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Nuclear Proliferation:
New Technologies, Weapons, Treaties

Edited by Alexei Arbatov
and Vladimir Dvorkin

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This collective volume was produced as part of the Carnegie Moscow Center's Nonproliferation Project and focuses on the important and complex processes that have intruded on nuclear nonproliferation and that are having an increasing impact on prospects for ending the escalation of the nuclear arms race. Issues explored include the development of nuclear energy, the proliferation of nuclear and conventional weapons delivery systems, and the development of strategic systems. The book also proposes recommendations for the parties involved.

The volume is aimed at specialists in international relations and security, nuclear nonproliferation, modern weapons systems and other fields, as well as at the broader public.

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Abbreviations

ALCM — Air-launched cruise missile
APR — Asia-Pacific Region
BM — Ballistic missile
CEP — Circular error probable
CIS — Commonwealth of Independent States
CM — Cruise missile
CSTO — Collective Security Treaty Organization
CTBT — Comprehensive Test Ban Treaty
EU — European Union
FBR — Fast breeder reactor
FMCT — Fissile Material Cut-off Treaty
GCS — Global Control System
GLCM — Ground-launched cruise missile
GNEP — Global Nuclear Energy Partnership
GNSS — Global navigation satellite system
IAEA — International Atomic Energy Agency
ICBM — Intercontinental ballistic missile
ICOC — International Code of Conduct against Ballistic Missile Proliferation
INS — Inertial navigation system
IRBM — Intermediate-range ballistic missile
IUEC — International uranium enrichment center
LEU — Low enriched uranium
LW — Laser weapon
MAWS — Missile attack warning system
MIRV — Multiple independently targetable re-entry vehicles
MTCR — Missile Technology Control Regime
NATO — North Atlantic Treaty Organization
NPP — Nuclear power plant
NPT — Nuclear Non-Proliferation Treaty
NSNW — Nonstrategic nuclear weapons
PAR — Phased array radar
PGM — Precision-guided munitions
PHWR — Pressurized heavy water reactor

PNI — Presidential Nuclear Initiatives
R&D — Research and development
SALT-1 — Interim Agreement between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitation of Strategic Offensive Arms (1972)
SALT-2 — Treaty between the USA and the USSR on the Limitation of Strategic Offensive Arms (1979)
SBL — Space-based laser
SDI — Strategic Defense Initiative
SIPRI — Stockholm International Peace Research Institute
SLBM — Submarine-launched ballistic missile
SLCM — Sea-launched cruise missile
SMV — Space-maneuvering vehicle
SNF — Strategic nuclear forces
SOC — Strategic offensive capability
SRBM — Short-range ballistic missile
SSBN — Ballistic missile nuclear submarine
START-1 — Treaty between the USA and the USSR on the Reduction and Limitation of Strategic Offensive Arms 1991
START-2 — Treaty between the Russian Federation and the USA on the Reduction and Limitation of Strategic Offensive Arms 1993
SWU — Separative work unit
TNW — Tactical nuclear weapons
UAV — Unmanned aerial vehicle
UN — United Nations Organization
VLS — Vertical launching system
WMD — Weapons of mass destruction

Introduction

Alexei Arbatov

This book is a new collection of monographs written, with one exception, by a group of Russian specialists as part of the Carnegie Moscow Center's research project, Proliferation of Weapons of Mass Destruction.

What makes this book different from previous publications in this area is that it focuses more on the 'external environment' than directly on issues of strengthening the Nuclear Non-Proliferation Treaty (NPT), its regimes and institutions. Previous publications from the Carnegie Center focused on strengthening the International Atomic Energy Agency's (IAEA) system of safeguards and export controls, toughening the rules for withdrawal from the NPT, and getting the nuclear powers to fulfill their nuclear disarmament obligations. Past publications have also examined issues such as preventing nuclear materials and technology from falling into the hands of terrorists and ending the production of nuclear weapons materials, as well as regional nonproliferation issues in the Middle and Far East and in South Asia.[1]

For the most part this book does not deal directly with these subjects, focusing instead on significant and complex processes and developments that have intruded upon the nuclear nonproliferation issue and have an ever-growing impact on the prospects for being able to end the horizontal escalation of the nuclear arms race.

Chapter One analyzes the future expansion of nuclear energy in the world in order to meet the predicted growth of energy demands in light of dwindling fossil fuel supplies and their evident negative effects on the environment, and it assesses the possible impact this expansion could have on the nonproliferation regime.

Chapter Two examines the nonproliferation problems and threats arising from the plans a good number of countries have for developing the nuclear fuel cycle as part of their nuclear energy development programs. It looks at the merits, weak points and difficulties in establishing and operating the international centers for uranium enrichment and spent fuel processing that are proposed as a guarantee against proliferation and an alternative to countries developing their own nuclear fuel cycles.

Chapter Three studies the pluses and minuses of global cooperation projects to develop new-generation nuclear energy aimed at guaranteeing against technological disasters and the proliferation of nuclear weapons through the use of nuclear energy.

Chapter Four looks at a subject related to nuclear proliferation — the proliferation of missiles and missile technology that gives nuclear weapons maximum reach and effectiveness in a situation in which the balance of nuclear forces and threats in the world is becoming increasingly multilateral. It examines the proposals for and obstacles to strengthening the control regime for the use, supply and enhancement of missiles and missile technology.

Chapter Five assesses the role of non-nuclear precision-guided munitions (PGM) in global and regional military plans and the possible consequences their development could have, both as a means of countering nuclear proliferation, and as an incentive to threshold countries to acquire nuclear weapons.

Chapter Six presents a detailed study of non-strategic nuclear weapons (tactical nuclear weapons — TNW) and the role they play in military-political relations between the big powers and in nuclear weapons proliferation among other countries. It analyzes the problems of restricting and eliminating TNW through treaties and agreements.

Chapter Seven studies the relations between strategic offensive weapons and missile defense systems. Development of missile defenses is encouraging the proliferation of missiles and nuclear weapons, which in turn has an impact on offensive arms programs, the dialog between the great powers on their restriction and reduction, and cooperation in nuclear and missile nonproliferation.

Chapter Eight deals with the fate of the Intermediate-Range Nuclear Forces Treaty (INF Treaty) and the potential for using intermediate-range missiles as a countermeasure to missile proliferation and the creation of missile defense systems that threaten strategic stability.

Chapter Nine examines the militarization of space and the development of space arms, their impact on nuclear proliferation, and the prospects for international agreements restricting the militarization of space.

The Appendix presents an evaluation of the possible effects of the deployment of a missile defense system in Central Europe, had the plans of the Bush Administration been implemented.

The book's overall objective is to broaden the analysis of the military, technical, political and legal issues that have an ever greater impact on the outlook for nuclear weapons nonproliferation and that must be taken into account if attempts to strengthen the nonproliferation regime are to succeed.

Notes

[1] A. Arbatov and V. Naumkin, eds., *Threats to the Nuclear Weapons Non-Proliferation Regime in the Greater Middle East* (Moscow: Carnegie Moscow Center, 2005); A. Arbatov and G. Churfin, eds., *Nuclear Confrontation in South Asia* (Moscow: Carnegie Moscow Center, 2005); A. Arbatov and V. Mikheyev, eds., *Nuclear Proliferation in Northeast Asia* (Moscow: Carnegie Moscow Center, 2005); A. Arbatov and V. Dvorkin, eds., Carnegie Moscow Center, *Nuclear Weapons after the Cold War* (Moscow: ROSSPEN, 2006); A. Arbatov, ed., Carnegie Moscow Center, *At the Nuclear Threshold: The Lessons of North Korea and Iran for the Nuclear Non-Proliferation Regime* (Moscow: ROSSPEN, 2007).

Part I

NEW NUCLEAR ENERGY TECHNOLOGIES

Chapter 1. Energy Resource Shortages, Global Warming and the Outlook for Nuclear Energy

Petr Topychkanov

At the start of the twenty-first century, the global energy sector continued on the fossil fuel-based course set during the preceding century. However, continuing on this path could soon lead to serious risks for the world's major economies and indeed for the entire global financial and economic system, and thus for the political system, too. It is therefore imperative to find ways to protect against these risks by developing energy-saving technologies and alternative energy sources, above all in nuclear energy. But can nuclear energy really solve current and future problems? What are the specific features and main trends in the current world energy situation in general and nuclear energy in particular?

Global Energy: the Current Situation

A number of recent publications see the development of nuclear energy as the main solution to problems such as rising energy consumption, coupled with finite fossil fuel resources, and environmental change, including global warming and the greenhouse effect caused by carbon dioxide emissions.[1]

Energy consumption continued to rise in 2006–2007, though not as fast as in preceding years. There were two reasons for the slowdown: a decrease in economic growth around the world, and the continued rise of the price of oil,[2] which is still the main energy resource in the global economy.[3] In 2005, energy consumption rose by 3.5%, but in 2006, the increase was 2.4%. The slowdown affected all energy sources except nuclear energy. Most of the increased consumption came from the Asia-Pacific region, primarily from China, where energy consumption was up by 8.4% in 2006 (by comparison, energy consumption in North America fell by 0.5% that same year).[4]

Rising industrial output and social transformation stemming from economic development in densely populated countries such as China and India are creating the effect of an 'energy tsunami',[5] which is bringing per capita energy consumption figures in the developing countries close to the 'golden billion' countries' levels.

One of the many signals that energy consumption in the Asia-Pacific region is set to undergo a sharp rise in the near future is that the number of cars is projected to increase by 7.1% a year on average in China and 8.9% in South Asia between 2005-2030 (the world average is 2.1%).[6] Overall, Asian countries could account for 63% of the increase in the number of cars in the world by 2030. In China, this would mean 62 cars for every 1,000 people, and in South Asia it would be 50 cars for every 1,000 people (by comparison, it is predicted that there will be 501 cars for every 1,000 people by this time in North America).[7] It therefore looks likely that the number of cars will continue to increase after 2030, and thus the demand for energy will also continue to increase.

In the rapidly industrializing developing countries much of the growth is driven by 'dirty' and/or energy-intensive sectors such as metals, petrochemicals, the automotive industry, electronics, the aviation industry, the pulp and paper industry, etc.[8] This not only creates increased demand for fossil fuels, but also adds to their negative environmental impact, in particular by raising the emissions of carbon dioxide, which is one of the greenhouse gases responsible for increases in atmospheric temperature.

