock for higher enrichment[23]). Other examples would be producing and stockpiling LEU close to the HEU threshold,[24] or producing HEU claimed to be required for future nuclear powered submarines. Another would be stockpiling of separated plutonium in excess of actual fuel needs.

(iii) The state is engaged in illicit procurement of nuclear material, 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.

(iv) The state is establishing facility types, or is engaged in 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, in which plutonium could be separated. Another example is abnormal operation of power reactors (e.g., unscheduled fuel discharges for "technical" reasons), resulting in the state accumulating low burn-up fuel.

(v) The state has 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.

[23] For example, LEU at 5 percent enrichment represents around 70 percent of the enrichment level needed for weapons-grade HEU, i.e. using LEU, weapons grade can be reached quickly with a relatively small number of centrifuges.

[24] LEU at just under 20 percent enrichment represents 90 percent of the enrichment level needed for weapons-grade HEU.

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 in the absence of 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,[25] there is no convincing reason why a state in good nonproliferation standing, with nothing to hide, would refuse to accept this, the most effective form of safeguards.[26]

Other indicators, some of which were discussed earlier, include:

(vi) apparent weaponization activities;

(vii) development of nuclear-capable delivery systems;

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

(ix) involvement of elements of the military in the operation of a "civil" program.

How Criteria Might be Applied

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 could 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 the DPRK.

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 *preventive* 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,[27] which take

[25] 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.

[26] 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 several years ago but has not yet signed it.

[27] INFCIRC/254/Rev.11/Part 1, paragraphs 6 and 7, http://www.nuclearsuppliersgroup.org/Leng/PDF/

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, which may be of equal or greater concern, and they have little effect against a program that is not dependent on legitimate nuclear transfers.[28]

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 proliferation sensitive nuclear areas such as enrichment and reprocessing. The Security Council could determine in advance, through the application of appropriate criteria, whether a program presented an unacceptable threat, or potential threat, to international peace and security, and could direct that such programs be ended.

One problem is 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. The state might even be found to have started weaponization activities. At that stage, however, it will be very difficult to compel the state to close its enrichment/reprocessing program, and it may well be too late to prevent the misuse of this program.

The current Iranian situation shows the practical difficulties in enforcing international decisions. If the above criteria were in place now, Iran would fail every one. Yet Iran is continuing its nuclear program in defiance of Security Council resolutions, and it seems the only realistic basis for a negotiated outcome is one in which the Iranian enrichment program will continue in some form. Whether this would resolve the problem or simply defer it remains to be seen.

infcirc254r11p1.pdf.

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

An Alternative to National Proliferation-Sensitive Programs

The pursuit of national enrichment and reprocessing programs highlights the latency/hedging dilemma. While every state wants energy security—to which nuclear energy could make an important contribution—this does not necessitate every state, or even many states, having national programs in proliferation-sensitive technologies. Paradoxically, having such programs could be counterproductive to a state's broader security interests, either directly, due to the threat perceptions and reactions of other states, or more generally through a weakening of the nonproliferation regime. A large part of addressing the latency/hedging problem will be to help states to understand this national security paradox.

The only sure way to address the issues of nuclear latency and hedging is to reach international acceptance that proliferation-sensitive stages of the fuel cycle should be under multilateral rather than national control. A new international framework for the nuclear fuel cycle is needed, which emphasizes 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 to guide governments and industry and will contribute to establishing international norms of behavior, including an interpretation of the NPT that appropriately reflects the international interest. A criteria approach may even become the basis for an international approval process for proliferation-sensitive stages of the fuel cycle. Ultimately, however, avoiding latency and hedging will require international support for multilateral fuel cycle approaches.

Chapter 1.5.

NUCLEAR LATENCY AND INDICATORS OF NUCLEAR WEAPONIZATION[29]

Tariq Rauf[30]

This paper discusses the concept of "nuclear latency," followed by a discussion of indicators of nuclear weaponization. A rich literature exists on these issues; nonetheless, they often are discussed even in the expert community in what might be termed a politically motivated or emotional manner. An attempt is made here to discuss these issues in a manner that hopefully is perceived as balanced.

Introduction

The concept of "nuclear latency"[31] refers to a state developing a capability to produce weapon-usable nuclear material along with advanced industrial know-how and infrastructure. Some experts claim that in certain 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. Nuclear latency, however, is a physical or technical capability to make nuclear weapons that has been developed in states with advanced nuclear technology and such capability cannot be

[29] The views expressed in this paper are solely those of the author and do not represent the views of the IAEA nor of any other entity.

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[31] See Scott D. Sagan, "Nuclear Latency and Nuclear Proliferation," Chapter 5 in *Forecasting Nuclear Proliferation in the 21st Century*, vol. I: *The Role of Theory*, ed. William Potter and Gaukhar Mukhatzhanova, 85 (Stanford: Stanford University Press, 2010).

categorized as *inadvertent*—either the capability exists or it does not. The capability is of a technical nature; whether the state chooses to deploy it to make nuclear weapons or not is a political and strategic choice.[32]

A nuclear-weapon-capable state, in other words, with a latent capability, has been characterized as possessing ten economic and technical indicators:[33] national uranium mining activity, indigenous recoverable uranium deposits, metallurgists, steel production, a construction work force, chemical engineers, nitric acid production, electrical production, nuclear engineers, physicists, chemists, and explosives and electronics specialists—all of which are necessary conditions for the production of nuclear weapons.[34] "A country is said to have a latent capacity when it has sufficient technical, industrial, material, and financial resources to support a wholly indigenous weapons program. Even though a State may have a latent capacity, it must still make an explicit decision to develop the particular facilities necessary to create weapons. However, once a State has a latent capacity, it is very difficult—perhaps impossible—to deny it nuclear weapons, since it is in essence self-sufficient. It may still be possible to alter the motivations of the State so as to persuade it not to proceed."[35]

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.

Thus, a state with a nuclear latency capability is limited only by a political decision whether or not to cross the threshold to nuclear weaponization.

[32] See, for example, Jacques E.C. Hymans, "When Does a State Become a 'Nuclear Weapon State'?," *Nonproliferation Review* 17, No.1 (March 2010), http://cns.miis.edu/npr/pdfs/npr_17-1_hymans.pdf.

[33] Sagan, "Nuclear Latency," p. 85.

[34] Latent Capacity Proliferation Model, developed by Stephen M. Meyer, *The Dynamics of Nuclear Proliferation*, (Chicago: University of Chicago Press, 1984) and modified by Richard Stoll of Rice University, http://es.rice.edu/projects/Poli378/Nuclear/Proliferation/model.html.

[35] Ibid.

For example, Japan has developed a complete nuclear fuel cycle, including enrichment and reprocessing, but has a longstanding political commitment to nuclear nonproliferation, albeit it was quite late in acceding to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT),[36] and it lacks weaponization but has a space launch rocket capability that could be easily converted to delivery systems for nuclear payloads should it decide to do so. 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 so, as it already has sizable stocks of separated Pu (albeit under full-scope IAEA 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 space launch vehicle (SLV) program, including the recent launch of the solid-fueled three-stage "Epsilon" rocket, 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, as well as the possibility of "break-out," i.e., weaponizing either clandestinely or after renouncing the NPT and associated IAEA safeguards. The Rokkasho reprocessing plant is difficult to safeguard.[37] Despite this, at present there are no indications of 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; lately, some senior officials have voiced interest in the possible development of nuclear weapons in response to North Korea's nuclear weapon program.

[36] Though Japan signed the NPT on February 3, 1970, it did not ratify it until June 8, 1976.

[37] "Lessons Learned From the Rokkasho Reprocessing Plant (RRP)," available at: https://www.google.at/#q=safeguarding+Rokkasho&spell=1; Frank Barnaby and Shawn Burnie, "Thinking the Unthinkable: Japanese nuclear power and proliferation in East Asia," http://www.cnic.jp/english/publications/pdffiles/ThinkingTheUnthinkable.pdf; and Frank Barnaby and Shawn Burnie, "Can Plutonium Bulk-Handling Facilities, such as the Rokkasho Reprocessing Plant be Adequately Safeguarded?" http://www.greenpeace.org/international/Global/international/planet-2/report/2006/6/planning-for-failure-internat-2.pdf.

With regard to the case of the Republic of Korea (ROK) in the context of nuclear latency and the ROK's interest in enrichment and reprocessing, it should be noted that enrichment and reprocessing is prohibited under the 1992 South-North Denuclearization Agreement, and the ROK 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 the ROK had engaged in undeclared nuclear activities involving sensitive nuclear material and had taken steps to conceal such activity from the IAEA; in its report the IAEA characterized these undeclared nuclear activities as a matter of serious concern. In its defense, the ROK claimed that fifteen scientists had misused a government facility and that the activities were not government sanctioned. The ROK later provided the required cooperation and access to the IAEA to resolve this matter, and with the implementation of an additional protocol to the ROK's comprehensive (NPT) safeguards agreement, the IAEA subsequently was able to conclude that there had not been a diversion of declared nuclear material to nuclear weapons and that there were no indications of undeclared nuclear activities and nuclear material.

Nuclear hedging is a related concept, which refers to putting in place the potential 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, the ROK, Switzerland, and Taiwan (China), among several others, as being close to nuclear hedging.

Given the march of technology and know-how, enrichment and reprocessing (E/R) technologies have disseminated to several states. This was 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. Multilateral approaches to the nuclear fuel cycle have been under consideration in different ways and in different forums since the 1950s, 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) new E/R facilities would be built under multilateral auspices, not national ownership; (2) existing E/R facilities would be converted to multilateral operations; (3) eventually all E/R would be under multilateral arrangements, and this framework would be supplemented 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 being constructed in the United States by the Enrichment Technology Company (ETC, which is a collaboration between URENCO and AREVA), plus the American Centrifuge facility, as well as the new French enrichment facility, are being built under national not multilateral auspices/operations. Further, nuclear-capable states such as Argentina, Australia, Brazil, Canada, Kazakhstan, South Africa, and Ukraine rejected giving up the national enrichment option, as did the Non-Aligned Movement (NAM) States. Nonetheless, in 2010, the IAEA LEU Reserve in Angarsk (Russian Federation) was operational;[38] in March 2011, the UK Nuclear Fuel Assurance (NFA)[39] 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[40] (which will be set up in Ust Kamenogorsk in Kazakhstan); in 2008, the Russian Federation set up the International Uranium Enrichment Center (IUEC)[41] 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 highly-enriched uranium from dismantled nuclear warheads.[42] 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. Thus, the proliferation risks, or nuclear latency and nuclear hedging, created by nationally operated uranium enrichment and plutonium reprocessing facilities continue unabated, held in check only by political commitments to the NPT—a critical Treaty, which increasingly is in a precarious state due to the nuclear-weapon States (NWS) reneging on nuclear disarmament obligations, the failure to establish a nuclear-weapon-free zone in the Middle East, and the lack of universality, among other challenges.

To deal with the risks created by the spread of enrichment and reprocessing technologies and capabilities, 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,[43] 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 with 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.[44]

Indicators of Nuclear Weaponization

In the context of nuclear latency and nuclear hedging, 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

38 "Russia Inaugurates World's First Low Enriched Uranium Reserve," http://www.iaea.org/newscenter/news/2010/leureserve.html.
39 "Nuclear Fuel Assurance (NFA)," http://www.iaea.org/OurWork/ST/NE/NEFW/Assurance-of-Supply/nuclear-fuel-assurance.html.
40 "IAEA LEU Bank," http://www.iaea.org/OurWork/ST/NE/NEFW/Assurance-of-Supply/iaea-leu-bank.html.
41 "IUEC and the LEU Guaranteed Reserve," http://www.iaea.org/OurWork/ST/NE/NEFW/Assurance-of-Supply/iuec.html.
42 U.S. National Nuclear Security Administration (NNSA), "DOE, NNSA Announce Availability of Reserve Stockpile of Nuclear Power Reactor Fuel Material from Down-blending of Surplus Weapons-Usable Uranium," http://nnsa.energy.gov/mediaroom/pressreleases/doennsaafs81811.

43 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.
44 Tariq Rauf and Zoryana Vovchok, "A Secure Nuclear Future," IAEA Bulletin, September 2009, http://www.iaea.org/Publications/Magazines/Bulletin/Bull511/51104871013.pdf; and Tariq Rauf and Zoryana Vovchok, "Fuel for Thought," IAEA Bulletin, http://www.iaea.org/Publications/Magazines/Bulletin/Bull492/49204845963.html.

uncertainty about such efforts have repeatedly led 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, assassination of nuclear scientists, 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 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 the 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[45] 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 is also 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.

45 "The Conceptualization and Development of Safeguards Implementation at the State Level," IAEA, August 12, 2013, http://armscontrollaw.files.wordpress.com/2012/06/state-level-safeguards-concept-report-august-2013.pdf.

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.[46]

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 time line only in abstract terms for nuclear-weapon development. According to the IAEA safeguards glossary, a significant quantity (the estimated quantity of materials sufficient for a weapon) is 8 kg of Pu 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

46 See, for example, Sonali Singh, "The Correlates of Nuclear Proliferation: A Quantitative Test," *Journal of Conflict Resolution* 48, No. 6 (December 2004): 859—885, http://jcr.sagepub.com/content/48/6/859.abstract; Los Alamos National Laboratory, "Nuclear Weapons Development: From Decision to Delivery," Report LA-UR-07-3211, http://www.lanl.gov/orgs/nso/docs/fy07/LA-UR-07-3211_Nuclear_Weapons_Development_From Decision_to_ Delivery.pdf; and Richard R. Paternoster, "Nuclear weapon proliferation indicators and observables," Los Alamos National Laboratory, December 1992.

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 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 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 bridgewire, diagnostic equipment, and single-use equipment such as neutron generators are 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 acquisition signatures.

Weaponization

Weaponization comprises a series of nuclear-weapon development activities, from device design to component engineering to non-nuclear testing, that 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 the DPRK 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 the 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—and in Israel, South Africa, India, Pakistan, and the DPRK 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 and 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 the ROK, indicators of nuclear weapon development (virtual or actual) may include decisions to shorten lead times for capabilities to develop and produce nuclear weapons and 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, ubiquitous availability of satellite imagery, national technical means, and related capabilities, clandestine production of SNM runs an unacceptably high risk of detection—the DPRK and Iran are cases in point. Thus, with a strengthened IAEA safeguards system supplemented by additional information and data sources, the probability of detection of 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 of 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, short of a global prohibition on nuclear weapons, supported by robust verification authority and supplemented by multilateralizing the sensitive parts of the nuclear fuel cycle.[47]

[47] See Tariq Rauf, "The Roles and Responsibilities of Nuclear-weapon Possessing States and Non-nuclear-weapon States," presentation at the Open-Ended Working Group (United Nations General Assembly (UNGA) RES 67/56), Taking Forward Multilateral Nuclear Disarmament Negotiations (Geneva, May 23, 2013), http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/OEWG/statements/23May_Rauf.pdf.