At the moment, the world energy consumption structure is as follows: oil – 36%, coal – 28%, gas – 24%, hydroelectricity – 6%, and nuclear energy – 6%.[9] If we compare the figures not only for the consumption, but also for the import of oil, gas and coal, we see that in 2006 67% of the oil consumed was imported, 26% of the gas, including liquefied natural gas, and 16% of the coal.[10] In other words, oil, gas and coal are energy sources of global, regional and local significance respectively.[11]

Energy resource import and export operations maintain the polarization and interdependence of the producer and consumer countries that took shape in international relations in the twentieth century.[12] A comparison of the list of regions that lead the world in proven energy resources and the list of the world's biggest consumer regions shows that the two barely coincide at all. The world leader in proven oil reserves is the Middle East (62% of world reserves), followed by Europe and the former USSR (12%), and Africa (10%), while the biggest oil consumers are the Asia-Pacific region countries (30% of world consumption), North America (29%) and Europe, including Russia and a number of the former Soviet republics, (25%). The contrast is even starker when the list is examined in more detail: Saudi Arabia has the biggest proven oil reserves (22%), followed by Iran (11%) and Iraq (10%), while the biggest consumers are the U.S. (24%), followed by China (9%) and Japan (6%).[13]

Thus, the world's largest economies depend increasingly on the regions that supply the bulk of the energy they consume (and the suppliers likewise depend on these economies' development). The U.S. and China are good examples of this kind of interdependence. The U.S. imports oil from Central and South America (21% of oil supplies), North and West Africa (14%), the Middle East (12%), Europe (5%), etc. Overall, 71% of the U.S.'s oil supplies came from imports in 2006. China imports oil from the Middle East (21%), Africa (13%), the Asia-Pacific region (10%), and the former USSR (7%). Overall, China imported 55% of the oil it consumed in 2006.[14] In this situation, the disruption of oil supplies for whatever reason, including domestic political causes, obviously poses a serious threat to large consumers such as the U.S. and China, making their national economic growth dependent on domestic and foreign political events in other countries. This risk motivates importers to build reserves 'for a rainy day' and pushes up energy prices, while at the same time it encourages consumer countries to diversify supplies and increase the share of nuclear energy and renewable energy sources in their energy consumption structure.[15] These measures are part of efforts to ensure energy security, while also striving to prevent accidents at and terrorist attacks on energy installations, maintain investment in the energy infrastructure, and optimize the organization of markets for all types of energy sources with the goal of avoiding a drop in affordable energy supplies.[16]

The energy exporters are also in a vulnerable situation. A decision by any of the major consumers to stop supplies would be a huge blow for the exporter country's economy. Thus, energy security implies not only guaranteed access for consumers to energy supplies, but also guaranteed access to the world market for energy exporters. In other words, the main purpose of energy security is to ensure the stable international flow of energy resources.[17]

The energy security issue is even more urgent when seen in the context of finite fossil fuel reserves, above all oil. Continued exploitation of easily accessible and long since developed oil fields, using modern technology, will lead to declining production not too far down the road. Proven world oil reserves are sufficient to satisfy growing energy demand until the 2030's,[18] but considerable investment and new technology will be needed to provide more efficient operation of easily accessible oil fields and develop new difficult to access fields. The figures on the development of offshore oil fields indicate that the pace of transformation in the world energy industry is rather slow: the share of oil from these fields rose from 26% to 34% of oil produced in 1992–2002.[19] This, combined with the political risks in the chief energy-producing countries and the uncertainty concerning the resource base, gives rise to instability on the energy markets and on the international political scene.[20]

Environmental Aspects of Fossil Fuels-Based Energy

Increasing consumption of fossil fuels, through development of difficult to access deposits, for example, creates new environmental threats at the regional and global level. The Russian oil and gas projects in the Far East provide examples of the consequences at the regional level. According to estimates made in 2006 by the Federal Supervisory Natural Resources Management Service, environmental damage caused by the Sakhalin-2 project, which covers the Piltun-Astokhskoye and Lunskoye oil fields,[21] was $10-15 billion (however, it is possible that these figures are artificially inflated for political and economic purposes).[22] The damage in question includes deforestation, soil erosion, environmental pollution and other measures that have a negative impact on the biological health of the region. The likelihood of an accident at the oil pipelines that cross Sakhalin from north to south, caused by seismic shifts underground, avalanches, mountain torrents and other hydrological processes, poses an even greater risk.[23]

The most frequently discussed global-scale environmental problem linked to the growing consumption of fossil fuels is global warming, which is caused by emissions of greenhouse gases into the atmosphere. These greenhouse gases include carbon dioxide (55% of the greenhouse gases produced by human activity), chlorofluorocarbons (24%), methane (15%), and nitrogen oxide (6%).[24] Emissions of greenhouse gases caused by human activity are 25 times lower than natural emissions, but they have a major impact on climate change even so. Around 85% of the carbon dioxide emissions resulting from human activity are caused by the burning of fossil fuels. Oil produces the largest share of these emissions (around 40%), followed by coal (around 39%) and natural gas (around 20%). China and India account for the highest emissions of carbon dioxide – 22% of world emissions in 2004. This figure could rise to 31% by 2030.[25]

The unprecedented jump in the concentration of greenhouse gases in the Earth's atmosphere over the last decades leads us to expect that the average temperature in the world will rise by 1-6 degrees C in the twenty-first century. If developments follow the worst-case scenario, this would mean that the temperature in some parts of the planet would rise by 10-15 degrees C (the increase in the average temperature was 0.7 degrees C for the entire twentieth century). Even the more optimistic forecasts still predict that the average temperature in the world will rise by 2 degrees C over the next 30 years. This means that economic losses caused by an intensification of meteorological phenomena (hurricanes, floods, etc.) alone could come to 0.5-1% of the world GDP. It is much harder to make quantitative and qualitative estimates for the negative biological and socio-economic consequences climate change could have. The economic losses here could be even greater.[26]

Energy Alternatives: the Economic Aspect

Economic and environmental problems should be resolved by carrying out comprehensive measures at every level – from individual economic actors to the world community as a whole. These measures include increasing the efficiency of electricity usage and generation, so as to conserve energy resources and reduce greenhouse gas emissions; increasing the use of renewable energy technology; introducing carbon capture and sequestration on a massive scale at fossil-fueled power plants; and increasing the share of nuclear energy in the world energy consumption structure (excluding any one of these measures would make it harder to resolve the problems overall).[27] The benefits of diversifying energy sources are clear if we compare the carbon dioxide emissions resulting from electricity production using different energy sources (in grams of carbon dioxide per kilowatt-hour): from coal – 755; natural gas – 385; biomass – 29-62; wind – 11-37; nuclear energy – 84-122.[28]

No one has any objections in principle to the need to increase energy efficiency, but the issue of transforming the world's energy consumption structure is the subject of heated debate relating to economic justification and safety. Naturally, these contradictions are further aggravated by pressure from lobby groups associated with this or that energy sector. Without going into the details of these debates, we should note that renewable energy sources (solar energy, biomass, wind, tidal and sea current-produced energy, hydro-energy) and nuclear energy remain more expensive at present than fossil fuels. According to a study carried out in 2003 by the Massachusetts Institute of Technology, using natural gas to produce electricity costs 3.8-5.3 cents per kilowatt-hour (depending on the cost of the raw material), coal costs 4.4 cents, and nuclear energy costs 7 cents.[29]

Similar figures were obtained at the start of 2007 by analysts from the European Commission, who gave the following figures for each kilowatt-hour of electricity produced, depending on the energy source used: gas – 4.6-6.1 cents; coal – 4.7-6.1 cents; nuclear energy – 5.4-7.4 cents; wind power (using wind generators built on land) 4.7-14.8 cents; wind power (offshore wind generators) – 8.2-20.2 cents.[30] The cost of nuclear energy is high because 75% of the cost consists of technical service and operation expenses, while the nuclear fuel itself accounts for only 26% of the cost. The cost of the nuclear fuel includes the cost of uranium ore production (52%), uranium enrichment (26%), spent nuclear fuel storage (11%), nuclear fuel production (7%) and conversion (4%). By way of contrast, the cost of gas and coal account for 94% and 78% respectively of the cost of electricity produced using these fossil fuels, while the technical service and operation costs of gas and coal-based energy installations accounts for only 6% and 22% of the overall cost respectively.[31]

The high costs, combined with the difficulties of developing nuclear technology and the risk of nuclear proliferation, hinder the nuclear energy industry's growth. But Europe's example shows that although nuclear energy and renewable energy sources have not yet become a reliable alternative to oil, gas and coal, the European Union has been forced by political, economic and environmental factors to increase their share in regional energy consumption. The EU plans to increase their share in its overall energy balance to 70% by 2025.[32] This is not a dramatic increase because, as we will see further on, the European countries already have a high share of nuclear energy production in their national energy balances. Experts predict a big increase of production in other regions. According to the most promising scenario for the world nuclear energy industry, the leaders in annual growth of nuclear energy as a share of national energy consumption over the first half of this century will be Pakistan (12.1%), China (10.5%), India (9.6%), Brazil (9.2%) and Argentina (5.6%). It is expected that by 2050, nuclear power plants (NPP) in these countries will account for 30% of energy production, while in Russia and the U.S., nuclear energy could account for up to half of all energy production by 2050 if the sector grows by 2.8% a year in Russia and by 3.6% a year in the U.S.[33] The growth in nuclear energy capacity will perhaps be faster in the countries in the South, which have in many cases launched their nuclear programs on the basis of nuclear technology and materials acquired from the countries in the North.

These prospects make it necessary to analyze the current state of the nuclear energy sector and the resource base for its development, taking into account the fact that unlike other alternatives to fossil fuels, nuclear energy poses the great danger of nuclear weapons proliferation based on peaceful nuclear technology and materials.

The State of Nuclear Energy

As mentioned above, nuclear energy accounts for 6% of world energy consumption (in 2006). The world's biggest consumer of nuclear energy is the U.S., which accounted for 29% of all nuclear energy consumed in the world in 2006. Next come France (16%), Japan (11%), Germany (6%), Russia (6%), South Korea (5%), Canada (3%), Ukraine (3%), Great Britain (3%), Sweden (2%) and so on (a total of 31 countries). Overall, the countries of Europe and the former USSR account for 45% of the total nuclear energy consumed in the world, North America for 33%, the Asia-Pacific region countries for 20%, South America for 1%, and Africa for 0.4% (there is no nuclear energy consumption in the Middle East countries, and Pakistan is included in the Asia-Pacific region).[34] Nuclear energy is generated by reactors at nuclear power plants that use fuel with uranium as the main component. Table 1 gives data on the main types of reactors currently in operation in the world and their characteristics.

This data makes it possible to analyze the specific regional characteristics of nuclear reactor operation. The regions rank as follows for number of nuclear reactors currently in operation: Europe – 34%; North and South America – 29%; the Asia-Pacific countries – 24%; the former USSR – 11%; Africa – 0.5%. A more detailed list of countries with the largest number of reactors reads as follows: the U.S. – 104 reactors (24% of the total number of reactors); France – 59 reactors (13%); Japan – 55 reactors (12%); Russia – 31 reactors (7%); South Korea – 20 reactors (6%); the UK – 19 reactors (4%); Canada – 18 reactors (4%); Germany – 17 reactors (4%); Ukraine – 15 reactors (3%). Nuclear energy is not the primary source of energy in most of these countries: nuclear power plants produce 19% of the electricity in the U.S., 30% in Japan, 16% in Russia, 39% in South Korea, 18% in the UK, 16% in Canada, 32% in Germany, and 48% in Ukraine. The world leaders in terms of electricity production using nuclear energy are France (78%), Lithuania (69%), Slovakia (57%), Belgium (54%), Ukraine (48%), Sweden (48%), Bulgaria (44%), Armenia (42%) and Slovenia (40%).[35]

What stands out in this list is, first, that all of the countries on the list are European, and second, in general, the countries that are most dependent on nuclear energy with few exceptions have a low average level of

Table 1

Nuclear Power Reactors of the World: Types and Characteristics (beginning of 2008)

Reactor type	Number in the world / share %	Country where located (number of reactors)	Total energy capacity gigawatts / share %	Fuel	Coolant	Moderator
Pressurized Water Reactor (PWR)	264 / 60.1	Armenia (1), Belgium (7), Brazil (2), Bulgaria (2), China (9), Czech Republic (6), Finland (2), France (58), Germany (11), Hungary (4), Japan (23), Korea (16), Netherlands (1), Pakistan (1), Russia (15), Slovakia (5), Slovenia (1), South Africa (2), Spain (6), Sweden (3), Switzerland (3), Ukraine (15), UK (1), U.S. (69)	250.5 / 65.1	Low enriched uranium dioxide fuel (UO_2)	Water	Water
Boiling Water Reactor (BWR, ABWR)	98 / 22.3	Finland (2), Germany (6), India (2), Japan (32), Mexico (2), Russia (4), Spain (2), Sweden (7), Switzerland (3), U.S. (35)	86.4 / 22.5	Low enriched uranium dioxide fuel	Water	Water
Pressurized Heavy Water Reactor (PHWR)	43 / 9.8	Argentina (2), Canada (18), China (2), India (15), Korea (4), Pakistan (1), Romania (2)	23.6 / 6.1	Natural uranium oxide fuel	Heavy water (D_2O)	Heavy water (D_2O)
Gas-cooled Reactor (GCR, AGR, Magnox)	18 / 4.1	UK (18)	10.8 / 2.8	Natural uranium metallic fuel	Carbon dioxide or helium	Graphite