PART II.

TECHNICAL ASPECTS OF NUCLEAR WEAPONS DEVELOPMENT

Chapter 2.1.
NUCLEAR WEAPONS AND DELIVERY VEHICLES

Vladimir Dvorkin[48]

In the context of the whole secure nuclear tolerance concept, the purpose of analyzing the processes of development of nuclear weapons and missiles should be primarily to assess the path that countries must traverse if they plan to create such weapons. This pertains to countries that are advancing toward the red line either overtly or covertly.

The experiences of the USSR/Russia, the United States, the United Kingdom, France, China, India, Pakistan, Israel, and North Korea in the development of nuclear missile weapons demonstrate certain necessary stages along this path. These include research and development efforts consisting of laboratory tests and integrated tests and the optimization of liquid fuel and dry fuel propulsion systems on test benches. The duration of these stages ranges from five to ten years. The next most crucial stage is flight tests. In the experience of the Big Five nuclear powers, flight tests of new missile systems in the twentieth century involved launches of fifteen to twenty missiles, some of which terminated in accidents in the initial stages. The duration of flight tests ranged from two to five years.

As a rule, the stages in the development of warheads suitable for ballistic and cruise missiles and air bombs took no longer than the development of delivery vehicles.

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After flight tests have been completed, the process of deploying missiles and making them operational begins, although these processes would often begin even before flight tests were completed.

The experience of the Big Five nuclear powers in the creation of missiles coincides to a certain degree with similar processes that took place in India, Israel, and Pakistan. However, where there are fewer launches, flight testing always takes longer.

The possibilities of external monitoring over all of these processes differ to a great degree due to the influence of a number of factors. Among other things, this was previously dependent on the state of national surveillance systems, i.e., photographic, optical-electronic, and radio monitoring capabilities.

During the initial stages, it was possible to monitor missile flight trajectory and telemetric signals from missiles and warheads. However, those signals were insufficiently informative. Moreover, in the Soviet Union, in order to prevent telemetric signals from being monitored, information coming from missiles was encrypted. Encryption was not used in the United States, but the transmission form was such that it was very difficult to qualify the signals, especially when the signals characterizing flight processes were transmitted continuously. It was possible to identify certain parameter signals, for example, the separation of warheads from reentry vehicles. And it was possible to evaluate missile characteristics only under the terms of the START-I Treaty, when the parties exchanged not only magnetic tapes with telemetry recordings from the missiles, but also the so-called calibration data.

Later, when spy spacecraft became significantly more advanced, ground tests could be monitored, including, for example, bench firing tests of missile propulsion systems. Such tests were most reliable when performed on open test benches. Subsequently, closed circuit bench test facilities that did not emit combustion products into the atmosphere were created.

It should be possible to take advantage of the experience gained to predict the processes of the creation of warheads and delivery vehicles in today's conditions with respect to countries that are planning to create nuclear weapons. In particular, the easiest thing to accomplish would be to monitor how developed countries with stable regimes and democratic or similar forms of government create nuclear missile weapons. To a significant degree, such countries will have to repeat the processes of developing such weapons that other nuclear countries have experienced.

At the same time, there are dozens of non-nuclear countries that possess missiles, but special conditions are required to equip those missiles with nuclear warheads, especially if the warheads are to be deployed on mid-range and long-range missiles. For example, nuclear warheads require lower internal temperatures upon entry into the dense layers of the atmosphere, a more robust reentry vehicle body, and a lower level of vibrations than warheads containing conventional explosives.

Intercepted telemetric information has to be analyzed in order to determine how previous flight tests were different from subsequent ones, while taking these preconditions into account. However, it would be practically impossible to determine the absolute values of the operational processes of missile systems in flight, but, in a sequence of launches, it should be entirely possible to compare parameters that have to do with how nuclear warheads are placed inside reentry vehicles.

It's extremely important to be able to assess the nature of parameter signals (or flags), which is an easier task to accomplish. For example, if parameter signals in flight tests show that there are warheads moving at an altitude of 300—600 meters, this could be indicative of a system test to detonate nuclear warheads, since there is no sense in detonating a conventional warhead at such an altitude. By the same token, experts should be aware of some other differences.

It's significantly more difficult, but still possible, to apply the experience described above to countries with abhorrent and secretive regimes. And the attitude toward them in terms of them approaching the red line and preventing them from approaching it needs to be different.

It is well known how North Korea created its nuclear weapons, and there were no special differences there as compared with other countries. But the experience of its extended range missile development 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 using that same missile. Other states with space programs had not been able to do this before. At the same time, the energy performance of this type of missile makes it entirely capable of carrying a nuclear warhead. And that is already a clear threat, since similar regimes in an emergency may make the disastrous decision to launch such missiles with nuclear warheads without paying attention to their extremely low level of reliability.

Light spacecraft have also been launched in Iran, but, according to available estimates, the delivery vehicles deployed so far cannot be equipped with nuclear warheads. Nevertheless, Iranian *Shahab-3* and *Sajjil* 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, and such missiles can also be equipped with nuclear warheads. Therefore, monitoring should be primarily concerned with the illegal development of such warheads. It is relatively easier to monitor the development of such warheads in countries that have ratified the 1997 Additional Protocol, but 22 states remain outside the area of the Protocol's application.

It must be kept in mind that, generally speaking, any single-body ballistic missile built by developing states that carries a payload of 500—1000 kilograms can be armed with a nuclear warhead. However, if such a missile were to be armed with a multiple reentry vehicle, approximately half of the missile's throw-weight would be taken up by the booster guidance system and post-boost vehicle (multiple warhead dispensing mechanism). It would likely be impossible to arm such a missile with multiple nuclear warheads.

Finally, it should be underscored that ballistic missiles are by far not the only delivery vehicles available for nuclear warheads. Nuclear air bombs can be deployed on many types of aircraft, including fighters. For example, Iran possesses twelve domestically produced *Azarakhsh* and *Saeqeh* fighters capable of carrying a load of 3.5—4.4 tons, as well as approximately 120 American F-5 fighters with a payload of 2.8—3.2 tons. Given this payload capacity, there is no need to minimize the mass and dimensions of nuclear warheads, as would be required to arm ballistic missiles. Dozens of non-nuclear States Party to the NPT possess significant quantities of similar and even more diverse types of aircraft.

It is unquestionable that the reliability of delivering nuclear warheads on aircraft may be reduced significantly by an advanced air defense system, although it can never be reduced to zero.

Ships with a very broad range of tonnage can be used as the carriers of nuclear weapons. A very simple nuclear explosive device with a mass of several tons can be loaded onto a ship and activated at any major seaport.

Under these conditions, we are left to rely upon the operations of leading states' intelligence communities and currently effective shipping control systems. Cooperation between intelligence agencies and shipping control systems does exist, but there remains significant room to improve its effectiveness.

Whether or not it is possible to monitor the creation of nuclear warheads and nuclear explosive devices depends on the types of those devices. The most obvious evidence of the process of creation of nuclear warheads and nuclear explosive devices is the conduct of nuclear testing. But the possibility remains that a state developing such weapons may choose not to conduct experimental nuclear explosions with weapons-grade uranium devices.

Detailed descriptions of the designs of such devices, their contents, the required materials, etc., can be found not only on the Internet, but also in generally accessible technical documentation accumulated over several decades.

Warheads that use plutonium require significantly higher technological experience in manufacturing, so it's entirely likely that they need to be tested.

It is extremely difficult to monitor the processes of the warheads' design development itself. And it is completely impossible to do so in countries that have not ratified the 1997 Additional Protocol, since such operations may be conducted in secret at any technological research institute or in an industrial design organization not connected to the nuclear infrastructure.

Thus, the task of monitoring states' progress toward the red line is a complex scientific and technical challenge. The IAEA has many highly-qualified inspectors at its service, but they cannot deal with challenges of instrumental verification of potential nuclear weapons delivery vehicles (for example, analysis of findings from ballistic and telemetry data).

Under these conditions, it is expedient to consider the possibility of forming a special closed Center (or Agency), mentioned in Chapter 1.1., 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 surveillance systems of China, France, Germany, Russia, the United Kingdom, and the United States (including optical-electronic, radio, and other assets), but also real-time intelligence information. The Center should be manned by highly-qualified specialists from the leading countries. The UN Security Council could make the decision to create and finance the Center.

Chapter 2.2.
PROBLEMS OF MONITORING NUCLEAR POWER ENERGETICS IN NON-NUCLEAR-WEAPON STATES

Anatoliy Diakov[49]

Atomic energy, which emerged as a byproduct of the implementation of nuclear weapons programs, plays a significant role in global electric power generation. At present, many countries that do not have nuclear energy capabilities have been demonstrating interest in the creation and development of such facilities. The main factors that have brought about and stimulated the growing interest in atomic energy are limited reserves of hydrocarbon fuel and the growing cost of such fuel, as well as the need to reduce greenhouse gas emissions, which lead to climate change.

However, the expected spread of nuclear energy and nuclear fuel cycle technologies—i.e. uranium enrichment and/or processing of spent nuclear fuel (SNF)—creates the greatest risks for the nuclear nonproliferation regime. Possession of the technologies of uranium enrichment and/or SNF reprocessing makes it possible for countries to produce weapons-grade nuclear materials and create nuclear weapons. As the example of North Korea has shown, this possibility may be realized by a country even if it is a Member State of the Nuclear Weapons Non-Proliferation Treaty (NPT) and its nuclear enterprises are under IAEA supervision. Therefore, the expected wide application of peaceful atomic energy is a natural cause for concern, and it demands a search for solutions that will eliminate risks to the nuclear nonproliferation regime.

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The current state and prospects of nuclear power development. At present, 434 power reactors with a combined capacity of 373.9 gigawatts (electric output), providing approximately 14 percent of global energy production, are in operation in 31 countries of the world.[50] According to the latest projections, 156 of the world's currently functioning nuclear reactors will be decommissioned and 298 new nuclear power reactors will be commissioned by 2030. Thus, the capacity of the world's nuclear power plants may reach the level of 570 gigawatts by 2030.

The disaster at Japan's Fukushima I Nuclear Power Plant in March 2011 may alter the timeframes for the implementation of certain countries' plans for the creation and development of nuclear power, but it will not alter the global trend of atomic energy growth. China, France, Russia, the United Kingdom, the United States, and other countries have declared unambiguously that they will not repudiate development of nuclear power because of the Fukushima events. The construction of new nuclear reactors continues in many countries. At the end of 2012, there were 69 reactors in the construction phase around the world, with a combined capacity of 66.8 gigawatts (electric output).[51] Forty-one of those 69 reactors are being built in the countries of the Far East and South Asia (28 in China, seven in India, four in Korea, and two in Japan).[52]

There are two factors that must be noted in the observed growth of interest in the wider application of atomic energy in the world, which some experts are calling a "nuclear renaissance." The first relates to the growth of nuclear power in countries that already have nuclear power plants and nuclear fuel cycle enterprises.

The second factor relates to the acquisition of nuclear power plants and respective nuclear fuel cycle technologies by new states that have yet to enter the circle of countries that possess atomic power generation facilities. It has been established that over 50 countries have applied to the IAEA for consultation and technical assistance in the development

[50] World Nuclear Association, "World Nuclear Power Reactors & Uranium Requirements," Information Library (London, April 1, 2014), http://www.world-nuclear.org/info/Facts-and-Figures/World-Nuclear-Power-Reactors-and-Uranium-Requirements/.
[51] Ibid.
[52] IAEA, "Under Construction Reactors," World Statistics (Vienna), http://www.iaea.org/PRIS/WorldStatistics/UnderConstructionReactorsByCountry.aspx.

of their own national atomic energy programs.[53] Bangladesh, Belarus, Jordan, Nigeria, Turkey, Vietnam, and the United Arab Emirates have already begun implementing plans for the creation of nuclear power generation systems.[54]

Why does the increasing number of new countries possessing sensitive nuclear fuel cycle technologies create potential risks for the nuclear weapons nonproliferation regime?

The nuclear fuel cycle. Energy is produced at nuclear power plants by means of a controlled fission chain reaction of uranium and/or plutonium isotopes. The primary component in the fuel of most modern power reactors is U-235. Along with uranium fuel, MOX fuel, in which plutonium is the principle fissile material, is produced and used in a number of European countries, e.g., France. It must be noted that fission of the same uranium and plutonium isotopes in an uncontrolled chain reaction is what creates the energy release in the detonation of a nuclear warhead.

Natural uranium contains approximately 0.7 percent U-235, i.e. the uranium isotope with mass number 235, and 99.3 percent U-238. Of those two isotopes, only U-235 is capable of maintaining a fission chain reaction that produces a release of energy. It is impossible to bring about an explosive fission reaction in natural uranium, and therefore it cannot be used to create weapons. According to the IAEA definition, uranium with a U-235 concentration of over 20 percent is a "direct-use" material and can be readily used to create a comparatively compact explosive device. Uranium enriched to over 90 percent U-235 content is classified as weapons-grade material and is used in nuclear weapons. Obtaining uranium with a U-235 concentration above that found in nature requires the application of a rather complicated isotope separation technology.

Plutonium is absent in nature and is an artificially produced element. It forms as the result of a U-238 nucleus capturing a neutron and a subsequent decay chain of the short-lived isotopes U-239 and Np-239 into Pu-239. The most appropriate device for the production of plutonium is a nuclear reactor that runs on natural or low-enriched uranium fuel. By means of the process described above, plutonium accumulates in the fuel as the reactor runs. That plutonium can be separated through chemical processing of the spent nuclear fuel.

[53] Steven E. Miller and Scott D. Sagan, "Nuclear power without proliferation," *Daedalus* 1 (Fall 2009).

[54] IAEA Director General Yukiya Amano, Opening Statement at IAEA Ministerial Conference on Nuclear Power in the 21st Century, http://nuclearforum2013.org/media/news/1261/.

The nuclear fuel cycle is conventionally divided into two stages: an initial or "front-end" stage and a final or "back-end" stage. The front-end stage of the nuclear fuel cycle begins with the extraction of uranium ore and production of U_2O_6 uranium concentrate. Then the uranium concentrate undergoes a conversion process, which produces uranium hexafluoride, UF_6. Uranium hexafluoride is fed to enrichment enterprises, where enrichment of the U-235 isotope, capable of maintaining a nuclear chain reaction, is conducted. The product of the enrichment facility is sent to enterprises where it is converted into uranium oxide, UO_2, which, in its turn, is used to manufacture nuclear fuel. As a rule, commercial thermal-neutron power reactors run on fuel made of uranium enriched to no more than 5 percent.

The back-end stage of the nuclear fuel cycle includes an operation in which the spent nuclear fuel is held in pools for the purpose of lowering its temperature. Spent nuclear fuel contains mostly uranium with about 1 percent enrichment, plutonium, and the products of radioactive decay. The plutonium content in spent nuclear fuel reaches 5—8 kilograms per ton of fuel. Depending on the disposal system applied, after the spent nuclear fuel is held for 3—5 years, it is sent either for radiochemical processing or for permanent storage. Radiochemical processing produces uranium, plutonium, and highly radioactive waste. The waste is sent for burial, while the uranium and plutonium can be used again to produce nuclear fuel.

It is important to note that the elements of the uranium chain in the initial stage of the nuclear fuel cycle and the plutonium chain in the final stage are exactly the same as those used in the technology of producing weapons-grade fissile materials. There is no question that not all elements of the nuclear fuel cycle are equally critical for the nonproliferation regime. The most sensitive elements of the cycle are the enrichment and processing of spent nuclear fuel.

Nearly all industrial enrichment enterprises in the world use a uranium enrichment technology based on the method of separating isotopes in gas centrifuges. There are currently only fourteen countries that have the technology and enterprises for the enrichment of uranium.[55]

It should be noted that due to a number of technical factors, it is the centrifuge method of uranium enrichment that creates the most serious risk to the nonproliferation regime. First of all, a uranium enrichment facility that uses gas centrifuges can be converted from the production of low-enriched to highly-enriched uranium within just a few days. This makes it possible for a state to "break out" from the NPT by quickly converting a civilian technology to military purposes. Second, it is difficult to uncover a hidden centrifuge-based uranium enrichment facility. A plant that occupies a small area is capable of producing a sufficient quantity of highly-enriched uranium over the course of a year to create one or two nuclear warheads.

The processing of spent nuclear fuel also poses a serious risk to the nonproliferation regime, since one of the results of that process is the separation of plutonium. As noted above, spent nuclear fuel in all types of reactors contains a certain quantity of plutonium. However, if the fuel is not processed, then the plutonium is relatively inaccessible due to the high level of radioactivity of the spent fuel. In technical terms, the technology of processing spent fuel is not a secret, since it has been described in sufficient detail in the technical literature. At the same time, the practical implementation of spent fuel reprocessing requires experience in creating reliable protection from radiation, the use of remotely controlled manipulators, and, as a result, great expenses.

Thus, the spread of nuclear power and the technologies of uranium enrichment and spent nuclear fuel reprocessing among a large number of countries will naturally create potential risks to the NPT regime. As the example of North Korea shows, **if a country has such technologies at its disposal, it is capable of creating nuclear weapons relatively quickly even if it is a Member State of the NPT and its nuclear fuel cycle enterprises are under IAEA supervision.**

[55] The countries that possess technology and/or enterprises for uranium enrichment include Brazil, China, France, Germany, India, Iran, Israel, Japan, the Netherlands, North Korea, Pakistan, Russia, the United Kingdom, and the United States.

Preventing the Proliferation of Nuclear Fuel Cycle Technologies in a Context of Broad Development of Nuclear Power

The nuclear weapons creation program successfully completed by North Korea—concealed during the initial stage by a nuclear power development program—shows that it is necessary to develop and undertake measures that minimize the risks of similar occurrences repeating in the future.

Certain countries that are pursuing plans to develop nuclear energy have already declared that they have the right and plans to acquire all the elements of nuclear infrastructure, including nuclear fuel cycle technologies. It must be noted that the Nuclear Weapons Non-Proliferation Treaty (NPT) does, in fact, establish that countries have this right.

As mentioned above, the NPT does not prevent the peaceful development and use of atomic energy. Article IV of the NPT asserts that "Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes."

However, while the NPT prescribes a right to the peaceful use of atomic energy, it imposes entirely specific obligations on Parties to the Treaty. Under Article II of the NPT, "Each non-nuclear-weapon State Party to the Treaty undertakes... not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices..."

The fact that the NPT contains the right to develop the nuclear fuel cycle—which is essentially a loophole in the nonproliferation regime—naturally raises questions both as to the NPT's congruence with the goals of nonproliferation and as to the Treaty's capacity to protect international security adequately from new threats as they appear. In contemporary conditions, when the main threats to peace involve nuclear terrorism and countries that strive to obtain nuclear weapons, there is a need to seek solutions that would prevent the wide spread of nuclear fuel cycle technologies without amending the letter of the NPT and without restricting the right of countries to generate nuclear power.

It is the opinion of many experts that it will be possible to resolve the problem of preventing the spread of nuclear fuel cycle technologies while the number of countries that use atomic energy is expanding by creating guarantees ensuring the provision of nuclear fuel cycle services, as well as by fortifying the system of IAEA safeguards. A follow-up measure could be to create institutional barriers. Supplier countries can play an important role by offering countries that are just now beginning to develop nuclear technologies various incentives for the acquisition of nuclear technologies and services from those suppliers.

All of these measures as a whole would provide countries new to nuclear technologies with an incentive to renounce the acquisition of nuclear fuel cycle technologies voluntarily without creating legal barriers to their development and the use of atomic energy.

Guaranteed provision of nuclear fuel cycle services. The main factors that motivate countries to obtain nuclear fuel cycle technologies are typically identified as the following: ensuring energy independence and security, ensuring national security and prestige through having the potential to create nuclear weapons, and gaining economic advantages.

Brazil, Iran, and South Korea can be tentatively identified as countries that are developing nuclear fuel cycle technologies for the first and second reasons listed above. Moreover, those two motivating factors may be present in various combinations, or the first may be an official pretext for the second.

The economic advantages argument for countries new to atomic energy appears to be highly questionable. This follows from the fact that the cost of nuclear fuel, including the cost of uranium and its enrichment, has an insignificant impact on the cost of generating electric power by means of nuclear power plants. Even if the cost of natural uranium increases by ten times (i.e. from $30 to $300 U.S. per kilogram), the cost of producing a kilowatt-hour of electricity will rise no more than 20 percent.[56] Similarly, a doubling of the cost per separative work unit will cause the cost of a kilowatt-hour to rise by just a few percentage points.[57] Therefore, it is not a convincing motivation for a country to obtain its own nuclear fuel cycle technologies for the purpose of gaining an economic advantage in producing electric power at nuclear power plants.

[56] William C. Sailor and Erich Schneider, *Nuclear Fusion*, Los Alamos National Laboratory, August 31, 2005.
[57] Harold Feiveson, "Managing the Civilian Nuclear Fuel Cycle" in the *Global Fissile Material Report 2007*, www.fissilematerials.org.

The only argument in favor of acquiring nuclear fuel cycle technologies that deserves attention is ensuring energy security. At one time, Japan used this argument actively to justify its reprocessing of spent nuclear fuel.

However, the justification of such arguments requires study of the capacity of international markets to provide guaranteed and reliable supplies of the entire set of products and services associated with the civilian-purpose nuclear fuel cycle, and primarily the supply of uranium and uranium enrichment services. Without such guarantees being provided, it is difficult to expect that states (especially so-called "problem states") will renounce their nuclear fuel cycle enterprises.

It must be noted that the uranium and nuclear fuel market has demonstrated high standards of reliability of supplies since the very beginning of atomic energy. It has never happened that power reactors had to be shut down because of interruptions in fuel supplies. The capacities of extant uranium enrichment facilities in the world will continue to exceed demand in the short term. Current world demand for uranium enrichment services amounts to approximately 50 million separative work units, which corresponds to the capacity of enrichment enterprises in the world.[58] If atomic energy continues to develop (reaching a total capacity of 600 gigawatts in 2030), assuming that only light water reactors will be in operation, the annual requirement for such services will reach the level of 60—66 million separative work units, while the combined capacity of the world's enrichment enterprises will reach the level of 72—95 separative work units. At present, four companies, including EURODIF, Urenco, USEC, and TENEX, provide for 85 percent of the market's demand for uranium enrichment services. In light of the potentials of these companies, it is believed that in terms of technological and economic opportunities, the market is capable of guaranteeing that demand for enrichment services will be satisfied under any development scenario of global atomic energy.

Thus, the risk of a consumer failing to obtain nuclear fuel cycle services on the market could be caused exclusively by political reasons. That is why it becomes necessary to create conditions under which any consumer that

[58] World Nuclear Association, "Uranium Enrichment," Information Library (London, October, 2013), http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Uranium-Enrichment/.

strictly follows the duties that it undertakes to comply with the nonproliferation regime must have solid guarantees that it will receive nuclear fuel cycle services. According to former Director General of the IAEA ElBaradei, this can be achieved through the development and creation of a multilateral nuclear fuel cycle mechanism.[59]

The task of creating such a mechanism has prompted the appearance of a number of initiatives that could both **prevent** the proliferation of sensitive nuclear technologies while the number of countries developing nuclear power is increasing and, at the same time, **guarantee** nondiscriminatory access for countries new to atomic energy to external sources of nuclear fuel cycle services and products. Twelve such initiatives were proposed by various states during 1995—2007, inclusively.

One of those initiatives would have had states that do not already possess technologies for uranium enrichment and spent nuclear fuel reprocessing renounce the acquisition of such technologies under the conditions that those states receive guaranteed nuclear fuel cycle services and that they perform their duties under the NPT. However, that initiative did not receive support, since implementing it would have involved creating yet another discriminatory division among NPT Member States. That is, in addition to the already existing division between "legally" nuclear states and non-nuclear states, states would be categorized as either being allowed or forbidden nuclear fuel cycle technologies. Many countries believe that restrictions on the development of technologies should be universal for all countries of the international community and should not permit things to some states and forbid them to others. Furthermore, implementing that initiative would have required revising the NPT. In other words, the Treaty would have had to be "opened up."

Two of the initiatives, both proposed by Russia, have already been implemented. The initiative that Russian President V. V. Putin proposed in 2006 involves creating a system of centers for the provision of nuclear fuel cycle services, including uranium enrichment and disposal of spent nuclear fuel, under the control of the IAEA. The first project for the implementation of this

[59] IAEA Director General Dr. Mohamed El-Baradei, "A New Framework for the Nuclear Fuel Cycle," Statement at Special Event (Vienna, Austria, September 19, 2006), http://www.iaea.org/about/policy/GC/GC50/Site Event/index.html.

initiative was the International Uranium Enrichment Center (IUEC), created jointly by Russia and Kazakhstan in 2007 on the basis of the enrichment facilities at the Angarsk Electrolysis Chemical Complex.[60] Formed as a joint-stock company, the IUEC allows interested countries to join it. The center's productive facilities have been put under IAEA safeguards. At present, Russia, Armenia, Kazakhstan, and Ukraine are co-owners of the IUEC.

The main task of the IUEC is to provide guaranteed access to uranium enrichment services to IUEC member organizations from states that have signed a respective intergovernmental agreement with the Russian Federation. Any country that intends to develop peaceful atomic energy executes an intergovernmental agreement with Russia and gains the opportunity to become a full-fledged founder, i.e. shareholder, of the IUEC. Besides obtaining guaranteed supplies of low-enriched uranium or provision of uranium enrichment services, an IUEC co-founder likewise takes part in managing the center, has all information on prices and contract terms, and receives its share of the income of this quite profitable business. However, foreign members of the IUEC do not have access to uranium enrichment technologies. On the other hand, executing such an agreement does not obligate a state to renounce its own independent development of uranium enrichment facilities.

The other Russian initiative was to create a reserve of low-enriched uranium at the IUEC for the purpose of creating an insurance mechanism under the aegis of the IAEA. The reserve of low-enriched uranium could be used by a state that is unable to obtain the low-enriched uranium that it needs to produce nuclear fuel for its nuclear power plants on the international market for political reasons. In furtherance of this initiative, Russia and the IAEA signed a respective agreement in March 2010. Under that agreement, the IUEC is to keep a reserve of 120 tons of enriched uranium hexafluoride. That product is to be supplied to a Member State of the IAEA that applies for supply of low-enriched uranium from that reserve. The reserve was first prepared in late November 2010, and Russia itself undertook the responsibility of covering all costs for its creation and storage.

[60] "Glava Rosatoma konstatiruet, chto protsess sozdaniya Mezhdunarodnogo tsentra po obogashcheniyu urana zavershen" [Rosatom head: creation of International Uranium Enrichment Center complete], *RIA Novosti*, May 10, 2007.

Institutional barriers and incentives. Institutional barriers include a number of duties that countries new to atomic energy must undertake in order to receive assistance in the development of atomic energy from nuclear technology supplier countries. Countries new to atomic energy are primarily obligated to develop and adopt laws and create the organizational infrastructure necessary for the secure application of peaceful nuclear power. Those laws and the organizational infrastructure must also guarantee that the state will perform its nonproliferation duties. The adoption and ratification of the 1997 IAEA Additional Protocol on safeguards and accession to the Vienna Convention on Civil Liability for Nuclear Damage should also be important steps.

A document entitled "Milestones in the Development of a National Infrastructure for Nuclear Power" was prepared and published relatively recently by the IAEA. It enumerates the basic elements of infrastructure that a state must have if it wishes to develop the peaceful use of nuclear power. It is obvious that the IAEA should make the decision as to whether a country is ready to develop nuclear power.

In order to keep countries new to atomic energy from perceiving these requirements as the creation of yet another discriminatory regime, it would be expedient for nuclear states to expand the application of the 1997 Additional Protocol to all of their civilian-purpose nuclear infrastructure.

It is also necessary to take advantage of mechanisms that could incentivize countries new to atomic energy to reject the acquisition of nuclear fuel cycle technologies for themselves. For example, offers of financial assistance and assistance in creating nuclear power infrastructure could be made to those countries. Another possible approach could involve the offering of "package" contracts under which the supply of power reactors would be inextricably linked to the supply of fresh fuel and collection of spent nuclear fuel throughout the functional life of that fuel. Such practices can be attractive to countries new to atomic energy, not simply because they guarantee the supply of fresh fuel, but also because they rescue them from the problems of spent nuclear fuel disposal. This removes serious barriers for national atomic energy development programs.