Table 1

Reactor type	Number in the world / share %	Country where located (number of reactors)	Total energy capacity gigawatts / share %	Fuel	Coolant	Moderator
Light-Water Graphite Reactor (LWGR)	12 / 2.8	Lithuania (1), Russia (11)	12.3 / 3.2	Low enriched uranium dioxide fuel	Water	Graphite
Fast Neutron Reactor (FBR)	4 / 0.9	France (1), India (1), Japan (1), Russia (1)	1.0 / 0.3	Mixed fuel (PuO_2 + UO_2)	Liquid sodium	None
Total	*439 / 100.0*	*31 countries*	*384.6 / 100.0*			

Sources: I. A. Andryushin and Y. A. Yudin, *Riski rasprostraneniya i problema energeticheskogo plutoniya* (Sarov: Analytical Center for Non-Proliferation, 2007), P. 10; "World Nuclear Power Reactors, 2006-08 and Uranium Requirements," January 14, 2008, http://www.world-nuclear.org/info/reactors.html; "Nuclear Power Reactors," November 2007, http://www.world-nuclear.org/info/inf32.html. See also: Energy Information Administration, "World Nuclear Reactors," Official Energy Statistics from the U.S. Government, http://www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/reactsum2.html.

economic development. France ranks sixth in the world in terms of GDP,[36] Belgium is 18th, Sweden 19th, Ukraine 51st, Slovakia 59th, Slovenia 67th, Bulgaria 72nd, Lithuania 75th, and Armenia 122nd.[37] Countries such as China and India, which are already driving up the demand for energy (and will continue to do so in the coming years) are not on this list at all. Growth in the world nuclear energy sector is therefore likely to come primarily from these countries.

China is currently building five reactors with total capacity of 4.5 GW, and India is building six reactors with total capacity of 2.9 GW. Furthermore, China is looking at the possibility of assembling another 30 reactors (total capacity of 32.0 GW), and India is examining plans for an additional 10 reactors (total capacity 2.9 GW). If these plans go ahead, the Asia-Pacific region could take the lead for the number of reactors in operation by 2050. Overall, according to data from January 2008, there are 30 reactors with a total capacity of 24.3 GW currently under construction in the world and plans to build another 92 reactors with total capacity of 101.6 GW[38] (see Chapter 2 of this monograph for the outlook for the nuclear energy sector).

The outlook for nuclear energy development has specific regional characteristics related to the particular nature of how reactor technology spreads in the world today. These specific characteristics are given in Table 2.

What stands out is that the Asia-Pacific region – the most promising region for the development of nuclear energy – uses primarily pressurized heavy-water reactors (PHWR), which some experts consider the most dangerous due to the possibility of using the plutonium they generate for military purposes (the same goes for gas-cooled reactors).[39] Although this type of reactor was chosen not just for political, but also for economic and technical reasons (cooperation with Canada, the supplier of the CANDU reactors, and the use of natural rather than enriched uranium as fuel), there is nonetheless a logic to the fact that this type of reactor is operated by India and Pakistan, neither of which are parties to the NPT. India, which operates more than a third of all the PHWRs, can thus manufacture around 35 nuclear warheads using the plutonium generated by the reactors.[40] Pakistan, which built a new PHWR with Chinese technical assistance in Khushab,[41] can expect to at least double the size of its plutonium-based nuclear arsenal, currently estimated to comprise 10-20 plutonium warheads. (Pakistan's total nuclear arsenal probably totals 50-60 warheads.)[42] Thus, the operation of existing and construction of new PHWRs in South Asia comes with the danger of a regional nuclear arms race.

Table 2

Regional Characteristics of the Operation of Nuclear Power Reactors (beginning of 2008)

Reactor type	Asia-Pacific	Africa	Europe	North and South America	Former USSR	Total
Pressurized Water Reactor (PWR)	49 / 18.6	2 /0.8	110 / 41.8	71 / 27.0	31 / 11.8	263 / 100.0
Boiling Water Reactor (BWR, ABWR)	34 / 35.8	—	20 / 21.1	37 / 38.9	4 / 4.2	98 / 100.0
Pressurized Heavy Water Reactor (PHWR)	22 / 50.0	—	2 / 4.5	20 / 45.5	—	44 / 100.0
Gas-cooled Reactor (GCR, AGR, Magnox)	—	—	18 /100.0	—	—	18 / 100.0
Light-Water Graphite Reactor (LWGR)	—	—	—	—	12 / 100.0	12 / 100.0
Fast neutron reactor	2 / 50.0	—	1 / 25.0	—	1 / 25.0	4 / 100.0

Note. The numerator shows the number of reactors and the denominator shows the share of the total as a percentage.

Sources: "World Nuclear Power Reactors, 2006-08 and Uranium Requirements," January 14, 2008, http://www.world-nuclear.org/info/reactors.html; "Nuclear Power Reactors," November 2007, http://www.world-nuclear.org/info/inf32.html.

Attention should also be paid to fast breeder reactors (FBR), which make it possible to produce more nuclear fuel during the operation process than is consumed, to use poor uranium and thorium ore and weapons-grade plutonium as nuclear fuel,[43] and also to burn actinides and highly active fissile fragments. FBRs currently account for only a small share of open nuclear fuel cycle-based reactors in operation worldwide (0.9%), but they can play a key part in developing nuclear energy based on a closed nuclear fuel cycle by making it renewable in a sense, which theoretically offers a solution to the long-term issue of finite energy resources.[44]

But FBRs working in breeder (rather than burner) regime pose a risk for nuclear nonproliferation because they produce weapons-grade plutonium. Operation of these reactors should be covered by international agreements. The Joint Statement of Principles for Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes, signed on November 19, 2007, in Washington, is an example of a first step in this direction. According to this agreement, weapons-grade plutonium will not be produced for the duration of the program at the BN-600 reactors at Russia's Beloyarsk NPP and at the BN-800 reactor under construction there.[45]

An example of the opposite kind is that of India's operation of a 40 MW capacity breeder reactor and the construction of a new 470 MW capacity reactor (both located in Kalpakkam, Tamil Nadu State), which are not covered by IAEA safeguards. Moreover, under the plan to divide India's nuclear program into civil and military components, which is a condition for developing U.S.-Indian nuclear cooperation, the reactors in Kalpakkam will be categorized as military installations and thus will remain outside IAEA safeguards and could be used in the future for military purposes.[46]

It is clearly not in the interests of international security to allow uncontrolled use of FBR technology, which is attractive in terms of developing nuclear energy but comes with greater risks in terms of nuclear weapons proliferation.

Nuclear reactors that produce electricity and also plutonium are just one of the 'two-edged swords' in the nuclear energy sector. As IAEA Director General Mohamed ElBaradei said in 2004, an even greater risk to the nonproliferation regime comes from links in the nuclear fuel cycle, such as uranium enrichment for the production of nuclear fuel and processing spent nuclear fuel.[47] Table 3 below lists nuclear fuel cycle installations around the world (some installations on which the IAEA does not have precise information might be missing).

Table 3

Nuclear Fuel Cycle Facilities (by country)

Country	Uranium produc-tion	Con-ver-sion	Enrich-ment	Fuel Fabrica-tion (Uranium)	Fuel Fab-rication (MOX)	Spent Fuel Storage	Spent Fuel Reprocessing	Spent Fuel Conditioning & Disposal	Zirconium Alloy Pro-duction	Heavy Water Pro-duction	Fuel Assembly Com-ponent
Argentina	7	2	1	1	0	2	1	0	2	2	0
Armenia	0	0	0	0	0	1	0	0	0	0	0
Australia	12	0	1	0	0	0	0	0	0	0	0
Belgium	1	0	0	1	2	3	1	0	0	0	0
Brazil	3	4	6	4	0	0	1	0	2	0	0
Bulgaria	3	0	0	0	0	1	0	0	0	0	0
Canada	14	4	0	5	2	6	0	0	3	6	0
China	8	1	2	2	0	1	1	0	0	0	0
Czech Republic	3	0	0	0	0	3	0	0	0	0	0
Dem. P. R. of Korea	0	0	0	1	0	0	1	0	0	0	0
Denmark	0	0	0	1	0	0	0	0	0	0	0
Egypt	0	0	0	2	0	0	0	0	0	0	0
Estonia	1	0	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	3	0	0	0	0	0
France	6	10	3	4	4	5	11	0	5	0	0
Gabon	1	0	0	0	0	0	0	0	0	0	0
Germany	4	0	3	5	3	22	4	1	2	1	0

Hungary	1	0	0	0	0	1	0	0	0	0	0
India	4	1	0	6	0	3	1	0	6	8	0
Indonesia	1	1	0	2	0	0	0	0	0	0	0
Israel	1	0	0	0	0	0	0	0	0	0	0
Italy	1	0	0	5	1	0	4	0	0	0	0
Japan	2	2	6	6	7	5	3	0	6	0	0
Kazakhstan	14	0	0	1	0	0	0	0	0	0	0
Korea, Republic of	0	1	0	5	0	1	0	1	0	0	0
Kyrgyzstan	1	0	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	2	0	0	0	0	0
Mexico	1	1	0	2	0	0	0	0	0	0	0
Mongolia	1	0	0	0	0	0	0	0	0	0	0
Morocco	2	0	0	0	0	0	0	0	0	0	0
Namibia	2	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	1	0	0	0	0	0	0	0	0
Niger	2	0	0	0	0	0	0	0	0	0	0
Norway	0	0	0	1	0	0	1	0	0	1	0
Pakistan	2	1	1	1	0	0	0	0	0	0	0
Portugal	9	0	0	0	0	0	0	0	0	0	0
Romania	1	0	0	1	0	1	0	0	0	0	0
Russian Federation	3	3	4	6	2	7	3	0	2	0	0
Serbia	1	0	0	0	0	0	0	0	0	0	0

Table 3

Country	Uranium production	Conversion	Enrichment	Fuel Fabrication (Uranium)	Fuel Fabrication (MOX)	Spent Fuel Storage	Spent Fuel Reprocessing	Spent Fuel Conditioning & Disposal	Zirconium Alloy Production	Heavy Water Production	Fuel Assembly Component
Slovakia	0	0	0	0	0	2	0	0	0	0	0
Slovenia	1	0	0	0	0	0	0	0	0	0	0
South Africa	18	1	3	2	0	0	0	0	1	0	0
Spain	4	0	0	1	0	1	0	0	0	0	0
Sweden	1	0	0	1	0	1	0	0	1	0	0
Switzerland	0	0	0	0	0	2	0	0	0	0	0
Syrian Arab Republic	1	0	0	0	0	0	0	0	0	0	0
Tajikistan	1	0	0	0	0	0	0	0	0	0	0
Tunisia	1	0	0	0	0	0	0	0	0	0	0
Turkey	3	1	0	1	0	0	0	0	0	0	0
Ukraine	2	0	0	0	0	3	0	0	0	0	0
United Kingdom	0	9	2	9	6	7	12	0	0	0	0
United States of America	56	5	8	18	9	47	10	0	5	0	0
Uzbekistan	1	0	0	0	0	0	0	0	0	0	0
Total	*201*	*47*	*41*	*94*	*36*	*130*	*54*	*2*	*35*	*18*	*0*

Source: "Numbers of Nuclear Fuel Cycle Facilities," *Nuclear Fuel Cycle Information System* (Vienna: International Atomic Energy Agency, Feb. 18, 2009) http://www-nfcis.iaea.org/NFCIS/NFCISMain.asp?RPage=1&RightP=Summary.