Another attractive mechanism for countries new to atomic energy that makes it possible for them to develop nuclear power would be to have nuclear power plants built in these countries based on the "build, own, operate" principle. This means that the supplier country would not only build the nuclear power plant, but would also own it and carry out all operation of the plant. The supplier country would also be accountable for the power plant's security. It has been proposed to implement such a mechanism in Rosatom's construction of the Akkuyu Nuclear Power Plant in Turkey. The other way to implement such a mechanism would be to supply low-capacity reactors. A reactor built in the supplier country could be delivered to the country new to atomic energy, and the supplier country would then service the reactor during its operations and would be fully accountable for the safety and security of its operations.

Conclusion

It appears that implementation of all of these measures will require incessant and consistent efforts on the part of the great powers and nuclear technology supplier countries over a long period of time. The practical creation of a system of positive and negative incentives that would accord due respect for national laws and the international obligations of supplier countries of nuclear technologies and materials and would not restrict the rights of countries new to atomic energy could make it economically and politically advantageous for those countries to renounce the creation of new national nuclear fuel cycle complexes while carrying out their plans for the use of nuclear energy.

Chapter 2.3.
TECHNOLOGICAL AND INDUSTRIAL POTENTIAL AS A PRECONDITION FOR THE CREATION OF NUCLEAR WEAPONS

Anton Khlopkov[61]

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 respective 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 direction. 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 its plans are to develop nuclear technologies for exclusively peaceful purposes or whether it has secret plans to use the technologies to develop and produce nuclear weapons.

This model can be further elaborated 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, the current analysis will be limited to the basic model set forth above.

These stages in the evolution of states' technological and industrial potential will be examined in greater detail, as well as examples of countries with respective potentials.

Stage 1: 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 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 USSR 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 USSR for training and build a research reactor based on a Soviet design (the IRT-2000). Likewise, the programs also made it possible for Iran to begin training personnel in the United States and build a research reactor following 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.

Approximately 70 countries in the world have now reached the first stage of technological potential. These primarily consist of countries that have at least one nuclear research unit on their territory or plans to build such units that are in the advanced stage of implementation. In particular,

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

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

1. Planning and development work involving the nuclear fuel cycle;
2. Creation of pilot units for conduct of the nuclear fuel cycle;
3. Creation of industrial enterprises that conduct the nuclear fuel cycle.

Furthermore, subcategories can also be added, depending on 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.

It must noted 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 be of concern, 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: 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, Israel, North Korea, and Pakistan.

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 the model in this paper, 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 USSR, never belonged to the third group of states. Those countries' nuclear weapons were brought 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: Conduct of nuclear tests with the purpose of confirming the performance and improvement of the warheads.

The next stage in the development of states' nuclear potentials after weaponization is the conduct of nuclear field tests, which make it possible to verify the performance of the chosen structure of warheads 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:

1. Enrichment of uranium begins to go beyond 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.
2. 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 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, it should be pointed out that the IAEA considers 25 kg of highly-enriched uranium and 8 kg of plutonium with the respective isotopic characteristics to be significant quantity. It is considered that approximately that much nuclear material can be used to manufacture the simplest nuclear explosive device. In contemporary conditions, when atomic 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 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 considered above.

Chapter 2.4.
SCIENTIFIC, TECHNICAL, AND INDUSTRIAL POTENTIAL AS A PRECONDITION FOR NUCLEAR WEAPONS DEVELOPMENT[62]

John Carlson[63]

In 1963 President Kennedy famously predicted that in the 1970s the world could have as many as 25 nuclear-armed states.[64] These remarks gave impetus to the negotiation of the Nuclear Non-Proliferation Treaty (NPT), which established the conditions under which the overwhelming majority of states have renounced the pursuit of nuclear weapons. At this distance, the basis for President Kennedy's prediction is not clear, but presumably it was a combination of factors—states seen to have motivation or interest in developing nuclear weapons (in the pre-NPT period many states were at least considering the option), and states that were industrially advanced and were thought to be capable of producing nuclear weapons if they decided to do so.

Commentators have given various estimates for states that at one time had a serious interest in developing nuclear weapons. Graham Allison, for example, suggests that "At least 13 countries have begun down the path to developing nuclear weapons with serious intent, and were technologically capable of completing the journey, but stopped short of the finish line: Argentina, Australia, Brazil, Canada, Egypt, Iraq, Italy, Libya, Romania, South Korea, Sweden, Taiwan, and Yugoslavia."[65]

[62] The views in this paper are the author's and not necessarily those of NTI.
[63] John Carlson is Counselor, Nuclear Threat Initiative (Australia).
[64] The President's News Conference, March 21, 1963.
[65] Graham Allison, "Nuclear Disorder: Surveying Atomic Threats," *Foreign Affairs* 89, issue 1 (January/February 2010): 74–85.

Without necessarily agreeing with this list—it can be questioned whether all of these had "serious intent"—two observations can be made: this number is somewhat lower than the overall number of states in President Kennedy's prediction, and it is by no means clear that all of these had the necessary technological capability.

This discussion leads to two key questions:

(a) what *is* considered sufficient scientific, technical, and industrial potential for the development of nuclear weapons? and

(b) could states acquire nuclear weapons without having this potential?

It is not helpful to take too broad a view of technological capability, for example to suggest that any industrially advanced state *could* produce nuclear weapons if it decided to. This might be true given unlimited time, but any effort to identify states of potential proliferation risk needs to focus on much more specific indicators than "industrial capability." At the same time, it would be a mistake to think that a state cannot develop or acquire nuclear weapons unless it has a substantial industrial capability.

It has been suggested there are four main stages in the evolution of a state's technological and industrial potential for developing nuclear weapons:

Stage 1: Planning and development of a nuclear infrastructure;
Stage 2: Development of the nuclear fuel cycle, particularly enrichment and/or reprocessing;
Stage 3: Weaponization;
Stage 4: Nuclear testing.

The IAEA describes 70 states as having "significant nuclear activities," which it defines as having nuclear material in a facility or particular type of location, or nuclear material in excess of the exemption limits set out in the standard NPT safeguards agreement. These states are clearly in Stage 1 of the above model. For the most part, these are states that have at least a research reactor or, in the case of 30 states, power reactors. A certain level of nuclear infrastructure—equipment, facilities, and human skills base—is required before a state could realistically plan for nuclear weapon development. Thus, for a state to enter Stage 1 could be seen as an indicator of a long-term interest in nuclear weapons. Most of the states with significant nuclear activities, however, are a long way from having a nuclear weapon capability.

Generally speaking, to produce nuclear weapons a state would need, as a minimum, the capability to enrich uranium and/or to separate plutonium (Stage 2 of the model). There are two important comments to be made here. The first is that a state's development of these capabilities might not be obvious to an observer. An example is where a state establishes covert facilities, as in the cases of Iran, Iraq, Libya, and Syria. Another example is a facility that apparently has a non-fuel-cycle purpose, such as large hot cells said to be for radioisotope processing, but that could be used for plutonium separation. The point is, it is not essential to have a reprocessing plant as such.

The other comment, as I note in my paper *Assessing and Minimising Proliferation Risk*, is that a proliferating state might not have to *produce* fissile material; it may obtain such material, overtly or covertly, elsewhere. There could be cases of states in Stage 1 that already have fissile material and thus are effectively at Stage 2. International efforts to minimize inventories of HEU (highly-enriched uranium) recognize this problem. However, there are no comparable programs to minimize inventories of separated plutonium (such as MOX fuel or plutonium-fueled critical assemblies).

Within these stages there can be intermediate stages and subcategories. As noted above, states can acquire fuel cycle experience and capabilities without obviously embarking on enrichment or reprocessing. It is instructive that all the cases of safeguards non-compliance[66] to date have involved, *inter alia*, misuse of research facilities (typically, undeclared chemical processing of spent fuel pellets or irradiated targets). There is good reason to look carefully at states seeking or developing facilities such as large research reactors and large hot cells. As with enrichment and reprocessing, there are certain research capabilities that would be better conducted at a small number of regional or multilateral centers rather than through a multiplicity of national programs.

[66] The states found by the IAEA as being in non-compliance with their safeguards agreements are the DPRK, Iran, Iraq, Libya, Romania, and Syria.

A serious phenomenon impacting the ability to assess states by their stage of nuclear development is the growth of a black market in nuclear material, equipment, technology, and even weapon designs. If a state is able to buy equipment and technology off the shelf it might not show the usual indicators of *developing* these capabilities. A major example is Libya, which was able to buy a complete, modular, centrifuge enrichment plant from the A. Q. Khan network. All it had to do was connect the modules and the plant was ready for operation. The other major example is the DPRK's construction of a gas-graphite reactor for Syria. These cases show the possibility of states entering Stage 2 without having undertaken the development work—and showing the indicators—usually required for this.

The A. Q. Khan network is known to have supplied weapon designs to Iran and Libya, and quite possibly others. The availability of weapon designs on the black market shows the possibility that states could even bypass Stages 3 and 4.[67] If a state has a complete weapon design, it will not need to undertake development work. Of course, it will need fissile material and the necessary fabrication capability, but the more it can buy off the shelf, the less it will need to develop itself, hence the fewer indicators there are likely to be of what the state is doing. There is even the possibility that a state will not need to conduct nuclear testing, if it is confident that a weapon design it has bought has been tested by the originating state.

While conventional thinking is that a state would want to test a nuclear weapon before deploying it, this depends on the state's assessment of the risks involved. Conducting a test will consume scarce fissile material, and there is the risk of failure—if a failed test is detected, the state's adversaries may be tempted to launch preemptive strikes before the state has the opportunity to solve the problem. On the other side of the risk calculus, if a state deploys untested weapons, would others call its bluff? Since conventional nuclear theory is that nuclear weapons are a deterrent and would only be used *in extremis*, a state might take the risk of skipping Stage 4. For both the state and its adversaries, the situation comes down to an assessment of the credibility of the weapons and the state's ability to deliver them.

[67] While action has been taken to close down the A.Q. Khan network, its activities highlight the need for ongoing vigilance against black market suppliers. The work of the Proliferation Security Initiative is vital here.

Delivery systems are something else that can be bought off the shelf. In the past, the DPRK has sold complete missiles to several states. In more recent times, it has been involved in collaborative missile development programs with Iran and Syria.[68] A state buying an off-the-shelf system does not need to develop its own capability. At the very least the buyer can take advantage of missile testing results from the supplier, so this is another aspect of weaponization (Stage 3) that could be cut short.

Could a state move *downward* through the development stages, for example, where a state renounces an existing nuclear arsenal—as South Africa has done? Here the key point is that once sensitive knowledge is gained it cannot be eliminated—although it is true that over time practical experience and know-how will be lost if a program is terminated. South Africa involved a difficult enrichment process, where the facility was dismantled. In this case it is reasonable to think in terms of a downward movement in capability. Other cases might not be so clear-cut, especially if the state retains enrichment or reprocessing programs.

The model outlined above, with its four stages, provides an excellent starting point on which to base a proliferation risk analysis for various states. However, as discussed here, not all states will fit neatly in this model. It is essential to define more specific indicators, and to design a program of activities for detecting these. Some of these indicators are discussed in my paper (mentioned earlier). It is important to focus attention on this subject, in order to better define not only warning signs, but also the limits of tolerance/accepted rules of behavior for national nuclear programs, and the point at which international engagement should be considered—which needs to be sufficiently far in advance to have a chance of resolving the problem.

68 See, e.g., Joshua Pollack, "Ballistic Trajectory, The Evolution of North Korea's Ballistic Missile Market," *Nonproliferation Review* 18, No. 2 (July 2011), http://cns.miis.edu/npr/pdfs/npr_18-2_pollack_ballistic-trajectory.pdf.

PART III.

ANALYZING THE EXPERIENCE OF THE DEVELOPMENT OF REGIONAL NUCLEAR PROGRAMS

Chapter 3.1.
NORTH KOREA'S SPECIAL PATH TO NUCLEAR WEAPONS

Anatoliy Diakov

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 spent fuel reprocessing plant 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 of the 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 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 that 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 the country. 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.

North Korea also 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 emphasizes the need 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.

Chapter 3.2.
IRAN'S GROWING NUCLEAR WEAPONS CAPABILITY

Mark Fitzpatrick[69]

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

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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[70] 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."[71]

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

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

[71] 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.

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 ongoing 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.[72] 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 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

[72] 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.

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.[73] In Iran's case, the A. Q. Khan network provided nuclear weapons design information[74] and Vyacheslav Danilenko and reportedly other former nuclear weapons scientists provided hands-on assistance.[75]

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.[76] 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.[77] 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 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,

[73] 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.

[74] IAEA, GOV/2011/65, Annex, para 35.

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

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

[77] 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.

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.[78]

To the time line 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.[79] 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 *Sajjil-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 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

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

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

for a nuclear weapon, which in September Prime Minister Benjamin Netanyahu said should be considered to be a red line.[80] 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.[81] Amos Yadlin, former head of Israel's Military Intelligence Directorate, asserted that reconversion could be accomplished in less than a week,[82] 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. Incrementally expanding the enrichment program may be a political tactic to gradually lull the international community into acquiescing to enhanced capabilities, akin to "salami slicing."

[80] Julian Borger, "Israel's Red Line on Iran: 240kg," *Guardian*, November 1, 2012.

[81] Mark Hibbs, "Reconverting Iran's U308 to UF6," *Arms Control Wonk* (April 27, 2013), http://hibbs.armscontrolwonk.com/archive/1748/reconverting-irans-u3o8-to-uf6.

[82] Yaakov Lappin, "Yadlin: Iranian nuclear program crossed 'red line'," *Jerusalem Post*, April 23, 2013.

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 time lines 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.[83]

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 time lines 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.

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.

[83] 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, 2012), http://www.chathamhouse.org/media/comment/view/186019.

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 States Party 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.[84] 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.[85] 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.

[84] Mark Fitzpatrick, *The Iranian Nuclear Crisis: Avoiding Worst-case Outcomes* (London: IISS, 2008).

[85] 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.

Chapter 3.3.
THE EXPERIENCE OF INDIA AND PAKISTAN CREATING NUCLEAR WEAPONS

Petr Topychkanov[86]

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 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."[87] This contradiction can be explained by the fact that, on the

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[87] I. Gandhi, *Articles, Speeches, Interviews*, translated from English by N.V. Alipova and G.A. Pribegina (Moscow: 1975), p. 320.

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 to 1968, 70 percent of Indians supported nuclear weapons.[88] 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 from 1971 to 1973 and prime minister from 1973 to 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."[89]

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

[88] R.K. Betts, "Incentives for Nuclear Weapons: India, Pakistan, Iran," *Asian Survey* 19, No. 11 (November 1979): 1068.