These data show that the most common nuclear fuel cycle facilities are installations for producing uranium dioxides (31% of the total), spent fuel storage (20%), uranium fuel production (14%), reprocessing (8%) and conversion (8%) of fissile materials. The United States has the largest number of facilities (24%). More than a third of the American facilities are uranium dioxide production facilities (35%), followed by spent fuel storage facilities (30%) and uranium fuel production facilities (11%). Coming a long way behind the U.S. are the UK and France, which each have 7% of the world's nuclear fuel cycle facilities. Russia has 30 nuclear fuel cycle facilities (5% of the world total) covering all parts of the cycle except for the production of heavy water, for which there is no need, given that Russia has no PHWRs.

The international community is deeply concerned about nuclear fuel cycle facilities in countries that have not signed the NPT – Israel, India, North Korea (which withdrew from the treaty in 2003), Pakistan – and also in Iran, which is a party to the NPT.[48] The existence and development of nuclear fuel cycle technology in these countries with no IAEA monitoring (in Iran's case, with detected past violations of IAEA safeguards and incomplete transparency of current nuclear activities)[49] could lead to the spread of nuclear fuel cycle technology and products in countries with unstable political regimes, or this technology could end up in the hands of terrorist organizations.

The transport of nuclear materials is also a potentially vulnerable activity. A total of 53 countries currently have nuclear fuel cycle facilities, and 31 countries have nuclear power reactors, but the main uranium ore deposits are located in just 14 countries. As Table 4 shows, the world leaders in uranium ore resources are Australia, Kazakhstan and Canada.

Table 4

Proven Mineable Uranium Resources and Production of Uranium Dioxide Concentrate

Country	Mineable uranium resources (2005) in thousands of tons	Share of world resources (2005) %	Production of uranium dioxide concentrate (2006) in tons	Share of world production (2006) %
Australia	1143	24	7593	19
Brazil	279	6	190	1
Canada	444	9	9862	25
China	60	1	750	2
India	67	1	177	1

Table 4

Country	Mineable uranium resources (2005) in thousands of tons	Share of world resources (2005) %	Production of uranium dioxide concentrate (2006) in tons	Share of world production (2006) %
Jordan	79	2	—	—
Kazakhstan	816	17	5279	13
Namibia	282	6	3067	8
Nigeria	225	6	3434	9
Russia	172	4	3262	8
South Africa	341	7	534	1
Ukraine	90	2	800	2
U.S.	342	7	1672	4
Uzbekistan	116	2	2260	6
Other countries	287	6	549	1
Total	*4743*	*100*	*39 429*	*100*

Sources: "World Uranium Mining" (Information Papers, World Nuclear Association, London, July 2008), http://www.world-nuclear.org/info/inf23.html; "Supply of Uranium" (Information Papers, World Nuclear Association, London, March 2007), http://www.world-nuclear.org/info/inf75.html.

More than 50,000 tons of nuclear materials have been transported over more than 30 million km since 1971. Currently, around 20 million deliveries of nuclear materials are carried out each year.[50] The biggest exporters of nuclear materials are Russia (23% of world exports in 2003), Canada (18%), and Australia (13%). The biggest importers are the U.S. (56% of world nuclear materials imports), France (17%) and Japan (12%).[51] Plans to develop national nuclear energy programs in the Asia-Pacific region could change this list over the first half of the 21st century.

There have been a number of cases of nuclear materials disappearing over the years since development of the nuclear energy industry began. The most well-known case was the 1968 disappearance of 560 drums of crude concentrate of uranium (around 200 tons valued at $3.7 million) that were being carried on board a ship, the Scheersberg A, flying the Liberian flag. The ship left Antwerp with its cargo on November 17, but instead of arriving at its planned destination of Genoa, it appeared in the Turkish port of Iskenderun on December 2 without its cargo. It is assumed that the cargo was delivered to Israel for the development of its military nuclear program.[52] Overall, 1080 incidents involving the illegal storage and transportation of nuclear materials were revealed from

1993 to 2006. In 67% of these cases the stolen or lost nuclear materials were not found.[53] The danger of this situation, characterized by the lack of effective means for international monitoring of the storage and transportation of nuclear materials, could increase as the nuclear energy industry develops.

There is in particular a lack of real control over transportation by sea. The IAEA receives notification of such shipments, but there are no inspections to verify the facts in the ports of loading and unloading. The possible rapid development of the nuclear energy industry in the foreseeable future will inevitably lead to an increase in the sale and transportation of nuclear materials. Fearing nuclear terrorism, the West and Russia have been introducing border controls to detect attempts to take radioactive materials across the border. However, most countries have no procedures for monitoring the transportation of nuclear materials, including failed states and countries with irresponsible regimes, where stolen nuclear materials could be taken and used to assemble nuclear explosive devices. If accounting, monitoring and safeguard procedures for the transportation of nuclear materials are not significantly strengthened, this could create new opportunities for people with criminal intent to exploit aspects of peaceful international nuclear cooperation.

The development of nuclear energy is an inalienable and irreplaceable part of the package of long term measures aimed at meeting the world's growing demand for energy over the next 30-50 years at least. Given the economic and environmental problems linked to the current state of the fossil fuels sector, there is no way to meet growing energy demand without developing nuclear energy. The aim is not to completely replace fossil fuels with nuclear energy, but to transform the world energy sector by boosting the share of nuclear energy.

The outlook for resolving these problems with the help of nuclear energy depends on ensuring a number of very important conditions. First is to ensure acceptable prices for nuclear energy; second is to continue improving its technical and environmental safety; third is to guarantee that all participants in the global energy market have access to the commercial production of nuclear energy; and fourth is to prevent nuclear proliferation.

Ensuring this final condition could be a source of growing problems as the nuclear energy industry develops. All of the nuclear powers that are parties to the NPT are among the world's leading consumers of nuclear energy, are exporters, and are also frequently importers of nuclear technology and materials. At the same time, they set a negative example to other countries with their nuclear weapons policy, not only by suspending talks on nuclear disarmament (in violation of Article VI of the NPT), but also by dismantling almost the entire system of nuclear weapons treaties and agreements.

Other sources of problems are the countries that have military nuclear programs that are outside the nonproliferation regime and that are at the same time active participants in the energy market and in nuclear energy cooperation (in particular India and Pakistan). As nuclear energy becomes more accessible, so too could the technology and materials needed to build nuclear weapons.[54]

Furthermore, the spread of nuclear energy to a growing number of countries will increase the risk of accidents with disastrous environmental consequences if the new countries developing these materials and technologies do not guarantee the most stringent safety standards that the advanced countries adopted after the traumatic experience of Three Mile Island (March 28, 1979) and Chernobyl (April 26, 1986).

There is also the possibility, as the North Korean case has shown, that the NPT parties could use the fruits of international cooperation to rapidly develop peaceful nuclear energy and then for whatever political motives (or carrying out secret plans they had right from the start) withdraw from the Treaty and make nuclear weapons. Furthermore, as Iran's example shows, existing IAEA safeguards (in a situation when not all countries have adopted the 1997 Additional Protocol) are not sufficiently reliable as a means for the timely detection of secret and undeclared activities, even on a very large scale. The likely rapid expansion of nuclear energy would make this problem even more acute and dangerous.

Thus, the probable 'renaissance' of nuclear energy, driven by the growing world energy demand, energy security needs and the environmental threats arising from fossil fuels, could have the opposite effect to that intended. The problem is that this 'renaissance' could create nuclear proliferation risks that pose an even greater threat to international security than the danger of the political consequences of insufficient energy to fuel world economic growth. Furthermore, insufficient safety standards in the new countries developing nuclear energy could lead to environmental disasters on an even greater scale and even more serious in their social and economic costs than the effect of greenhouse gas emissions.

The current nuclear weapons nonproliferation regime and nuclear energy safety standards are insufficient to prevent these consequences. Urgent and radical measures are needed to bolster the NPT regime, mechanisms and institutions, covering all the NPT provisions (including Article VI), and broad additional legal, financial, economic, administrative and scientific-technical measures are also needed to ensure acceptable safety levels in the nuclear energy industry today and in the future.

Notes

[1] Australian Uranium Association, "The Nuclear Renaissance" (Briefing paper # 104, Australian Uranium Association, Melbourne, May 2007), http://www.uic.com.au/nip104.htm. See also: R. Gottemoeller, "Global Nuclear Energy Cooperation," in *At The Nuclear Threshold: The Lessons of North Korea and Iran for The Nuclear Non-Proliferation Regime,* ed. A. Arbatov, Carnegie Moscow Center, P. 142 (Moscow: Publishing House EchoBook, 2007); M. Y. Konovalikhin, "Atomny renessans v Shvetsii," *Rossiya v globalnoi politike,* June 24, 2007, http://www.globalaffairs.ru/books/0/7712.html.

[2] A. Arbatov, M. Belova and V. Feygin, "Russian Hydrocarbons and World Markets," *Russia in Global Affairs,* # 1, January-March 2006, http://eng.globalaffairs.ru/numbers/14/1004.html.

[3] J. Griffin, ed., *World Oil Outlook: 2007* (Vienna: OPEC Secretariat, 2007), P. 1.

[4] BP, *BP Statistical Review of World Energy: June 2007* (London: BP, 2007), P. 2.

[5] Expression used by Academician Nikolai Ponomaryov-Stepny, Vice-President of the Russian Research Center "The Kurchatov Institute". (See: V. Pokrovsky, "Gazovoi pauzy na vsekh ne khvatit," *Nezavisimaya gazeta,* July 12, 2006.)

[6] Other such signals include the growing urbanization illustrated by the following figures: in 1900, 10% of the world's population lived in cities, but in 2007, the world had an equal number of people living in cities and in the countryside, and by 2050, 75% of people will be living in cities. This will result in growing energy demand and increased environmental pollution (R. Burdett, "Beyond City Limits," *Foreign Policy,* January-February 2008, P. 42).

[7] Griffin, ed., *World Oil Outlook: 2007,* P. 39.

[8] N. G. Rogozhina, *Regionalnaya ekopolitologiya* (Moscow: MNEPU Publishing House, 1999), P. 29.

[9] Calculations are based on data for 2006 that takes into account only one type of renewable energy source — hydro-energy (*BP Statistical Review of World Energy: June 2007,* P. 41).

[10] Calculations are based on data presented in the following publications: *BP Statistical Review of World Energy: June 2007; U.S. Department of Energy/Energy Information Administration International Energy Outlook: 2007* (Washington, DC, 2007).

[11] A. Goncharenko et al., "The Evolution of the Global Energy Market," *Russia in Global Affairs,* # 1, January-March 2007, http://eng.globalaffairs.ru/numbers/18/1084.html.

[12] A. A. Arbatov "Yedinstvo i borba syryevykh protivopolozhnostei," *Rossiya v globalnoi politike,* # 1, January-February 2006, P. 49, http://www.globalaffairs.ru/numbers/23/6687.html.

[13] Data from the end of 2006 (*BP Statistical Review of World Energy: June 2007,* PP. 7, 12).

[14] Calculations based on data presented in the publication: *BP Statistical Review of World Energy: June 2007.*

[15] L. M. Grigoryev, "Politicheskiye riski dvigayut neftyaniye tseny vverkh," *Ekonomicheskoye obozreniye,* # 3, April 2006, PP. 4-5; Leonid Grigoryev, presentation at the round table "Political risks for energy security," May 11, 2006, in *An agenda for Russia: Materials from the round tables of the "Unity for Russia" Foundation for 2006,* ed. V. A. Nikonov, P.139 (Moscow: FORUM, 2007).

[16] International Energy Agency, *Energy Security* (Paris: International Energy Agency, 2002), P. 3. See also: V. Milov, "Global Energy Agenda," *Russia in Global Affairs,* # 4, October-December 2005, http://eng.globalaffairs.ru/numbers/13/967.html.

[17] Z. Sapir, "Energobezopasnost kak vseobshchee blago," *Rossiya v globalnoi politike,* # 6, November-December 2006, PP. 66-69, http://www.globalaffairs.ru/numbers/23/6687.html.

[18] Proven oil reserve volumes have increased by 100% since the start of the 1980s, while total oil production over the same period amounted to less than a third of the total oil reserves explored since the start of the 1980s (Griffin, ed., *World Oil Outlook: 2007,* P. 5).

[19] N. A. Simonia, "Neft v mirovoi politike," *Mezhdunarodniye protsessy,* 3, # 3, (September-October 2005): P. 9, http://www.intertrends.ru/nineth/001.htm. See also Nodari Simonia, presentation at the round table "Political risks for energy security," May 11, 2006, in *An agenda for Russia: Materials from the round tables of the "Unity for Russia" Foundation for 2006,* ed. V. A. Nikonov, P.143 (Moscow: FORUM, 2007).

[20] A. Arbatov, M. Belova and V. Feygin, "Russian Hydrocarbons and World Markets," *Russia in Global Affairs,* # 1, January-March 2006, http://eng.globalaffairs.ru/numbers/14/1004.html; Grigoryev, "Politicheskiye riski dvigayut neftyaniye tseny vverkh," P. 4.

[21] For details on the project see: N. Poussenkova, "The Wild, Wild East. East Siberia and the Far East: A New Petroleum Frontier?" (Working papers # 4, Carnegie Moscow Center, Moscow, 2007), PP. 54-56.

[22] L. Podobedova, "Lesniye zloklyucheniya Sakhalin Energy: Rosprirodnadzor khochet oshtrafovat kompaniyu za vyrubku lesov," *RBK Daily,* December 20, 2007.

[23] For details on the environmental risks see: World Wildlife Fund, "Sakhalin Offshore Projects," http://www.wwf.ru/about/what_we_do/oil/sakhalin.

[24] AllChem Company, "Refrigerants: Ecological Purposefulness of the Use," http://www.allchemi.com/eng/refregerants/eco.html.

[25] U.S. Department of Energy, *International Energy Outlook: 2007,* PP. 73-74.

[26] A. O. Kokorin and S. N. Kurayev, *Obzor doklada Nikolasa Sterna "Ekonomika izmeneniya klimata"* (Moscow: WWF Rossii, 2007), PP. 20-24.

[27] J. Deutch et al., *The Future of Nuclear Power: An Interdisciplinary MIT Study* (Cambridge: Massachusetts Institute of Technology, 2003), P. 18.

[28] By nuclear energy here we refer to the whole chain from the production of nuclear fuel from uranium ore to the production of electricity. (S. van Leeuwen, "Nuclear

Power and Global Warming," in *Secure Energy? Civil Nuclear Power, Security, and Global Warming,* ed. F. Barnaby and J. Kemp [London: Oxford Research Group, 2007], PP. 41-42).

[29] The cost of oil-based electricity production was not presented in the study. The conditions for defining the cost are: first, a 25-year period for return on investment and second, an 85% capacity coefficient (J. Deutch et al., *The Future of Nuclear Power,* PP. 39, 42).

[30] Australian Uranium Association, "The Economics of Nuclear Power" (Briefing paper # 8, Australian Uranium Association, Melbourne, December 2007), http://www.uic.com.au/08%20Economics%20of%20NP.pdf.

[31] P. Bradford et al., *Nuclear Power Joint Fact-Finding, June 2007* (Keystone: The Keystone Center, 2007), P. 38.

[32] P. S. Kanygin, "Toplivnaya strategiya ES i rossiisky eksport syrya: Evrosoyuz ukhodit ot ispolzovaniya uglevodorodov," *Nezavisimaya gazeta,* November 13, 2007.

[33] J. Deutch et al., *The Future of Nuclear Power,* PP. 112-115.

[34] *BP Statistical Review of World Energy: June 2007,* P. 36.

[35] "World Nuclear Power Reactors 2006-08 and Uranium Requirements," January 14, 2008, http://www.world-nuclear.org/info/reactors.html.

[36] In 2007, the Russian authorities stated officially that Russia was in seventh place in the world in terms of the size of its GDP, ahead of France, which accordingly dropped into eighth place after Russia. However, the method used by Russia in its calculations is unclear and not recognized internationally. Therefore, France is still presented in sixth place in this chapter.

[37] "Total GDP, 2006," July 1, 2007, http://siteresources.worldbank.org/DATASTATISTICS/Resources/GDP.pdf.

[38] "World Nuclear Power Reactors, 2006-08, and Uranium Requirements," January 14, 2008, http://www.world-nuclear.org/info/reactors.html.

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[46] Sh. Squassoni, *India's Nuclear Separation Plan: Issues and Views, CRS Report for Congress* (Washington, DC: Congressional Research Service, Dec. 22, 2006), PP. 19-21.

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[48] For details see: A. Arbatov, ed., Carnegie Moscow Center, *At the Nuclear Threshold: Lessons of the North Korean and Iranian Nuclear Crises for the Non-Proliferation Regime* (Moscow: ROSSPEN, 2007), PP. 16-61.

[49] Iran is cooperating with the IAEA on addressing problems with past violations but has not ratified the 1997 Additional Protocol it signed in 2003, which is supposed to ensure confidence that declared activities and materials correspond to the facts, and that no undeclared nuclear activities are taking place, as the IAEA director general's reports constantly note.

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[53] IAEA Illicit Trafficking Database (ITDB) (International Atomic Energy Agency, Vienna, 2006), PP. 3-5.

[54] "The concern is that an increase in the number of enrichment and reprocessing plants and an increased flow of fissile material may increase the risk of misuse and diversion." (*Weapons of Terror: Freeing the World of Nuclear, Biological and Chemical Arms* [Stockholm: Weapons of Mass Destruction Commission, 2006], P. 74).

Chapter 2. Nuclear Fuel Cycle Security

Anatoly Dyakov

The biggest risk to the nuclear nonproliferation regime today comes from the spread of fissile material production technology. Countries that possess uranium enrichment and/or spent nuclear fuel reprocessing technology are potentially able to quickly make a nuclear weapon, even if they are parties to the Nuclear Nonproliferation Treaty and their facilities are under IAEA safeguards. As IAEA Director General Mohamed ElBaradei put it, the nuclear fuel cycle is the nonproliferation regime's Achilles heel.[1]

However, it would be wrong to lay the blame for this loophole on the NPT's founders. The fact of the matter is that immense change has taken place in the world over the four decades since the NPT came into force. To a great extent, the NPT was originally designed to prevent industrially developed countries, such as the Federal Republic of Germany, Italy, Sweden, Switzerland, South Korea, Taiwan and others, from acquiring nuclear weapons, while at the same time offering them the benefits of peaceful nuclear energy and security guarantees. Back in the 1960s, when the NPT was being drafted, no one could imagine that the main players in proliferation and the dangers associated with it would eventually be not only countries that had only just recently freed themselves from European colonial domination and were considered developing or third-world nations, but also non-state entities in the form of extremist organizations. As experience has shown, economic, scientific and technical progress, globalization and the information revolution have made this possible, as have the huge inflows of financial resources into energy-exporting countries and also the nuclear weapons states' reluctance to carry out their nuclear disarmament commitments.

The new conditions that have emerged in the world call for the urgent adaptation of the NPT's mechanisms and regime and require a detailed review of some of its provisions (in particular, the extent of IAEA safeguards, the framework of peaceful nuclear cooperation under Articles III and IV, procedures for withdrawal from the Treaty in accordance with Article X, the export control regime, and so on). In this context, priority should be given to problems associated with the nuclear fuel cycle.

The fact that the nonproliferation regime has a loophole in the form of the right to develop the nuclear fuel cycle raises questions about whether the NPT meets nonproliferation objectives and also whether it can adequately protect the international community from threats that arise. Since for legitimate reasons countries in ever increasing numbers are being forced to turn to nuclear energy, preventing the spread of sensitive nuclear technologies and ensuring access for interested countries to nuclear fuel cycle services and products are essential conditions for maintaining the international nuclear nonproliferation regime.

The Outlook for Nuclear Energy Development

Nuclear energy arose at the start of the 1950s and developed rapidly over the following decades. By 1985, the combined capacity of all of the nuclear power plants (NPPs) in the world came to 250 GW. Many countries enthusiastically drew up nuclear energy development plans. The IAEA forecast made in 1982 projected that the combined capacity of all of the NPPs in developed countries would come to 1,200 GW by the year 2010.[2] But the Chernobyl disaster led to waning interest in nuclear energy and forced many countries, above all developed nations, to revise their plans. Most countries abandoned plans to build new nuclear power plants. Before 1986, around 30 new reactors a year were brought on line around the world, but the figure dropped to only five new reactors a year on average over the last 15 years. In the middle of 2007, 31 countries had nuclear energy, and there were a total of 445 nuclear energy reactors in the world. They have a combined capacity of 372 GW and produce around 16% of the world's electricity.[3]

Today, more and more countries are rethinking the role of nuclear energy and coming back to it as an alternative means of meeting rising energy demand. Forecasts predict that the world electricity demand will double by 2030, compared to 2003, reaching a level of 22,000 GWh.[4] Continuously rising prices for fossil fuels and their limited supply, as well as the need to take action against the climate change caused by the carbon dioxide emissions released into the atmosphere by using organic fuel, have also led to renewed interest in nuclear energy.

According to an IAEA forecast, under an optimistic scenario the combined capacity of all of the world's NPPs would reach a total of 679 GW by the year 2030.[5] A study carried out by the Massachusetts Institute of Technology predicted that by 2050 sixty countries would have nuclear energy, and total combined capacity would come to 1,500 GW.[6]

The development of nuclear energy is particularly intensive in South Asia and the Pacific Region. China, India, Japan and South Korea are all carrying out large-scale nuclear energy development programs. Vietnam, Indonesia, Thailand, the Philippines and Malaysia are also showing interest in developing nuclear energy. It is worth noting that of the 31 reactors most recently brought on line, 21 are in Asia, and half of all reactors currently under construction are in this region.[7] Just recently, Belarus, Poland, Algeria, Turkey, Egypt, Morocco, Saudi Arabia and Tunisia have all announced plans to build nuclear energy reactors.[8]

However, above all an analysis of the benefits of nuclear energy must take into account the risks that its extensive expansion would pose for the nuclear fissile materials control regime. The spread of sensitive nuclear fuel cycle technologies, such as natural uranium enrichment and spent nuclear fuel reprocessing, raises the biggest concerns.

The Nuclear Fuel Cycle

Most modern energy reactors use fuel with uranium-235 as the main component. Along with uranium fuel, some European countries (France, for example) produce and use MOX-fuel, in which the main fissile material is plutonium.

Natural uranium contains around 0.7% uranium-235, i.e. the uranium isotopes with a mass number of 235, and 99.3% of uranium-238. Of the two, only uranium-235 is able to sustain a fission chain reaction that will result in the production of energy. It is impossible to accomplish an explosive-type fission reaction with natural uranium and, therefore, it cannot be used to make nuclear weapons. But according to the IAEA's definition, uranium with an enrichment of more than 20% U-235 is a material that can be used directly to make a relatively compact explosive device. Uranium with a U-235 concentration of more than 90% is classified as weapons-grade material and is used to make nuclear weapons. Uranium with a U-235 concentration higher than the natural level can be obtained only by using complex technology to separate the isotopes.

Plutonium does not exist in a natural state and is an artificially produced element. It is obtained when a U-238 nucleus captures a neutron, creating short-lived U-239 and neptunium-239, which subsequently disintegrate into plutonium-239. The most suitable device for producing plutonium is a nuclear reactor running on natural or low-enriched uranium fuel. Through the process described above, the reactor's operation leads to the buildup of plutonium in the fuel, which can then be separated during chemical processing of the spent nuclear fuel.

The nuclear fuel cycle is usually divided into two stages: front-end and back-end. Fig. 1 shows the main processes in the nuclear fuel cycle using uranium and plutonium and illustrates the processes that can be used to obtain weapons-grade nuclear materials.