[89] F.H. Khan, *Eating Grass: the Making of the Pakistani Bomb* (Stanford: Stanford University Press, 2012), p. 63.

invariably important for the Indian elite.[90] 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."[91] 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.[92] 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.[93] 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.[94]

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.

An important peculiarity that India and Pakistan share is that there is no consensus among military leaders on the necessity of creating nuclear weapons.[95] 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

[90] 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.

[91] S. Krishna, "The Social Life of a Bomb: India and the Ontology of an 'Overpopulated' Society," in *South Asian Cultures of the Bomb*, ed. I. Abraham, 72 (Bloomington: Indiana University Press, 2009).

[92] "India Test-Fires Agni-V; Joins Elite Missile Club," *Deccan Herald*, Apr. 19, 2012.

[93] S.P. Cohen, *The Idea of Pakistan* (Washington: Brookings Institution Press, 2006), pp. 119—120.

[94] 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.

[95] Betts, "Incentives for Nuclear Weapons," p. 1068; Cohen, *Idea of Pakistan*, pp. 119—120; Khan, *Eating Grass*, p. 80.

political leaders on how to react to the 1998 Indian tests.[96] 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.

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,

[96] Private conversation between the author and the general under condition of anonymity (April 3, 2012, Islamabad).

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.[97] 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.[98]

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[99] and threats to use them. Indian leaders believed that Islamabad had voiced such threats at least twice: in 1986—1987 and in 1990.[100]

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 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.[101]

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

[97] *Prospects for a Proliferation of Nuclear Weapons Over the Next Decade*, National Intelligence Estimate, October 21, 1964, No. 4-2-64, p. 1, http://www.gwu.edu/~nsarchiv/nukevault/ebb401/docs/doc%203.pdf.
[98] See, e.g., M. Edwardes, "India, Pakistan and Nuclear Weapons," *International Affairs* 43, No. 4 (October 1967): 658, 661.
[99] Yadernye ispytaniya dlya obespecheniya natsional'noy bezopasnosti [Nuclear tests to ensure national security]; A.B. Vajpayee, *Indiya na puti v budushchee: 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).
[100] 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.
[101] Cited in: S. Talbott, *Engaging India: Diplomacy, Democracy, and the Bomb* (New Delhi: Penguin Books, 2004), p. 53.

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.[102] 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.[103]

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."[104] 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.[105]

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 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.[106]

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

[102] Subrahmanyam, "Nuclear Deterrence in the Indian Context," pp. 60, 67.
[103] C.U. Bhaskar, "Comparing Nuclear Pledges and Practice: The View From India," in *The China-India Nuclear Crossroads*, ed. and transl. L. Saalman, 36 (Washington: Carnegie Endowment for International Peace, 2012).
[104] Cited in: Khan, *Eating Grass*, p. 50.
[105] "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.
[106] 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, March, 2005); P.V. Topychkanov, "Nuclear Weapons and Strategic Security in South Asia," Working Papers No. 3 (Moscow: Carnegie Moscow Center, 2011), pp. 9—12.

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."[107]

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."[108]

Technological Factors

Apathukatha Sivathanu Pillai, general director of the Russian-Indian joint 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.[109]

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

[107] S. Inderjit, "Advani Tells Pakistan to Roll Back Its Anti-India Policy," *Times of India*, May 19, 1998.
[108] 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.
[109] 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).

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.[110] 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.[111] In essence, with the assistance of other countries, India and Pakistan provided their nuclear programs with the necessary human resources.

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.

[110] M.V. Ramana, "Nuclear Power in India: Failed Past, Dubious Future," in *Gauging U.S.-Indian Strategic Cooperation*, ed. H. Sokolski, 76 (Carlisle: Strategic Studies Institute, 2007).
[111] Khan, *Eating Grass*, pp. 53, 57.

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.[112] These suspicions became certainty after the test of a nuclear explosive device in 1974. The plutonium for the device had been processed in BARC.[113]

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.[114] 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.[115]

This forced Pakistan to shift its attention from the development of a military nuclear program based on plutonium to a program based on uranium. In 1978, a pilot project was launched for the processing of uranium ore in Dera Ghazi Khan, Punjab, and in 1990 in Isakhel, Punjab. 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.[116]

As for the import of nuclear technologies and related technologies and materials, India and Pakistan have been compelled to be both proactive and

[112] Ibid., p. 60.
[113] Ramana, "Nuclear Power in India," p. 76.
[114] Ibid, p. 61.
[115] Betts, "Incentives for Nuclear Weapons," p. 1070.
[116] Khan, *Eating Grass*, p. 185.

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),[117] 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.[118] 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.[119]

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 from 1972 to 1975.[120] 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.

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

i. 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.

ii. 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.

[117] *India's Heavy Water Shortages*, National Security Agency, October 1982, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB187/IN32.pdf.
[118] G. Milhollin, "Stopping the Indian Bomb," *American Journal of International Law* 81 (1987): pp. 596 – 597.
[119] IAEA Nuclear Fuel Cycle Information System, *List of Nuclear Fuel Cycle Facilities*, http://infcis.iaea.org/NFCIS/Facilities/Facilities.
[120] 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).

iii. 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.

iv. 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.

PART IV.

ADDITIONAL MEASURES TO SUPPORT SECURE NUCLEAR TOLERANCE

Chapter 4.1.
CLARIFYING THE RIGHT TO WITHDRAW FROM THE NPT

Alexei Arbatov[121]

One of the most important aspects of nuclear tolerance—the degree to which one is permitted to develop peaceful nuclear energy, which the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) encourages—is a State Party's sovereign right to withdraw from the Treaty. Article X.1 of the NPT establishes that "Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests."[122]

Once the NPT came into force in 1970, the priority in strengthening the nonproliferation regime was to extend the list of States Party to the Treaty as much as possible and to improve the effectiveness of IAEA safeguards and the export controls over transfers of nuclear materials and technologies. However, with the mass accession of new countries to the NPT in the 1990s, the Treaty had become virtually universal in limiting nuclear weapons, and it was the problem of withdrawal from the NPT that became paramount.

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[122] *Yadernoe Nerasprostranenie* [Nuclear Nonproliferation], vol. II, (Moscow: PIR Center, 2002), p. 28.

Four countries are currently outside the Treaty: India, Israel, Pakistan, and North Korea, and all of them already have nuclear arms.

Thus, the only path for the proliferation of nuclear weapons in the future would be for other Member States of the NPT to develop nuclear weapons in secret, in breach of the Treaty, or to opt out of the Treaty and openly acquire nuclear weapons.[123]

Indirectly this also has to do with the threat of nuclear terrorism, since the likelihood of terrorists gaining access to nuclear explosive devices or nuclear materials increases exponentially as the group of nuclear armed states grows, and particularly when they are ruled by ideologically radical regimes. The North Korean precedent in this context is exceptionally symptomatic and dangerous and is, indeed, what prompts such caution over Iran's nuclear program and over the prospect of other non-nuclear NPT States' nuclear programs.

Admittedly, the evidence does suggest that North Korea engaged in secret activities in violation of the NPT, before it publicly withdrew from the Treaty, while Iran is suspected of previous activities in contradiction of IAEA safeguards.[124] Even in the absence of any Treaty violation, however, there is nothing, in theory, to prevent other States from amassing nuclear materials, technology, and specialists within the scope of and with the assistance of the Treaty and then, pending the three months' advance notice required by article X.1, openly and legally withdrawing from the Treaty. As the North Korean example demonstrated during the previous decade, not only does such behavior not trigger effective sanctions or other coercive measures, but it can also provide the means of blackmailing the international community and serve as a bargaining chip to wrest economic and political concessions from other powers.

In that sense, the worst threat derives from the components of the nuclear fuel cycle, primarily from the technologies and facilities for natural uranium enrichment (especially when the country in question has its own

[123] Such a threat could also arise from new future states should they decide to acquire nuclear weapons. However, an examination of this category would go beyond the scope of the present study.

[124] See *Yadernoe Rasprostranenie v Severo-Vostochnoy Azii* [Nuclear Proliferation in Northeast Asia], ed. A. Arbatov and V. Mikheyev (Moscow: Carnegie Moscow Center, 2005); *Ugrozy Nerasprostraneniyu Yadernogo Oruzhiya na Blizhnem i Srednem Vostoke* [Threats to the Nuclear Weapons Nonproliferation Regime in the Greater Middle East], ed. A. Arbatov and V. Naumkin (Moscow: Carnegie Moscow Center, 2005).

natural uranium deposits) and for reprocessing spent nuclear fuel to separate plutonium.[125] The Treaty prohibits neither of these things so long as IAEA safeguards apply. If anything, the NPT can be perceived to promote international transfers of such technologies under article IV, since whole series of States (the DPRK, Germany, Iran, Japan, the Netherlands, and South Korea) acquired or developed their own technologies from abroad within the NPT framework.

Given what happened with North Korea's and Iran's nuclear programs and the international policy response, the problem of withdrawal from the NPT prompts a number of considerations provided below.

The Right to Withdraw

The right to withdraw from the NPT, just as with any other treaty, and, especially with disarmament treaties, is an inalienable part of the sovereignty of any State Party. Any attempt to curb that right (along the lines of the USSR's proposals of the mid-1980s, which called for an agreement to be concluded with the United States that they not exercise their right to withdraw from the ABM Treaty for a predetermined period of time), would be absurd legally and politically untenable. Such treaties refer to the "jeopardy to supreme interests" as a justification for withdrawal, so it would be nonsense to demand that States refrain from exercising that right when faced with a catastrophic threat on that scale. Furthermore, attempts to suppress the right of withdrawal despite the NPT provisions could produce quite the opposite effect with the demise of the Treaty itself. Inasmuch as the Treaty's 190 States Party acceded to the Treaty with all of its provisions intact, including article X.1 on the right of withdrawal, any move to retroactively change one of the most important provisions only stands to make the NPT unravel altogether.

Nonetheless, by the same token, withdrawal from the NPT—now the principal nuclear disarmament treaty, having 189 Member States—cannot be treated as a trifling, routine, and wholly arbitrary act. According to the language of article X.1, withdrawal must be based on very serious motives

[125] See *Yadernoe Oruzhie Posle Kholodnoy Voiny* [Nuclear Weapons After the Cold War], ed. A. Arbatov and V. Dvorkin, 137–362 (Moscow: Rossiyskaya Politicheskaya Entsiklopediya [Russian Political Encyclopedia] (ROSSPEN), 2006).

and entail certain procedures. More importantly, the logic of the Treaty itself would dictate that several important preconditions[126] apply, defining the limits of tolerance in this area of international security.

First of all, it is out of the question that a State should benefit from the international collaboration afforded by the NPT in developing the "peaceful atom" only to go on to withdraw from the Treaty and exploit its military applications.

Second, withdrawal from the Treaty is unacceptable if it is for the purpose of concealing previous violations of the NPT committed while still being a Party to the Treaty.

Third, under no circumstances should the official grounds provided for withdrawal from the Treaty be deemed a mere formality; withdrawal must be justified in complete accordance with the spirit and letter of the Treaty, and in such manner as to indicate the State's true reasons for withdrawing from the NPT and the State's subsequent intentions, thus to enable the international community to determine proper responses.

Fourth, it is for the remaining NPT States Party and the members of the UN Security Council to determine whether a State's motives for withdrawal are in compliance with article X.1, and not for one or several powers alone on their own initiative.

Fifth, it is the sole prerogative of the IAEA, and not that of any power, to establish whether violations of the Treaty have occurred. The same is true of any additional investigation into possible prior violations of the NPT in the event a State should announce its intent to withdraw from the Treaty.

Sixth and finally, the UN Security Council alone is authorized to accept a State's grounds for withdrawal from the NPT as valid or to decide on sanctions or the use of military force (in the event that withdrawal is unjustified or that the IAEA has discovered previous undisclosed violations of the Treaty). There was a good reason for the UN Security Council Member States to assert back in 1992 that the proliferation of weapons of mass destruction constitutes a "threat to international peace and security

[126] Certain of these principles are examined in an article by two of the world's most respected experts in this field, George Bunn and Roland Timerbaev. See: G. Bunn and R. Timerbaev, "Pravo Vykhoda iz DNYAO—Mnenie Dvukh Uchastnikov Peregovorov po Vyrabotke Dogovora" [The Right to Withdraw from the NPT: Opinions of Two NPT Negotiators], *Yaderny Kontrol'* [Nuclear Control], PIR Center, No 3 (2005).

as understood in the UN Charter."[127] Hence a State's withdrawal from the NPT should be treated as a "threat to international security," implying possible responses in line with Articles 41 and 42 of the UN Charter, which envision the possibility of the application of economic sanctions, blockade, or direct use of force.

The cases of North Korea and Iran transgress virtually all of the foregoing fundamental considerations. The permissive attitude adopted by the great powers on these matters is doubtless one of the main reasons for the protracted and menacing security crises stemming from the North Korean and Iranian problems, all of which provides ample lessons to be drawn for the future in order to prevent a recurrence of nuclear proliferation at the hands of other states and to establish clear and definitive bounds to nuclear tolerance.

Grounds for Withdrawal and Prior Notification Period

It is common knowledge that North Korea acceded to the NPT in 1985 at the insistence of the USSR so as to pave the way for cooperation between the two countries in the peaceful use of nuclear energy under Article IV of the NPT. Nonetheless, the safeguards agreement which Pyongyang had to sign with the IAEA within eighteen months of acceding to the Treaty (Article III p.4) was only signed five years later, in 1992.

After the conclusion of the agreement with the IAEA, the first inspections were already unveiling serious discrepancies between the information submitted by Pyongyang and the facts discovered on the ground. IAEA inspectors were mandated to conduct a special inspection that would take them beyond North Korea's declared sites, i.e. to the radioactive waste storage facilities for the Yongbyon reactor, to resolve the inconsistencies, but they were denied access by Pyongyang. Later, in 1993, North Korea announced its decision to withdraw from the Treaty. Pyongyang cited two arguments in defense of its decision: the joint United States-South Korea "Team Spirit" military exercises; and a "lack of impartiality" among the Agency's inspectors requesting the right to a special inspection.[128]

[127] Cited from Ibid., p. 41.

[128] J. Cirincione, J.B. Wolfsthal, and M. Rajkumar, *Deadly Arsenals: Tracking Weapons of Mass Destruction* (Washington: Carnegie Endowment for International Peace, 2002), pp. 241—254.

In no way did such grounds for withdrawal satisfy the requirements of Article X.1, since neither the military exercises (which had been a regular occurrence in the past) nor the "partiality" of the IAEA inspectors could be construed as "exceptional circumstances" "jeopardizing supreme interests," the sole admissible grounds for withdrawal from the NPT.

Hence, Treaty denunciation was a ploy by North Korea to cover up its previous violations committed while still a Party to the NPT, an unacceptable device that should have elicited an appropriate response from the UN Security Council. However, that supreme international body failed to act, despite the unprecedented unanimity that prevailed among its members in the early 1990s in the aftermath of the Cold War. Since China was prepared to veto a UN SC-sponsored resolution on sanctions, the Security Council merely issued an appeal to the DPRK that it allow the special inspection. Pyongyang declined.

Instead of the UN Security Council, the Democratic administration in Washington became the scene of discussions on possible sanctions, including military measures. But no such measures were taken, because during a visit to the DPRK former President of the United States Jimmy Carter persuaded North Korean leader Kim Il Sung to retract the decision to withdraw from the NPT. In exchange, the United States, Japan, and South Korea drew up a package of proposals, which subsequently evolved into the Agreed Framework and the 1994 KEDO project. Pyongyang reversed its decision to withdraw from the NPT one day before the three-month notification prescribed in Article X.1. North Korea's nuclear sites were placed under IAEA control and their further operations were suspended.

Nevertheless, no investigation was ever launched into the alleged NPT violations from 1985 to 1992. Nor did North Korea's illegitimate grounds for its withdrawal from the Treaty in 1993 ever have any legal or political consequences. Due conclusions were never drawn from the UN Security Council's failure to act. All would seem to have been forfeited either for the sake of political pragmatism or expediency, including the gains Western states believed they had scored in ousting Russia from the sphere of nuclear cooperation and political influence over North Korea, which the Soviet Union traditionally had. This later came to have a most adverse impact on the Korean developments.

When North Korea next withdrew from the NPT it was under the George Bush Republican administration, which had taken a harsh stance on North Korea, relegating it to the "Axis of Evil" and condemning the previous administration for flirting with "rogue states." After the disastrous terrorist attacks of September 11, 2001, the rhetoric soared to new heights. The initial success in applying force against the Taliban and Al Qaeda in Afghanistan, preparations for a military invasion of Iraq, and plausible threats against North Korea and Iran provided the backdrop for Pyongyang's decision to withdraw from the NPT.

What served as the ultimate pretext for North Korea's withdrawal was the United States' accusation in October 2002 that North Korea had a secret uranium enrichment program that wasn't placed under IAEA safeguards. The U.S. version was that the North Korean authorities themselves acknowledged the existence of such a program, and, despite North Korean denials, the United States went on to put a halt to all fuel supplies to North Korean thermal power plants, though they had been an integral part of the 1994 KEDO package of agreements. After the failed negotiations in January 2003, Pyongyang notified the UN Security Council of its withdrawal from the NPT, "under the grave situation where our state's supreme interests are most seriously jeopardized."[129] In addition, in referring to its 1993 announcement of withdrawal, which had been retracted one day before the NPT Article X.1-prescribed three-month notification period would have elapsed, the DPRK declared that withdrawal would become effective within one day, i.e., immediately.[130]

This was on all accounts a flagrant breach of the NPT, since North Korea's grounds for withdrawal, unconvincing back in 1993, could scarcely qualify ten years later. As both the grounds for withdrawal and the notification period contradicted the letter of the NPT, this would have qualified for UN Security Council sanctions. However, Russia and China did not support sanctions, insisting on further negotiations. Talks did begin soon afterwards in a six-party format, but with nothing to show for them after several rounds. On October 9, 2006, the DPRK carried out a nuclear test and became the world's ninth nuclear state.

[129] C. Applegarth and R. Tyson, *Major Proposals to Strengthen the Nuclear Nonproliferation Treaty: A Resource Guide* (Washington D.C.: Arms Control Association and Women's International League for Peace and Freedom, 2005), p. 30.

[130] Ibid.

The United States' pressure tactics and its violation of the 1993 agreement would seem to have only further compelled Pyongyang to develop nuclear weapons and furnished it with a pretext to withdraw from the NPT. Moreover, the United States' pullout from the ABM Treaty in 2002 and refusal to ratify the Comprehensive Nuclear-Test-Ban Treaty afforded North Korea the political "indulgence" to withdraw from the NPT and then carry out a nuclear test.[131] But beyond all else, the extremely negative factors were the lack of unity in the UN Security Council and the casual attitude taken by the NPT States and UN Security Council members toward the blatant flouting of article X.1's provisions on the rules of withdrawal.

As distinct from the Korean nuclear saga, Iran's nuclear program and accompanying policies are at an earlier stage. Tehran remains adamant that its nuclear program is strictly peaceful in character and professes allegiance to the NPT, though the signs were there of future disasters in the making. For example, from 2005 to 2006, Iran, taking its cue from the North Korean paradigm, issued repeated warnings that it would cease compliance with the 1997 Additional Protocol, which it had signed but not ratified, if its "case" were referred from the IAEA to the UN Security Council, which it was. Then Tehran threatened to end its cooperation with the IAEA and even to withdraw from the NPT, if the UN Security Council imposed sanctions.

All the same, a UN Security Council deliberation, or even sanctions, could hardly qualify as grounds for withdrawal from the Treaty, given the wording of article X.1 ("extraordinary events, related to the subject matter of this Treaty" which "have jeopardized the supreme interests of its country"). The major powers failed to respond to such threats in any decisive way, however. Yet again, disunity among the UN Security Council powers enabled Iran to make IAEA safeguards compliance under the NPT and its status as State Party to the Treaty itself a tool for blackmail and a means of obtaining political concessions from other countries (just as North Korea had done in the past). Rather than exercise a curbing influence on countries'

[131] It should be noted that in legal terms, the U.S. decision to withdraw from the ABM Treaty cannot be compared to the North Korean decision to withdraw from the NPT, since the United States had never been accused of previous violations of the ABM Treaty, observed the six-month notification period, and provided a legitimate (if strategically questionable) motive. In addition, Article XV.2 of the ABM Treaty requires no notification of the UN Security Council and stipulates no review by the latter.

nuclear policies, the NPT and its mechanisms have offered a lever for violators or potential violators with which to exert reverse pressure on an IAEA and a UN Security Council striving to preserve the Treaty.

Grounds for withdrawal from the NPT came up for discussion at the 2005 NPT Review Conference. Many participants, including Russia and Western countries, called for stricter assessments of States' declared grounds for withdrawal as per the spirit and letter of article X.1. Interestingly, the United States chose instead to defend the "sovereign right" to withdraw for any reason whatsoever.[132] Clearly, by doing so the United States aimed to deflect criticism of its own denunciation of the ABM Treaty in 2002.

This was yet another example of how the NPT had been weakened by major powers' failure to uphold their own nuclear disarmament commitments under Article VI. In a broader sense, the ruinous effect of seeking to deny this link was seen in the utter fiasco of the 2005 NPT Review Conference, which was brought about by the United States' stern refusal to discuss nuclear disarmament in the spirit of 1995 and 2000 NPT Review Conference decisions. As a result, it became impossible for the parties to agree on a number of crucial decisions that were proposed during the Conference, including one on withdrawal from the NPT, as described below.

Withdrawal from the NPT for the Purpose of Concealing Violations

It is more than likely that Pyongyang's move to withdraw from the Treaty in 1993 was directly related to IAEA safeguards violations it sought to conceal. The case for associating North Korea's subsequent and ultimate withdrawal from the NPT in 2003 with concealing Treaty violations is far less certain, although there have been suspicions about a clandestine uranium program. Despite Pyongyang's flawed grounds though, its withdrawal was more likely a reaction to being leaned on by the U.S. Republican administration and the default by the United States on its 1994 Agreed Framework obligations. Therefore, in the latter instance, the lessons are more about major powers' policies toward "threshold" countries and nuclear disarmament obligations.

[132] S. Horn, *Statement of U.S. Representative to 2005 NPT Review Conference* (Washington, D.C.: U.S. State Department, 2005). Accessed June 1, 2005, http://www.state.gov/t/vc/rls/rm/46644.htm.

Tehran's refusal to adhere to the 1997 Additional Protocol in 2005 after the "Iranian dossier" was referred to the UN Security Council, and the threat to withdraw from the NPT if sanctions were to be imposed, do give rise to serious suspicions about a cover-up of previous Treaty violations. Moreover, failure to implement the Additional Protocol appears to entail more risk than a resumption of the uranium enrichment program despite the fact that the Protocol was never ratified. Iran's threats, ideally, should have given the IAEA and the Security Council grounds to toughen their stance, but attention was focused on stopping enrichment (which the NPT does permit) rather than compliance with the Additional Protocol.

In 2004, a report by the High-level Panel on Threats, Challenges, and Change, appointed by the UN Secretary General and made up of twelve reputable former government officials from around the world, proposed that the UN Security Council call States withdrawing from the NPT to account for violations committed while they were still parties to the Treaty. That would imply implementation in the year 2005. The Panel was of the view that once a State had given notice of its intention to withdraw from the NPT, there should be an immediate inspection into past compliance with the Treaty, sanctioned by the UN Security Council, if necessary.

One year later, at the 2005 NPT Review Conference, essentially the same proposals were put forward by Australia, the European Union, Japan, New Zealand, and the United States.[133] Russia was less clear, favoring greater state accountability for a decision to withdraw under Article X and agreement on a number of political procedures and measures, but stating its opposition to a revision of Treaty provisions.[134]

The "5 + 1" nations' interim agreement with Iran in November 2013 gave hope for a peaceful resolution of the Iranian nuclear problem. Unfortunately, that agreement did not mention the necessity of Iran's strict adherence to the 1997 Additional Protocol. Neither did it provide for the suspension of all uranium enrichment operations, which have no legitimate justification

[133] *Working Paper submitted to the NPT Conference by Japan* (New York: 2005 NPT Review Conference, 2005). Accessed May 17, 2005, http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N05/332/11/PDF/N0533211.pdf?OpenElement.

[134] *National report on the implementation of the Treaty on the Non-Proliferation of Nuclear Weapons by the Russian Federation* (New York: 2005 NPT Review Conference, 2005). Accessed May 11, 2005, http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N05/340/74/PDF/N0534074.pdf?OpenElement.

by peaceful needs, which was also in contrast to the six UN SC resolutions on the subject from 2006 to 2010. Including these conditions, among other issues, in the final comprehensive agreement will determine the chances of peacefully resolving this explosive international problem.

Withdrawal from the Treaty in Order to Pursue Military Applications of the Benefits of the "Peaceful Atom"

Various measures have been proposed to prevent such an eventuality. For example, at the 2005 NPT Review Conference, the European Union and a number of other states proposed agreeing on a rule whereby even a State that has withdrawn from the NPT would still be obliged to continue using all materials and technologies solely for peaceful purposes, for which they had been designed, just as had been the case during its time as an NPT State Party, and to maintain IAEA safeguards over them. An even tougher approach was proposed to cover all materials and technologies obtained from outside sources through participation in the Treaty. Any State withdrawing from the Treaty would be bound, on pain of UN Security Council sanctions, to mothball such assets for subsequent dismantling or return to the suppliers under IAEA supervision.[135]

None of these proposals were implemented because of the collapse of the 2005 NPT Review Conference. Even had such measures been instituted well in advance, there is no telling what their effect on the DPRK and Iran would have been. Following withdrawal from the Treaty in 2003, North Korea's military program relied mainly on materials, technologies, and expertise produced domestically or acquired from China and the USSR before the NPT came into being—and before China acceded to it—as well as from Pakistan, not a party to the Treaty. As such, it would have been difficult to ensure that such materials and technologies be kept under IAEA safeguards or that they be dismantled or returned after North Korea's withdrawal from the Treaty.

In the event that Iran should withdraw from the NPT, aforementioned measures could scarcely be made to apply to the uranium enrichment

[135] *Final Document* (New York: 2005 NPT Review Conference, 2005). Accessed May 27, 2005, http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N05/390/07/PDF/N0539007.pdf?OpenElement.

facility in Natanz, which was built mostly independently and with some Pakistani cooperation. However, since that project was put into effect in violation of the IAEA safeguards agreement, a special decision might be reached. Measures like maintaining materials and technologies under IAEA safeguards could be made to apply to the Bushehr nuclear power plant and sites in Arak being built in collaboration with foreign countries within the context of the NPT provisions. A far more contentious issue is the dismantling and return of these facilities, and this is where the position of China and Russia would prove decisive, as it would entail a UN Security Council resolution, without which such measures would hardly be possible.

In terms of their practical feasibility, such measures would be extremely problematic, even if confined to keeping materials and technologies under IAEA safeguards. As the experience of North Korea has shown, IAEA inspectors risk expulsion at any moment together with their equipment when a state has no fear of sanctions, even military ones. This is all the more true if the State has been able to create a nuclear weapon, an explosive device, or at least a convincing impression of having one. From that standpoint, the most effective remedy would be to dismantle the materials and technology and have them returned, which should, at the very least and above all else, be the case for dual-use technologies (like uranium enrichment and plutonium separation). Clearly, such measures should follow immediately upon a State's withdrawal from the NPT, without waiting for nuclear weapons to be created.

Extending IAEA safeguards to non-nuclear NPT States Party is meant to ensure the longest possible time interval between a State's hypothetical act of withdrawal from the Treaty and its creation of a nuclear weapon, as well as to prevent States effectively from developing nuclear weapons in secret before they withdraw from the NPT.[136]

This would be the toughest measure, though, as the elimination and return of technologies and materials pose very serious legal, financial, and technical problems: e.g., compensation for materials and technologies acquired and purchased under contract, fuel removal, and the dismantling of reactors and other facilities.[137] Still more problematic indeed would be the disposal

[136] For more detail on this, see Ibid.

[137] *Universal Compliance: A Strategy for Nuclear Security* (Washington, D.C.: Carnegie Endowment for International Peace, 2004). Accessed February 14, 2005, http://wmd.ceip.matrixgroup.net/UniversalCompliance.pdf.

of materials and technologies that the State had created independently or acquired outside cooperation with other Member States of the NPT.

What is more important still is that, essentially, the only way one could enforce this approach against a country that disagrees with these measures is through military occupation. Military occupation presumably preceded by military action would, in all likelihood, involve regime change. After this the country could easily be returned to the NPT and its military nuclear program shut down, thereby dispensing with the need to dismantle and return materials and technologies.

A Preferable Approach to the Problem of Withdrawal from the NPT

It seems that to resolve this problem on the basis of international law and common sense, the major powers, all nations that adhere to the NPT, the UN Security Council, the IAEA, and other institutions and organizations will need to agree on the acceptable and secure limits of nuclear tolerance. The analysis of the North Korean and Iranian cases makes it possible to formulate the following key proposals.