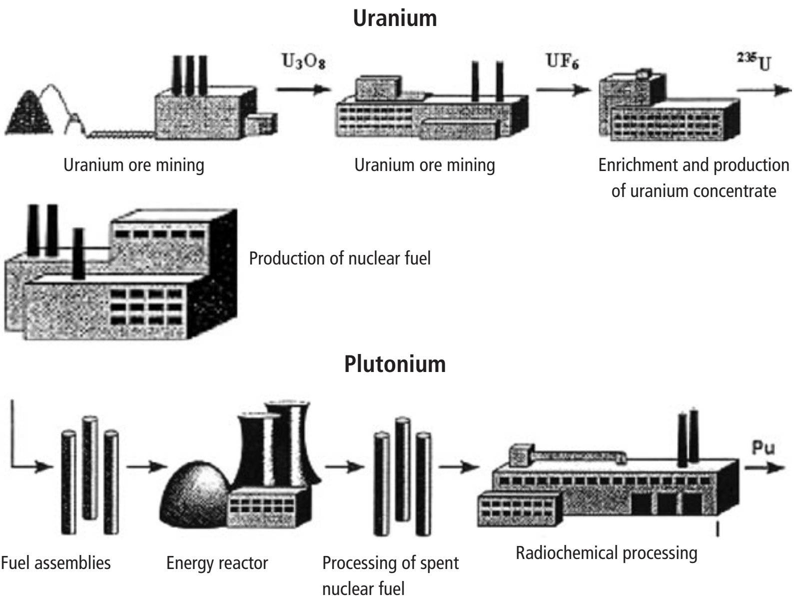

Fig 1. Main processes in the nuclear fuel cycle

It is important to note that the elements of the uranium chain in the front-end stage of the nuclear fuel cycle are absolutely the same as those used to produce weapons-grade fissile materials. However, not all elements of the nuclear fuel cycle pose the same level of risk to the nonproliferation regime. The most sensitive are uranium enrichment and spent fuel reprocessing.

Two types of enrichment technology are currently in industrial use: one is based on gaseous diffusion and the other is based on the separation of isotopes in gas centrifuges. A special term – separative work unit (SWU) – is used to compare the effectiveness of the different technologies and the capacity of the uranium enrichment plants. Around 200 SWU are needed to produce a kilogram of weapons-grade uranium, and 7-8 SWU are needed to produce a kilogram of uranium fuel with an enrichment level of around 5%.

A list of the countries that have uranium enrichment facilities is shown in Table 5.

Table 5

Countries with Uranium Enrichment Facilities

Country	Enrichment method	Capacity (1000 SWU a year)
Brazil	Gas centrifuge (under construction)	120
China	Gas centrifuge	500
	Gas centrifuge (under construction)	500
France	Gaseous diffusion	10800
	Gas centrifuge (under construction)	7500
Germany (Urenco) *	Gas centrifuge	1800 (4500)
Great Britain	Gas centrifuge	4000
India	Gas centrifuge	4-10
Iran	Gas centrifuge (under construction)	100-250
Japan	Gas centrifuge	1050
Netherlands (Urenco) *	Gas centrifuge	2500 (3500)
Pakistan	Gas centrifuge	15-20
Russia	Gas centrifuge	24000 (28000)
U.S.	Gaseous diffusion	18400
	Gas centrifuge (under construction)	6500

* The enrichment facilities in Germany and the Netherlands are not the property of these countries but belong to an international company, Urenco.

Note: The figure in parentheses is the capacity after the completion of a planned expansion.

Source: Global Fissile Material Report 2006, published by the International Panel on Fissile Material (IPFM), http://www.fissilematerials.org.

The gas centrifuge enrichment method is more effective and has become the dominant technology in use around the world. The U.S. and France continue to use gaseous diffusion technology, but both countries are building modern gas centrifuge facilities. It should be noted that because of its technical characteristics, uranium enrichment based on gas centrifuges creates a bigger risk for the nonproliferation regime. First, an enrichment facility using gas centrifuge technology needs only a few days to convert from low-enriched to high-enriched uranium production, thus creating the possibility of a breakout from the NPT, when civilian technology is quickly switched over to military use. Second, concealed centrifuge enrichment production is difficult to detect, and a small facility can produce enough high-enriched uranium in a year to make one or two nuclear explosive devices. The amount of electric energy that centrifuge technology uses for the enrichment itself (around 150 kWh/SWU) is similar to the amount of electricity used to light the workshop where the production is taking place.

Spent nuclear fuel reprocessing also creates serious risks for the nonproliferation regime, because its end result is the production of plutonium. Spent nuclear fuel from all types of reactors contains a certain amount of plutonium, but if the spent fuel is not reprocessed, the plutonium is relatively inaccessible, because of the fuel's high level of radioactivity. Technically, there are no secrets as to how to reprocess spent fuel, and the process has been described in detail in literature. But at the same time, actually carrying out reprocessing requires experience in reliable radiation protection and the use of remotely operated equipment, making it a very costly undertaking. Furthermore, it is more difficult to conceal the chemical processing of spent fuel, as it is inseparably linked to the production of radioactive krypton-85, a gas that is easy to detect. Traces of radioactive krypton in the atmosphere can be registered at a distance of several hundred kilometers from the reprocessing facility.

Making the Nuclear Fuel Cycle Safe

Clearly, in the context of the anticipated wide use of nuclear energy, maintaining the nuclear nonproliferation regime requires efforts to prevent the spread of sensitive nuclear technologies, while at the same time ensuring that interested countries have guaranteed access to peaceful nuclear power.

It seems that the cardinal solution could be a transition to innovative nuclear methodologies that would guarantee the stability of the nonproliferation regime through their inherent physical and technical characteristics. However, this would require the development of new types of nuclear power reactors and the fuel cycles associated with their operation. The development and use of this kind of new nuclear technology will therefore provide a solution only in the distant future. Over the coming decades nuclear power will continue to be based on existing fuel cycle technology. It is therefore expedient today to start erecting the institutional, economic and political barriers that will not prevent countries from developing and using nuclear power, but at the same time will motivate them to voluntarily renounce the acquisition of nuclear fuel cycle technologies.

The main motivations that compel countries to obtain nuclear fuel-cycle technologies include:

- ensuring national security and raising national prestige through the possession of the potential to make a nuclear weapon;
- guaranteeing energy independence and security;
- obtaining economic benefits.

Iran and Brazil could be conditionally included in the list of countries developing nuclear fuel cycle technology mainly for the first and second reasons. Both motives can exist in various combinations, since the second motive can be used as an official cover for the first.

As for the economic motivation, its justification often looks dubious. That is because the cost of the nuclear fuel, including the cost of uranium and its enrichment, has only a very minor impact on the cost of electricity production at nuclear power plants. Even if natural uranium prices rose ten-fold (from $30 to $300 per kilogram) the production cost of one kWh would not increase by more than 20%.[9] Similarly, a doubling of the SWU cost would increase the cost of one kWh by only a few percent.[10] Arguments for acquiring enrichment technology in order to make electricity production at nuclear power plants more profitable are therefore unconvincing. Establishing enrichment facilities in order to export their products is another matter. The profits in this case would depend on the current situation on the world market.

Acquiring nuclear fuel cycle technologies in order to ensure energy security is a serious argument. Responding to it requires a study of the world market's ability to guarantee reliable supplies of the entire list of civilian nuclear fuel cycle products and services, above all uranium supplies and enrichment services. Unless such guarantees are provided, countries (especially the 'problem' countries) cannot be expected to give up plans to develop their own enrichment facilities.

Currently annual world demand for natural uranium to ensure the operation of all 445 reactors in the world comes to around 67,000 tons, while mining produces only a little more than 40,000 tons.[11] Accumulated reserves make up most of the difference between consumption and production. With nuclear energy production projected to reach a level of 680 GW, annual natural uranium production will have to increase to 120,000 tons. This would require a sizable increase in mining capacity, which at the moment comes to 50,000 tons. Total proven natural uranium resources, for which mining costs are not more than $130 per kilogram, come to around 4.7 million tons; thus, if nuclear power develops as predicted, there will be sufficient resources to easily satisfy uranium demand for many decades to come.

In 2006, global demand for enrichment services came to around 42 million SWU.[12] If the nuclear energy industry develops according to the moderate forecast (680 GW by 2030), and if we assume that only light water reactors will be in operation, the annual demand for enrichment services will reach 82 million SWU. At the moment four companies dominate the world market for uranium enrichment services: EURODIF, Urenco, USEC and TENEX, which together satisfy 95% of enrichment demand.

The U.S. company USEC has used gaseous diffusion technology for a long time. Its two plants in Portsmouth and Paducah have a combined capacity of 18.4 million SWU a year. But the company has suspended production at the Portsmouth plant and will probably not resume it. The gaseous diffusion method requires more than ten times more energy to produce one SWU than the centrifuge method and is thus less economical.[13] The U.S. is currently building two new enrichment plants using gas centrifuge technology. One plant in Piketon, Ohio, will have a capacity of 3.5 million SWU/year and will use centrifuges designed and developed in the U.S. The other plant, in Eunice, New Mexico, will have a capacity of 3 million SWU/year and will use centrifuges developed by Urenco.

The multinational company EURODIF (with France, Italy, Spain, Belgium and Iran holding stakes), which is part of the AREVA group, has a gaseous diffusion plant, Georges Besse, in Tricastin (France), with a capacity of 10.8 million SWU per year. The company's stakeholders have the right to guaranteed enrichment services, but France alone possesses the enrichment technology. Work is currently underway at Georges Besse to replace the diffusion technology with centrifuges. The modernized plant's installed capacity will come to 7.5 million SWU/year, but it can be increased to 11 million if necessary.[14] The first stage of centrifuge production is expected to come on line in the first half of 2009.

The multinational company Urenco (Germany, Great Britain and the Netherlands) uses centrifuge technology for uranium enrichment. The company's three plants had a total production capacity of 8 million SWU a year as of the end of 2007.

The Russian company TENEX has four enrichment plants using sixth, seventh and eighth generation gas centrifuges, with a total production capacity of around 24 million SWU. As part of Russia's program to modernize its uranium enrichment industry, older centrifuges are being replaced with newer ones, and it is expected that by the end of 2010 total production capacity will reach 28.8 million SWU.[15]

It should also be noted that right from the start of nuclear energy's development the market for uranium and nuclear fuel has demonstrated high standards for reliability of supplies. The capacity of the existing uranium enrichment facilities in the world today will exceed demand for some time to come. Given the activity and potential of the market players offering enrichment services, we can assume that the market will have the technological and economic capability to guarantee demand for these services whatever course nuclear power development takes in the world. The technology is already in place, and unless demand starts to grow, the companies have no need to increase their capacity. Enrichment is a profitable business, and the competition on the enrichment services market is fierce, so we can be confident that any growth in nuclear energy capacity around the world will bring with it an increase in enrichment capacity.

However, there is still a risk that consumers of nuclear fuel cycle services will not have access to the services they desire, mostly for political reasons. Conditions must therefore be put in place to ensure that any consumer acting in strict compliance with its nonproliferation regime obligations should have convincing guarantees of access to nuclear fuel cycle services. In the opinion of IAEA Director General Mohamed ElBaradei, this could be achieved by developing and establishing a multilateral nuclear fuel cycle mechanism.[16] Without undermining countries' sovereign right to the peaceful use of nuclear energy, and without creating a new discriminatory division of countries into those who can and cannot have nuclear fuel cycle technology, this mechanism's objective would be to ensure the non-discriminatory and guaranteed provision of the relevant services and act as an effective incentive for countries to renounce the acquisition of their own nuclear fuel cycle technology.

Guarantees for the Provision of Nuclear Fuel Cycle Services

In the view of experts from the World Nuclear Association, establishing this kind of mechanism requires the development and implementation of a series of measures to strengthen the existing nuclear fuel cycle services market and make it economically advantageous for any country using nuclear energy and renouncing the acquisition of sensitive technology to buy these services on the international market.[17] The revelation in 2003 of a clandestine network, created by Pakistani nuclear scientist Abdul Qadeer Khan to supply nuclear technology and equipment, provided the impetus for new initiatives to address these issues.