- Improving on IAEA safeguards and making the 1997 Additional Protocol universal should prevent secret NPT violations in a reliable manner and thus eliminate the issue of States withdrawing from the Treaty in order to conceal past violations.
- A State's announcement of its pending withdrawal from the NPT should lead to: (1) intensive inspections by the IAEA to identify possible previous violations of the Treaty or the safeguards agreement; (2) the convening of an extraordinary conference of States Party to the NPT to examine the State's grounds for withdrawal from the Treaty; (3) in the event the declared grounds should be found to be inconsistent with article X.1 and/or it is determined that the problem cannot be resolved diplomatically, the matter is to be referred to the UN Security Council for consideration under Chapter VII, Article 41, of the UN Charter.
- Any resistance to IAEA inspections and failure to comply with notification periods for withdrawal should become the subject of a UN Security Council decision on sanctions as per Chapter VII, Article 41, of the UN Charter.

- All materials and technologies present within the country at the time of its withdrawal from the Treaty, irrespective of their origin, are to be used solely for peaceful purposes and to remain under IAEA safeguards.
- All dual-use materials and technologies (for uranium enrichment and plutonium separation, as well as higher than 5 percent enriched uranium and plutonium) acquired from outside sources or developed independently while the State was still Party to the Treaty are to be mothballed immediately and subsequently dismantled or returned to the suppliers under IAEA supervision. This applies *a fortiori* to materials and technologies acquired from states not party to the NPT during the period of the NPT membership of the State in question, i.e. in violation of the NPT provisions and IAEA safeguards.
- Refusal to comply with the latter two provisions shall prompt a decision by the UN Security Council to impose sanctions under Chapter VII, articles 41 and 42, of the United Nations Charter that may extend to the use of military force.

Arguably, even such radical measures as these cannot fully guarantee that no State ever withdraws from the Treaty. However, they can serve as a sufficiently powerful disincentive to such a move and thereby limit the withdrawal-associated damage to international security. It is also obvious that all of these conditions would need to be enshrined in decisions by NPT States Party and in UN international norms and statutes.

For example, the Nuclear Suppliers Group (NSG) could approve an exhaustive list of the technologies, facilities, and units that are key to dual-use production. As such, it would then be advisable for the NSG to include the requirement that such materials and technologies be dismantled or returned in the event of a withdrawal from the NPT as a mandatory clause in any future contract for transfers of such technologies under Article IV of the Treaty. Since a law cannot have retroactive effect, this would not apply to non-nuclear States that already have the nuclear fuel cycle, although it would be well for such States to adopt a politically binding declaration to that effect.

The same goes for the NSG including a condition of full adherence to the 1997 Additional Protocol as a standard provision of all future contracts on peaceful nuclear cooperation under Article IV of the NPT.

Finally, it stands to reason that such measures will only succeed if there is consensus among the major powers and UN Security Council members, something that will only be possible if nuclear nonproliferation is recognized as the top priority in practice within their international security strategies.

Further, a strong moral and political stance on the part of the major powers and their cooperation with the majority of non-nuclear NPT States requires as a matter of necessity that the nuclear-weapon States consistently work to fulfill their nuclear disarmament commitment under Article VI of the Non-Proliferation Treaty.

Chapter 4.2.
IMPROVING NUCLEAR WEAPONS DELIVERY VEHICLE NONPROLIFERATION REGIMES

Sergey Oznobishchev[138]

One of the ways to restrict the development of nuclear missile potentials, i.e., to create conditions that will prevent crossing the red line that demarcates the limit of secure nuclear tolerance, is to improve control over the proliferation of missile technology, viz. potential nuclear weapons delivery vehicles. Currently applicable missile and missile technology nonproliferation regimes have not brought about a substantial reduction in the rates of missile potential development and have not created insurmountable barriers for those countries that have taken on the task.

The Missile Nonproliferation Regime and Its Drawbacks

There are a number of factors that facilitate the aspiration of a number of countries to obtain missile technology. First of all, there is the persistence of a high level of regional and international tension, which creates military-political incentives for the acquisition, development, and improvement of missile technologies. Furthermore, the possibility of equipping delivery missiles with nuclear warheads will signify the appearance of a limited nuclear potential, which is seen as providing a serious guarantee of the defense of state sovereignty and the prevention of the use of force and threats

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of the use of force. It is also attractive that the current unofficial members of the nuclear club clearly enjoy heightened attention from leading world powers and obtain political and other benefits.

Despite the measures taken by the international community, there remains a high level of accessibility of missile hardware and technologies. This applies equally to the possibilities of obtaining information and skills in creating missile potentials.

All of this has the most immediate negative impact on the effectiveness of missile nonproliferation regimes themselves. It erodes incentives to join missile technology control regimes, and the idea of improving the regimes and unifying them into a coherent system—i.e., transforming them into a binding multilateral treaty—fails to gain the number of supporters it needs.

The above-described factors have facilitated a conjuncture under which many states during recent decades have not only imported missiles and missile technologies; they have also been able to create their own powerful design and manufacturing base for building missiles. This includes Argentina, Brazil, China, Egypt, India, Iran, Israel, Libya, North Korea, Pakistan, South Africa, South Korea, Spain, Syria, Taiwan, Turkey, and certain others.

The first attempt at restricting missile proliferation was the adoption of the missile and missile technology export control regime (MTCR) in 1987. This regime was created upon the initiative and with the participation of the G7 countries, including Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, for the purpose of reducing the threat of missile proliferation. However, as of now, only 34 countries, including Russia, have joined the MTCR—less than one-sixth of the world's states. Bulgaria, the most recent member to join, joined ten years ago. Thus, the overwhelming majority of the world's countries are currently off track for technical restrictions in this area.

But even those countries that did decide to join the regime enjoy a great deal of freedom within it. It is not in itself a legally binding agreement, does not possess enforcement mechanisms for its limitations, and is built on the principle of voluntary acceptance of the MTCR provisions by states that share the aims of missile nonproliferation. Thus, the regime amounts to the

voluntary acceptance of the MTCR's provisions by states that declare that they share the aims of missile nonproliferation.

The central declared task of the MTCR Guidelines is "to limit the risks of proliferation of weapons of mass destruction... by controlling transfers."[139] There is yet another noticeable flaw in the regime here, since it is extremely difficult to exert effective control without resorting to substantially intrusive methods in a number of cases (including intervention in domestic affairs, violating states' sovereign rights, etc.).

The Guidelines are elaborated in the so-called Equipment, Software and Technology Annex, where restrictions are based not on existing missile systems and specific missile types and models, but on individual missile elements and certain stages in the process of their creation. Such a principle creates a rather indistinct and unclear basis for the restrictions and leaves open loopholes for circumventing the restrictions.

Under the regime's procedures, the question of whether or not it is permissible to supply missile mechanisms and technologies must be decided individually in each specific case, taking into consideration the character of the recipient country's missile programs, among other things. However, the data available on this matter may be contradictory, imprecise, or confidential. Moreover, the supplier country may interpret those data in light of its peculiar political biases.

Within the MTCR regime, the logic of restrictions is based on each country complying with its adopted national control lists that are correlated with the specified Equipment, Software and Technology Annex, which is updated and supplemented at annual meetings. However, restrictions recommended on the international level may be very far from being fully incorporated into the export control laws of individual states. In actuality, the MTCR is built upon states' voluntary compliance with accepted understandings as to what is subject to export and what is not.

It is obvious that such key decisions in the area of missile technologies as, for example, the assessment by one of the regime's members of whether or not a recipient country's missile and space programs have a military

[139] *Guidelines for Sensitive Missile-Relevant Transfers*, www.vertic.org/assets/nim_docs/MTCR%20Documents/Guidelines/ MTCR%20Guidelines%20(en).pdf.

purpose may not necessarily be shared by the regime's other participants. As a result, the specific practice in the application of MTCR restrictions rather frequently becomes the source of mutual accusations and conflict situations related to the character or purpose of supplies. Moreover, regime participants have no legal duty to abide by provisions agreed upon at the international level.

The regime and compliance with the regime do not involve effective mechanisms for the identification and control of real violations of the restrictions adopted in the MTCR. There is no coherent system of sanctions for violations. The mutual accusations of regime violations that occur from time to time never reach the point at which binding decisions are made regarding those violations. There is no provision for any kind of arbitrating body that could examine such accusations independently. Therefore, there is never any kind of liability that would apply even in cases of uncontested violations.

The MTCR has no permanent leadership. The regime's chairmanship, i.e., the office that prepares and implements decisions pursuant to the MTCR, rotates among the countries from year to year. Measures to improve the regime have a limited and cosmetic character and appear to be incapable of preventing the increasing proliferation of missile hardware and technologies. The fact that regime participants have various approaches to compliance with the restrictions also serves to weaken the regime as a whole.

The fact that the very countries regarding which justified concerns exist over their policies and tendencies to develop military potentials have yet to become MTCR members is a cause for serious alarm. During the over twenty-year period of the regime's existence, it has not managed to restrict access to missile weapons for Iran, Iraq, and Syria. India, Israel, and Pakistan are also outside of the regime and continue to develop their missile programs. In each of these states, extended-range missiles have been created and deployed in significant excess beyond MTCR limits in reliance, to a greater or lesser extent, on assistance from abroad. Analyses have shown that the concerns relate not only to the presence, quantity, and type of missile potentials in those countries, but also to a combination of a number of factors, including when a country's missile potential is accompanied by suspicions that the country is creating or possesses weapons of mass destruction and when a country's government has made statements and pursued policies that engendered serious concerns.

There now exists a substantially long list of countries that have committed violations of the regime on multiple occasions and continue to violate it. However, those states have not incurred any penalties.

Dissatisfaction with the problem of missile proliferation and the small number of participants led to the appearance of a document adopted in the Hague in November 2002 known as the Hague Code of Conduct Against Ballistic Missile Proliferation (HCOC). Over 120 states have subscribed to the HCOC. Although this document has a larger group of signatories than the MTCR, it is political in character and does not impose any technical restrictions relating to missiles or the actions of its participants.

In conclusion, as of now, none of the currently effective international legal regimes is capable of securing a satisfactory state of affairs in the nonproliferation of missiles and missile technologies.

Challenges to Strengthening the MTCR

It is possible to overcome the current problems by improving the MTCR regime in a number of ways. As explained above, agreement participants do not see the MTCR Guidelines as binding. Many international law experts have concluded that MTCR norms cannot even be considered to be international legal norms.

Therefore, the general task that would resolve many issues is to raise the status of the regime, i.e., to make the restrictions legally binding. Establishing a much more effective missile proliferation prevention system than the current one would fully conform to the interests of strengthening international stability. Attempts to create barriers in addition to the MTCR and HCOC in this way were made approximately fifteen years ago, when Russia proposed the idea of creating a Global Control System (GSK).[140]

The proposed system was to include a number of transparency provisions, including a voluntary duty to submit information on both planned

[140] The Russian Federation proposed the idea of a Global Control System (GSK) in 1999. The proposed system was to include a number of transparency provisions, including a voluntary duty to submit information on both planned and completed ballistic missile launches and on launches of space launch vehicles.

and completed ballistic missile launches and on launches of space launch vehicles. This also included a proposal to provide assistance for the development of national space programs as an incentive for states to restrict or renounce missile delivery vehicles. A promise to provide security guarantees to states rejecting the possession of missile delivery vehicles was an important element. However, the circumstance that these proposals were made in opposition to American plans to develop a national missile defense system meant that the United States would adopt a negative attitude toward them.

Subsequently, proposals to give the MTCR and HCOC a legally binding character appeared periodically on various levels. In particular, one of the recently proposed initiatives was a recommendation by several dozen world-renowned authoritative experts to begin immediate consultations aimed at raising the status of the MTCR and HCOC. The experts made the recommendation in a Declaration of the International Luxembourg Forum on Preventing Nuclear Catastrophe in May 2007.[141]

At the same time, it must be acknowledged that there are a number of serious difficulties on this road that need to be overcome. As a rule, legally binding international treaties and agreements concerning arms control have an elaborate system for their enforcement. In this respect, Russia/the USSR and the United States have accumulated tremendous experience in the development of an enforcement system and confidence-building measures within the framework of the START and INF treaties for ballistic and cruise missiles. However, this relates to a limited class of missiles with fixed basing systems, launch system types, control centers, and other missile infrastructure sites.

In contrast, the MTCR includes, in addition to ballistic missiles, a broad range of cruise missiles of all basing types and unmanned aerial vehicles (UAVs). For example, as for UAVs, with the implementation of new technologies for materials, engines, and control and targeting systems, they have become so diverse in their various types and dimensions (up to and including miniature UAVs) that the problems of creating an acceptable system to enforce limits on such vehicles, including export control, appear at present to be nearly irresolvable. And the difficulties of enforcement frequently serve as the basis for the main arguments of those opposed to joining treaties and agreements. An example would be the refusal of the United States to join the proposed treaty prohibiting weapons in space, the dead-end in development of the Fissile Material Cut-off Treaty (FMCT), the Comprehensive Nuclear-Test-Ban Treaty (CTBT) (to a certain extent), and others.

There may be relatively fewer difficulties in developing and agreeing to an enforcement system if only the HCOC is converted into a legally binding agreement. However, the issue will remain of how to deal with diverse missile and basing types.

Under these conditions, various ways of improving the effectiveness of the missile nonproliferation regime can be considered, from raising the status of the MTCR and HCOC separately to developing a draft treaty that would unite those two documents. However, in any case, in light of the problems described above concerning an enforcement system, there will need to be a redistribution of proportions from enforcement systems to confidence-building measures in the practices of treaty compliance. This means that compliance with treaty or agreement provisions could be confirmed, to a large extent, by means of notifications and information exchanges on missile construction programs and launch plans. This would involve the granting of viewing access to missiles, launch systems, and other missile infrastructure sites, admission of observers to sites, and other confidence-building measures.

The effectiveness of the new treaty could be enhanced by including in it restrictions on the production of missile systems and measures to ensure their physical security in order to prevent them from falling into the hands of terrorists (this relates, in particular, to cruise missiles and UAVs). A regularly updated, agreed list of restricted missile systems and their parameters could be made an annex to the treaty. That annex could consist of a fundamentally altered version of the currently effective Equipment, Software and Technology Annex to the MTCR Guidelines, and it could include not only restrictions on the specific parameters of missile systems and technologies,

[141] International Conference on Preventing Nuclear Catastrophe, *Declaration* (Luxembourg, May 24—25, 2007), http://www.pnc2007.org/declaration/declaration.

but also restrictions on the types and models of restricted missile vehicles, including both existing ones and vehicles still being developed.