The Initiative of IAEA Director General Mohamed ElBaradei

Speaking at a United Nations session on November 3, 2003, Mohamed ElBaradei proposed that uranium enrichment and fuel reprocessing be carried out exclusively at facilities under international control.[18] ElBaradei set up an independent group of experts to study the possible approaches and incentives for getting countries involved in establishing multilateral nuclear fuel cycle centers. The group's report proposes the following measures:

- Turning existing national nuclear fuel cycle centers into multinational centers;
- Setting up multinational regional nuclear fuel cycle centers on the basis of joint ownership rights.[19]

But the report also notes that current international law offers no legal basis for demanding that countries use these guaranteed providers of nuclear fuel cycle services.

U.S. President George Bush's initiatives

Seeking to close the loophole in the NPT that gives countries the lawful right to acquire nuclear fuel cycle technology, U.S. President George Bush called on countries in the Nuclear Suppliers' Group not to deliver uranium enrichment and spent nuclear fuel reprocessing technology to any country that does not currently have functioning enrichment and reprocessing facilities.[20]

Bush also proposed guaranteed nuclear fuel supplies at a 'fair' price to countries that renounce the acquisition of such technologies. But this initiative, put forward in 2004, has little chance of being realized, because it would add a new discriminatory division among NPT signatory countries alongside the existing division into 'haves' and 'have-nots' in terms of nuclear weapons. The biggest question is which countries would be allowed to have nuclear fuel cycle technology and which would not. Canada, for example, would not be allowed because it currently has no enrichment facilities, although it is considering building an enrichment plant to produce low-enriched uranium for its CANDU reactors. But Brazil, which already has a functioning enrichment program, would be allowed. Overall, this initiative would weaken rather than strengthen the NPT. The Iranian case shows that an additional division of countries into those who 'can' and 'cannot' have their own enrichment and reprocessing facilities would not only undermine the unity of the NPT members, but would also encourage the development of a black market for nuclear technologies.

In February 2006, President Bush proposed a more developed initiative – the Global Nuclear Energy Partnership (GNEP), aimed at reducing nuclear proliferation risks. The GNEP proposes developing nuclear energy through the creation of new types of reactors and improved nuclear fuel cycle technology, and it also calls for the formation of an international consortium of countries (the U.S., France, Great Britain, Russia, China and Japan) that have enrichment and reprocessing technologies. This consortium would renounce the transfer of enrichment and reprocessing technologies to other countries. At the same time, it would offer other countries guaranteed fuel cycle services, including the lease of fresh fuel and return of spent fuel, under the condition that they renounce national programs to acquire fuel cycle technologies.

But given the proposed program's complexity (the proposed development of new generation nuclear reactors and new elements of the nuclear fuel cycle), even if it is successfully implemented it would provide a solution to the problem of nuclear technology proliferation only in the quite distant future. Furthermore, this initiative has undergone serious criticism from non-governmental experts in the United States, who say in particular that because the initiative proposes fuel reprocessing, it would increase the risk of spreading sensitive technology.[21] (Chapter 3 gives more detail on this issue.)

President Vladimir Putin's initiative

In January 2006, President Putin proposed establishing an international center with other countries as co-founders for providing nuclear fuel cycle services, including uranium enrichment.[22] In accordance with this initiative, any country that wants to develop peaceful nuclear power and does not seek to acquire sensitive technology would conclude an intergovernmental agreement with Russia and have the opportunity to become a full-fledged partner – a shareholder in other words – of the International Uranium Enrichment Center (IUEC). One of the key principles of the center's operation is that its production facilities would be under IAEA safeguards, and the IAEA could also be a partner in the center's management. Partners in the IUEC would have the following guaranteed rights:

- Low-enriched uranium supplies or enrichment services;
- Participation in the center's operation and management;
- Complete information on contract prices and conditions and confidence in their fairness;
- A share of the earnings from this profitable business.

The only thing to which the foreign partners will not have access is the enrichment technology itself.

Russia's IUEC initiative is already in the implementation stage. Russia and Kazakhstan signed an intergovernmental agreement and the center was established at the enrichment plant in Angarsk (Russia's Irkutsk Region). Work on the creation of the IUEC is practically complete and the center has already begun operation.[23] Armenia became a partner in the center in February 2008, and a number of countries, including Ukraine, Mongolia, South Korea and Japan, have also shown interest in taking part in the center's work.[24]

Other initiatives

In June 2006, six countries that have enrichment plants (France, Germany, the Netherlands, Russia, the U.S. and Great Britain) proposed a project for discussion that would offer guaranteed supplies of low-enriched uranium to countries that renounce building their own enrichment facilities and sign a comprehensive safeguards agreement with the IAEA, including the 1997 Additional Protocol. The essence of this project is that if a situation occurs when one of the six countries is unable to fulfill its obligations to supply low-enriched uranium (LEU), the other members of the group will provide the deliveries, but only if the IAEA confirms that the recipient is in full compliance with its nonproliferation obligations. The mechanism for carrying out this initiative involves setting up a multi-level system of guarantees, from duplicating guarantees of ordinary contracts to establishing reserve stocks of LEU, which the IAEA would have the right to use. In September 2006, Japan proposed setting up an 'IAEA reserve system for guaranteed nuclear fuel supplies'. This complements the six-country project and proposes establishing an information exchange system to prevent any collapse of the nuclear fuel market. Finally, in September 2006, Great Britain put forward the idea of 'enrichment obligations' that could provide greater guarantees to countries in need of these services.

In September 2006, the American NGO Nuclear Threat Initiative announced that it was making $50 million available to start work on building up LEU reserves that would be in the IAEA's possession.[25] The IAEA could use these reserves to ensure the guaranteed supply of fuel without discrimination and political demands on the countries that have renounced national enrichment programs. But the NGO was making the money available on the condition that one or more IAEA member states contribute an additional $100 million. The proposal is difficult to implement, however, not only because of this condition, but also because such issues as the degree of the LEU stocks' enrichment and place of storage, the place where fuel would be produced from these reserves for specific consumers and the price have not been settled.

Russia also supported the idea of creating a nuclear fuel bank. Speaking at the IAEA 51st General Conference, Sergei Kiriyenko, Director of the Russian nuclear energy agency Rosatom, said that Russia plans to establish an LEU fuel bank worth $300 million at the IUEC in Angarsk.[26] This reserve stock would be sufficient to produce the amount of fuel needed for two 1000 MW reactors operating at full load. The criteria for access to this fuel bank are expected to be drawn up together with the IAEA in 2008.

At the same time, although plenty of initiatives have been suggested, they all raise many questions that still need to be answered.

It was already mentioned that international law contains no provisions obliging nuclear fuel consumer countries to take part in the international fuel cycle centers. Furthermore, as emerged from discussions of the proposed initiatives at a seminar organized by the IAEA in September 2006, most countries made it clear that they would not support any plan that would strengthen the division of countries into fuel suppliers and fuel recipients. The proposed initiatives' success will therefore depend above all on the recipient countries and whether they are willing to choose the world market over developing their own nuclear fuel cycle facilities. Obviously, only guaranteed supplies and advantageous price conditions can encourage countries to make this choice.

The idea of setting up an LEU and nuclear fuel bank under IAEA supervision and making them available at discount rates to countries that renounce the acquisition of their own nuclear fuel cycle facilities raises a whole number of problems. The idea looks wonderfully attractive and simple, but as always, the devil is in the details, and there are still more questions than answers. For example, who will pay for the work of the enrichment and fuel production plants, and at what price? If nuclear materials are supplied to 'reliable' consumers at a discount, who will cover the difference between the market price and the discount price in order to keep the plants profitable and provide dividends for investors? The IAEA budget does not provide for such expenses, and the Agency is not authorized to engage in commercial activity. It also needs to be decided exactly what is meant by 'under IAEA control'. Does this mean that the materials are the property of the IAEA, or will the Agency carry out some kind of management or supervisory functions or ensure safeguards?

There is also the more general question of what will happen to the world nuclear materials market if there is what amounts to a fixed cartel price for LEU supplied by the international centers. What guarantee will there be that this cartel price will really be the lowest, therefore encouraging importers to renounce their own nuclear fuel cycle plans? What can be done to preclude the possibility that the recipient countries, seeking ever greater discounts and privileges in nuclear cooperation in accordance with Article IV of the NPT, could use the concept of 'guaranteed LEU supplies' as an instrument for blackmail? After all, any country in theory could demand supplies under such preferential conditions (and perhaps also supplies of ready-to-use fuel), saying that otherwise it will develop its own nuclear fuel cycle.

The establishment of multilateral nuclear fuel cycle centers would also entail many economic, technical and legal difficulties. Will individual countries' rights to receive LEU or nuclear fuel depend on their share of investment in the international center, or will it depend only on their renunciation of their own nuclear fuel cycle, with the price and amount of services determined by a world market mechanism? In other words, if a country does not wish to invest in an international fuel cycle center abroad, will it have the right to guaranteed supplies solely in return for giving up its own nuclear fuel cycle? What kind of economic relations will the international fuel cycle centers have with the national companies operating on the export market, especially if one and the same country is participating in the international centers and also has national companies that export fuel cycle services? Does this mean that the international centers with their guaranteed supplies will eventually squeeze the national uranium enrichment companies into working only with countries that possess the nuclear fuel cycle? Who will provide compensation to the companies working within the international centers for the losses arising from guaranteed LEU supplies at lower prices? Which members of the international centers will take on the commitment of bringing spent nuclear fuel from importer countries into their own territory, then reprocessing and storing it?

Another issue to consider is that if the international centers monopolize the key phases in the nuclear fuel cycle (uranium enrichment and spent fuel reprocessing), this could have a negative impact on the market for the other phases in the fuel cycle – the production of uranium concentrate, uranium hexafluoride and fuel assemblies for reactors. This is particularly true of fuel assemblies because, as a rule, the supply of certified fresh assemblies and the removal and reprocessing of irradiated assemblies is technically and commercially closely linked to the supply of the reactors themselves.

Finally, the success of the initiatives to gradually internationalize the fuel cycle, proposed by the IAEA leaders and implied by the international fuel cycle center expansion plans, will largely depend on progress in ending the production of fissile materials for military purposes. All of the countries that do not have nuclear fuel cycle facilities can hardly be expected to agree to tie their nuclear energy needs once and for all to the international centers if the countries that possess fissile material production technology, including the five NPT members that are nuclear weapons states and the four 'outsider' countries, do not reach an agreement on prohibiting the production of fissile materials for military use, and if their enrichment and spent fuel reprocessing plants remain outside IAEA supervision. This issue could in principle be resolved through negotiations on the Fissile Material Cut-Off Treaty (FMCT), but for several years now these negotiations have been stuck firmly in a dead-end at the Geneva Conference on Disarmament because of the parties' military, technical, and political differences.

All of these issues require objective, thorough and competent study. The experience of research in the 1970s and 1980s should also be taken into consideration. Furthermore, analysis is needed of the current practical solutions aimed at resolving the problem of preventing the proliferation of nuclear fuel cycle technologies. In this respect, the construction of a nuclear power plant in Iran by the Russian company Atomstroyexport is of interest. In accordance with an intergovernmental agreement, Russia took on the commitment to supply fresh fuel and take back the spent fuel for the entire period of operation of this power plant. If this practice were used in all countries developing nuclear power, this would help make the nuclear fuel cycle safer. This practice is also attractive for recipient countries because it frees them from the problem of spent nuclear fuel management. Thus, this removes a serious barrier for developing national nuclear power programs. But the Iranian example also shows that these kinds of bilateral agreements do not rule out countries' interest in developing their own nuclear fuel cycle.