The treaty could include many of the existing concepts that have yet to be applied. For example, the treaty could establish a mandatory requirement, allowing for no exceptions, of notification of any missile and space launches, as well as of current arsenals of ballistic and cruise missiles with certain specifications. Furthermore, it would be possible, by means of the treaty, to implement the idea of imposing the restrictions on recipients as well as on suppliers of missile hardware.[142]

It would be expedient and appropriate at the same time to begin preparing a draft of a broader treaty, with a view to long-term prospects, that would integrate the provisions of the MTCR, HCOC, and GSK as the bases of a new global and legally binding missile nonproliferation regime to be enshrined in an international agreement on missile and missile technologies nonproliferation of the same type as the NPT. A regularly updated, agreed list of restricted missile systems and their specifications could be made an annex to the treaty. It would have to contain all of the technical definitions of the objects of the agreements, enforcement and confidence-building measures, and mechanisms for monitoring compliance, identifying violations, and imposing sanctions for violations, as well as methods for resolving disputes.

The crossing of the so-called red line, which should become an issue of concern for experts, politicians, and, most importantly, international organizations, should be determined by the creation and testing of missile systems with flight specifications and other performance specifications differing from those that were agreed. Purchases of components that can be used for systems that go beyond the agreed lists and large-scale research projects should be sufficient to elicit serious concern. However, the principal initial criterion for drawing a red line would be mainly the testing of missile systems.

A circumstance that complicates the effectiveness of the missile nonproliferation regime, independent of the current or future status of the

[142] V. Dvorkin, *Raketnoe rasprostranenie, monitoring puskov i protivoraketnaya oborona* [Missile Proliferation, Monitoring of Launches, and Missile Defense], http://www.carnegie.ru/ru/pubs/media/9170Dvorkin-report.doc.

agreements reviewed above, would be the fact that the countries (primarily, the countries mentioned above) that present the greatest threat to the regime are not members of the MTCR and HCOC and are unlikely to accede to new documents without additional incentives.

A key element that would ensure at least some modest progress in negotiations is the possibility of joint action by leading states, primarily the United States and Russia. This was demonstrated vividly in 2013 with the beginning of the dialogue on Syria and Iran.

Pressure on North Korea to limit its missile programs exerted through the Six-Party Talks periodically becomes consonant with the resolution of the nuclear crisis, and it has had certain positive results due to the deepening socioeconomic problems of that country. There is no such consonance in talks on the Iranian nuclear dossier, at which some progress was finally registered in November 2013. However, regardless of the further development of talks concerning restrictions on Tehran's nuclear program, the question of restricting programs for the development and testing of mid-range and intercontinental missiles must be added to the agenda for the talks.

Such restrictions would have key significance in terms of seeking an agreement between Russia and the United States regarding plans to deploy an American missile defense system to defend Washington's allies in Europe and other regions of the world. As a whole, greater consonance between the problems of missile defense and missile proliferation would be highly justified.

It is particularly difficult to develop restrictions under conditions when threats are perceived differently. North Korea, for example, is located geographically closer to Russia than to the United States, which, in general, should cause Moscow to react much more acutely to that country's withdrawal from the NPT in January 2003, multiple missile launches, and testing of nuclear warheads. However, such has not been the case, although the *Rodong-1* missiles currently in Pyongyang's possession, as well as the *Taepodong-1* and *Taepodong-2* extended-range missiles, which are currently in the testing stage, are hypothetically more dangerous for a significant part of Russia's (and China's) territory, than that of the United States.

For Japan and the United States, the very character of the North Korean regime and its hostile relationship with them remain a substantial component of the threat emanating from that country. At the same time, for China and Russia, which have working relations with Pyongyang, its nuclear programs may create a big foreign policy problem, but are not seen as a direct national security threat.

Agreement on common criteria and approaches to existing challenges and threats, both in the realm of missiles and more generally, is seen today as one of the most topical and important tasks of international security. In the broader context, it must be acknowledged that without common progress on the way to arms reduction and restriction, it would be very problematic to intensify the MTCR and make it legally binding. The present conjuncture on the principal directions of arms control has practically reached a dead end. Not only has dialogue on these issues been broken off, but incentives to talk have been practically eliminated, a condition that had not occurred since the 1960s. Reestablishing dialogue in this area would potentially open up the prospect both of raising the MTCR regime to a new level that would be binding upon its participants, and of clarifying the parameters of restrictions with the possibility of designating red lines.

CONCLUSION

The analyses of this study are focused on the elaboration of extra concepts and measures needed to fortify the entire nuclear nonproliferation regime, based on the provisions of the NPT. This should be done not by amending the articles of the Treaty, but by supplementing it with additional norms, agreements, and mutual understandings, as well as by setting up special new supporting agencies.

The group of authors of this book is united by the principal idea that the development of an evidence-based system of signs (indicators or criteria) of state activities in the nuclear field would be an important new step in this direction. These criteria will make it possible to conclude with sufficient certainty that a state is approaching a threshold designated as a "red line," i.e., the capability of obtaining nuclear weapons by wrongfully using the materials and technologies of the "peaceful atom," even without formally violating the NPT and before announcing intent to withdraw from the Treaty under its Article X.1.

From this viewpoint, the limits of secure nuclear tolerance and the specific technical aspects of nuclear weapons development are thoroughly analyzed by the authors, a team of specialists from different countries. Certain lessons may also be learned from the recent developments in the realm of regional nuclear programs.

There is a separate task of defining a critical set of indicators (signs) of states suspected of approaching the "red line," which by no means must necessarily include all of the indicators listed above.

The analyses done by the authors of the book reveal that a nuclear-weapon-capable state may be characterized by the presence of a number of economic and technical indicators: national uranium mining activity, indigenous recoverable uranium deposits, metallurgists, steel production, a construction work force, chemical engineers, nitric acid production, electrical production, nuclear engineers, physicists, chemists, and explosives and electronics specialists—all of which are necessary for the production of nuclear weapons.

It has been suggested that there are four main stages in the evolution of a state's technological and industrial potential for developing nuclear weapons: planning and development of a nuclear infrastructure; development of the nuclear fuel cycle, particularly enrichment and/or reprocessing; weaponization of materials and concurrent technologies; and testing of nuclear explosives. Such gradation provides a framework in which a proliferation risk analysis for various states may be conducted.

The study revealed a number of signs that would indicate that the limits of the secure (strictly peaceful) development of nuclear energy and science had likely been crossed. For example, the following could be seen as such signs:

- a state's failure to accede to the Additional Protocol of 1997 to IAEA safeguards;
- creation of elements of the nuclear fuel cycle (foremost uranium enrichment facilities), despite a small number of active or realistically planned nuclear reactors, which renders such elements economically inefficient for peaceful purposes;
- development of other elements of the nuclear fuel cycle (including separation of plutonium from spent nuclear fuel) in the absence of reactors that operate on mixed uranium-plutonium fuel (i.e., MOX fuel);
- construction of reactors producing an increased amount of plutonium in irradiated nuclear fuel (i.e., heavy water reactors fueled by natural uranium);
- operation of light water reactors in a mode to produce an increased amount of weapons-grade plutonium;
- refusal to engage the services of foreign national and multilateral centers for the supply of enriched uranium and nuclear fuel, despite a small number of the country's own active nuclear reactors;
- accumulation of significant reserves of enriched uranium (and especially highly-enriched uranium) that do not correspond to the needs of available nuclear reactors or if available reactors must use only certified foreign-produced fuel in line with contracts on peaceful nuclear cooperation;
- construction of hardened (underground) nuclear industry facilities using dual-purpose technologies that can produce weapons-grade nuclear materials;
- development and testing of delivery vehicles designed to be fitted with nuclear warheads;
- research and experiments associated with manufacturing nuclear explosive devices and nuclear warheads;
- production of highly-enriched uranium (with over 20 percent uranium-235) under the pretext of providing fuel for naval nuclear reactors in the absence of a realistic need for a nuclear-powered navy;
- production of highly-enriched uranium for research and medical needs in volumes that exceed those needs;
- construction of facilities that have the features of facilities for conducting nuclear explosion tests;
- international cooperation outside of IAEA safeguards for the transfer of nuclear technologies and materials, including with countries that are not members of the NPT;
- interference with the IAEA's inspection activities;
- announcement of an intention to withdraw from the NPT in the absence of "circumstances" that would threaten the "supreme interests" of the country in question (per Article X.1).

At the same time it should be noted that if a state is determined to achieve a break-out capability or actual nuclear weapon potential—as some advanced non-nuclear-weapon states have done—there is no absolute guarantee or means to prevent such a break-out. This is the enduring dilemma of nuclear technology, which by definition is dual-purpose (short of a global prohibition of nuclear weapons, supported by a robust verification system and supplemented by multilateralizing the sensitive parts of the nuclear fuel cycle).

Thus, a state with a nuclear latency capability is limited only by a political decision whether or not to cross the threshold to 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 and plutonium.

The development of the regional nuclear programs also provides certain lessons to be learned. Among the features stimulating the creation of a military nuclear potential and indicative of such a process are:

- the growing influence of the proponents of nuclear weapons and the formation of a national consensus on obtaining nuclear weapons;
- the maintenance of a high level of regional tension, or tension between a regional state and one of the great powers, the experience of military conflicts between them, and the suspicions of one of those states that others are likely to develop or already have nuclear weapons;
- the ability to allocate significant human, financial, technological, and industrial resources for a nuclear program in the absence of realistic plans or needs to develop peaceful nuclear energy;
- the possibility of obtaining necessary nuclear technologies and materials from external sources within the framework of open cooperation in the field of nuclear energy or various illegal mechanisms of nuclear proliferation.

If some of the factors indicated above are present in a certain country, this may provide the rationale for a careful study and monitoring of that country's activities related to nuclear technologies.

The analysis of the North Korean and Iranian cases makes it possible to formulate some key proposals that are bound to strengthen the NPT regime significantly:

- improving on IAEA safeguards and making the 1997 Additional Protocol universal should prevent secret NPT violations;
- a state's announcement of its pending withdrawal from the NPT should lead to intensive inspections by the IAEA of possible past violations and convening an extraordinary conference of States Party to the NPT;

- any resistance to IAEA inspections and failure to comply with notification periods for withdrawal should become the subject of a UN Security Council decision on sanctions as per Chapter VII, Article 41 of the UN Charter;
- all materials and technologies present within the country at the time of its withdrawal from the Treaty are to be used solely for peaceful purposes and to remain under IAEA safeguards;
- all dual-use materials and technologies acquired from outside sources or developed indigenously while being a member of the NPT are to be mothballed immediately and subsequently dismantled or returned to foreign suppliers under IAEA supervision;
- refusal to comply with the latter two provisions shall prompt a decision by the UN Security Council to impose sanctions as per Chapter VII, Article 41or 42 of the UN Charter.

The attempts by politicians and international organizations and the proposals of well-known NGOs (including those of the International Luxembourg Forum on Preventing Nuclear Catastrophe) have brought some positive results. After a lengthy period of pressure and sanctions against Iran with the aim of putting the Iranian nuclear program within the secure limits of the NPT's provisions, the so-called Joint Plan of Action was elaborated by the P5+1 as a first step, which should be followed by a final agreement.

Another way to restrict the development of states' nuclear military potential is to introduce restrictions on the proliferation of nuclear weapons delivery vehicles. In a broad sense, it would be expedient and appropriate to draw up a new treaty that would integrate the provisions of the regimes that are already in existence and the proposals that have been formulated in order to enshrine them in an international agreement on the nonproliferation of missiles and missile technologies, using the model of the NPT.

If the great powers, the IAEA, and the states of the Nuclear Suppliers Group agree on a set of indicators of suspicious activity, and the IAEA or a new legitimate international organization discovers signs that any state is approaching the "red line" or is in the process of crossing that line (which can take years, as in the case of North Korea from 2003 to

2006), the UN Security Council should make decisions on appropriate countermeasures.

One of the proposals that deserves special attention is that the UN SC should consider the establishment of a subsidiary organ on a permanent basis for the verification and supervision of suspect nuclear proliferation events, which are beyond the current scope of IAEA monitored activities or technologies. It becomes increasingly important to monitor more broadly the activities of non-nuclear-weapon NPT Member States that can bring them closer to the “red line,” and to prevent such actions in a timely manner, even if they do not directly relate to the goals and competences of the IAEA and the Nuclear Suppliers Group.

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 nongovernmental 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 more than 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 *Hans Blix*, Ambassador, former Director General of the International Atomic Energy Agency (IAEA), Ph.D. (Sweden); *Rolf Ekeus*, Ambassador, former High Commissioner on National Minorities of the Organization for Security and Co-operation in Europe (Sweden); *Mohamed ElBaradei*, Director General Emeritus of the IAEA, former Director General of the IAEA and Vice President of Egypt, Nobel Peace Prize Winner 2005, Ph.D. (Egypt); *Gareth Evans*, Chancellor, Australian National University, former Australian Senator and Member of Parliament, Minister of Foreign Affairs, 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 Deputy Chairman of the Council of Ministers of the USSR, Chairman of the State Committee of the USSR Council of Ministers for Science and Technology; *Sam Nunn*, Co-Chairman and Chief Executive Officer of the Nuclear Threat Initiative, former Chairman of the Armed Services Committee and the Permanent Subcommittee on Investigations of the U.S. Senate; *William Perry*, Professor at Stanford University, former Secretary of the U.S. Department of Defense; and *Roald Sagdeev*, RAS Academician and Distinguished University Professor, Department of Physics at the University of Maryland, Director Emeritus of the Russian Space Research Institute (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.

The 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 cooperation. 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 for 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 and could also help to identify the limits of secure tolerance within the nuclear nonproliferation regime.

These ideas were developed in 2013 when the Forum held a conference in Montreux (May 21-22) and a Supervisory Board meeting in Warsaw (December 10-11). During the SB meeting in Warsaw, the delegation of the Forum met and discussed the state of nonproliferation and arms control with the Secretary of State and Head of the National Security Bureau, Republic of Poland, and with the leadership of the Polish Ministry of Foreign Affairs.

In Warsaw the SB members endorsed and supported the new initiative to unite the efforts of leading international nongovernmental organizations active in the area of nuclear weapons reduction and nonproliferation. The goal is to work out the general draft proposals comprising the principal ideas of the leading international NGOs. This will be done during the round table in Geneva (June 10-11, 2014).

The International Luxembourg Forum continues its work, propounds 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.