It is no secret that the current interest in nuclear fuel cycle issues grew above all out of the protracted crisis over the Iranian and North Korean nuclear programs. The precedent set by North Korea's withdrawal from the NPT and its manufacture of nuclear weapons using resources it had acquired through cooperation with the IAEA has forced the international community to adopt a highly negative view of Iran's nuclear fuel cycle program, which is being carried out in violation of IAEA safeguards. But at the same time, the new nuclear fuel cycle concepts are unlikely to provide any real solution in the cases of North Korea and Iran. Special multilateral talks on specific solutions for each of these two cases are already underway. The most that can be hoped for is that guaranteed supplies of LEU or nuclear fuel will figure in one form or another in the agreements reached. But even if solutions are found to the Iranian and North Korean problems, the idea of internationalizing the nuclear fuel cycle must not be allowed to slip from the agenda; otherwise the dangers and complications in this area will almost inevitably resurface.

Overall, it will be possible to develop nuclear energy on a broad scale while at the same time preventing the spread of sensitive nuclear technology through the nuclear fuel cycle only if the following basic conditions are met:

- The NPT members need to recognize the necessity of renouncing construction of their own new national enrichment plants, including small-capacity facilities;
- Countries that already have enrichment technology need to cooperate in this area and ultimately make a full transition to working through the international fuel cycle centers in the long term;
- The gradual internationalization process of existing fuel cycle services must begin in suitable forms and preferably under the auspices of the IAEA;
- Efforts must be made to strengthen the existing market for nuclear services by concluding long-term contracts and making them more transparent, and also by providing guaranteed nuclear fuel cycle services without discrimination to NPT members that renounce the development of their own uranium enrichment and spent fuel reprocessing technologies;
- Alongside price incentives, a comprehensive system of technological and commercial incentives for countries renouncing the nuclear fuel cycle must be developed;
- The eventual transition to international fuel cycle centers under the auspices of the IAEA must be accompanied by the application of the 1997 Additional Protocol to the entire civilian nuclear infrastructure of the nuclear weapons states and, if the FMCT is concluded, by its application to all of their uranium enrichment and spent fuel reprocessing plants.

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Chapter 3. The Global Nuclear Energy Partnership as a Driver for U.S.-Russian Nuclear Energy Cooperation: Successes and Failures

Rose Gottemoeller

The Bush Administration's Global Nuclear Energy Partnership (GNEP), launched with great fanfare in February 2006, was designed to transform U.S. policy toward nuclear power. Although nuclear reactors generate twenty percent of the electricity in the United States, since the Three-Mile Island and Chernobyl accidents, nuclear energy had become extremely unpopular among Americans. Many politicians, especially in the Democratic Party, officially opposed the nuclear option, and no new nuclear power plants had been licensed in the United States for nearly thirty years.

What is more, since the 1970s, the United States has not engaged in the separation of plutonium through reprocessing. Consequently, the United States has avoided acquiring technologies or processes that would result in the acquisition of plutonium or its utilization. This included not only reprocessing methods, but also certain power plant designs that could be used to produce plutonium – fast burner reactors, for example, operating in a breeder mode. Throughout this time the U.S. was helped by the fact that plutonium was not an economical way to generate electricity. Natural uranium was relatively abundant and cheap, so it was the preferred source of nuclear power plant fuel.

Because it has not been reprocessing, the United States has acquired a large amount of spent nuclear fuel, which it had planned to store in a geological repository at Yucca Mountain, in the state of Nevada. However, the Yucca Mountain facility has been plagued by uncertainties. Among other questions, scientists have been concerned about the amount of heat that could be generated by the spent fuel stored there, and whether heat accumulation might create the potential for accidents. This uncertainty has created a significant degree of local resistance to the facility. Moreover, the amount of spent nuclear fuel that the United States will be responsible for storing is already outstripping Yucca Mountain's total capacity of 70,000 tons.

The Global Nuclear Energy Partnership boldly proposed to change this picture. GNEP would help the United States solve the problems of nuclear power and then facilitate its expansion to respond to the burgeoning demand for energy in the United States and beyond. As Secretary of Energy Samuel Bodman said in announcing the initiative, "GNEP brings the promise of virtually limitless energy to emerging economies around the globe, in an environmentally friendly manner, while reducing the threat of nuclear proliferation. If we can make GNEP a reality, we can make the world a better, cleaner, safer place to live."[1]

Within two years after the initiative was announced, the United States developed international partnerships with 20 countries to design joint cooperation on expanding nuclear energy programs globally. "They recognize GNEP as a valuable forum in which to explore the benefits of safe and emissions-free nuclear energy," said Dennis Spurgeon, U.S. Department of Energy Assistant Secretary for Nuclear Energy. "GNEP is made up of countries with a wide range of experience related to nuclear power and this diversity strengthens the partnership, assuring that the common goal of safely expanding the use of nuclear energy worldwide moves forward."[2]

The bilateral GNEP partnership with Russia has enjoyed the most high-level attention. On two occasions, at the St. Petersburg G-8 summit in July 2006 and the Kennebunkport summit in July 2007, Presidents Putin and Bush announced joint programs to develop cooperation on nuclear power, building on GNEP, as well as on the initiative to establish international fuel services centers that Putin launched in January 2006 in St. Petersburg.[3]

The high-level attention has borne significant political fruit, but it has not yet led to concrete programs of nuclear technology cooperation between the United States and Russia. This essay will explore the positive developments in U.S. and Russian cooperation, but also will examine the problems that continue to plague it. Some of the problems are associated with uncertainties and difficulties surrounding GNEP itself, while others are specific to the poor relationship that currently exists between the United States and Russia. It is interesting, however, that nuclear energy continues to be an area where there is a high degree of interest in cooperation among technical experts, as well as politicians – despite the sour mood between the two countries.

The Political Fruits of GNEP

When Bush and Putin agreed in St. Petersburg to pursue nuclear energy cooperation, they were following on a history of failed attempts. Even during the 1990s, the Clinton administration had sought to engage Russia in wide-ranging nuclear energy cooperation in exchange for halting construction of the Bushehr nuclear power plant in Iran. Although Russia had stopped the sale of centrifuges to Iran under a deal brokered between Prime Minister Chernomyrdin and Vice-President Gore, the Russians argued that a light-water nuclear power plant did not represent a proliferation risk and refused to pull out of the Bushehr project.

By the time the Bush administration came to office, the Russian Ministry of Atomic Energy had begun to develop a fuel services contract with Iran, which strengthened the argument that Bushehr did not pose a proliferation risk. Fresh nuclear fuel would be delivered to the power plant from Russia, and spent nuclear fuel would be returned for storage and disposition. In this way, Iran would not have access to enriched uranium or the potential to separate plutonium from the spent fuel.

The Bush administration seemed to acquiesce to this argument in 2002, when it agreed to conduct a sixty-day study with Russia on nuclear energy technology cooperation that could be pursued. The acquiescence was predicated, however, on the notion that Russia would not build more than one reactor unit at the Bushehr site. As the study was underway, a 'strategic plan' was released from the Russian prime minister's office, calling for Russia to build up to five additional reactors in Iran.[4] The Americans reacted strongly to this news, since it appeared to contradict their condition. They stopped the sixty-day study and essentially ceased discussion of nuclear energy technology cooperation with Russia for the next four years.

For that reason, the Bush proposal that Russia and the United States work together to implement the Global Nuclear Energy Partnership was a major breakthrough in U.S. policy. Once it was linked to the Putin proposal to provide fuel services, the bilateral cooperation took on a larger international purpose and therefore acquired a greater chance of survival through swings in the political environment. Of greater importance, however, was the Bush administration's willingness to negotiate on two matters critical to the Kremlin: the uranium anti-dumping suspension agreement and the agreement for peaceful nuclear cooperation, which is usually called a '123 Agreement'.[5]

The United States had launched an antidumping action against Russia in the early 1990s for selling uranium too cheaply on the world market. Under the U.S. anti-dumping law, the resulting penalties could only be suspended through a process of negotiation, in which Russia would agree to certain conditions to govern its participation in the market in the future.

Although the price of uranium had risen considerably since that time, the United States had not been willing to enter into negotiations with Russia on the matter. After the St. Petersburg summit, this position changed, and the U.S. and Russia signed an anti-dumping suspension agreement on February 1, 2008.[6]

The United States had also refused to negotiate a 123 Agreement with Russia following the debacle of the Prime Minister's strategic plan in 2002. Washington insisted that Moscow was not being helpful on Iran, and until the Kremlin changed its policy, the U.S. would take no steps to facilitate nuclear energy cooperation with Russia. The 123 Agreement is critical for nuclear energy cooperation with any country, because it provides the legal basis on which the cooperation can occur. The United States has 123 Agreements with all major countries with which it is pursuing or hopes to have nuclear energy cooperation, including China. A controversial 123 Agreement was also recently negotiated with India, although political problems on the Indian side are preventing its entry into force.

The lack of a 123 Agreement with Russia, therefore, was a political sore point between the two countries. Furthermore, its lack was arguably not in the U.S. interest, because Russia is among the most advanced of nuclear energy technology-producing countries. Without a 123 Agreement, U.S. scientists and engineers could not work with Russia on technology projects beyond the stage of planning and paper studies. Therefore, the United States' insistence on linking the 123 Agreement to Russia's nonproliferation policy was preventing cooperation that would benefit the United States.

Addressing this issue became critical as the U.S. launched the Global Nuclear Energy Partnership, because the Americans were hoping to pursue technologies such as fast reactors and recycling of spent fuel that the Russians had been working on for many years. While U.S. nuclear energy technology programs lapsed after the Three-Mile Island accident, Russia had continued to pursue them even after Chernobyl and the economic crisis that accompanied the collapse of the Soviet Union. Therefore, Russia was in a good position to give the United States a technological boost in the arena of nuclear power – but a 123 Agreement would be needed to get beyond the study stage.

As the St. Petersburg summit approached, President Bush signaled that his administration recognized this problem and was ready to take the policy steps to resolve it. He stated publicly for the first time in April 2006 that the Bushehr reactor would not pose a proliferation risk, if the Russians delivered the necessary quantity of nuclear fuel to Bushehr, so that Iran would not have to acquire enrichment technology one way or the other. Speaking about this, Bush specifically emphasized that he was taking this step because he wanted the Russians to become part of the team that was trying to convince the Iranians to reject the development of a nuclear weapon.[7] He repeated this position most recently in December 2007, when the Russians sent the first shipment of fuel to the Bushehr reactor. In this way, the President began to publicly point out that Russia could play a positive role in solving the Iranian nuclear crisis.

This changed U.S. policy was the underpinning for a rapid and successful negotiation, which produced a 123 Agreement text ready for initialing in June 2007, right before the meeting in Kennebunkport. According to those involved on both the U.S. and Russian sides, there were few hiccups during the negotiations. The fact that the two sides were able to work so smoothly and quickly to produce an agreed text seemed to indicate the degree to which both recognized the importance and high priority of having the agreement in place.

The problems that emerged in working with the U.S. Congress will be described in detail below, but the success of these two negotiations – the anti-dumping suspension and 123 Agreement – pointed to the way in which the Global Nuclear Energy Partnership brought about major changes in U.S. policy. The conditionality that had dogged attempts at nuclear energy cooperation began to give way to a focused campaign to put in place the legal and policy means to effect such cooperation. In other words, the U.S. side had gone a long way toward changing the dynamic in favor of cooperation with Russia in the field of nuclear energy technology. In that way, the Global Nuclear Energy Partnership bore important policy fruit, even if the process was not completed.

Problem Area # 1: the Program Critiques

The Global Nuclear Energy Partnership got off the ground quickly with a major attempt to reach out to other nuclear energy countries around the world – and not only Russia, but also France, the UK, Japan and others. It also got off the ground quickly in the U.S. domestic context – too quickly, as its critics noted. The program faced questions early on from skeptics who were afraid that its emphasis on new technologies would take attention away from efforts to reinvigorate nuclear power in the United States along more conventional lines. The U.S. nuclear industry, for example, has been focused on completing the licensing procedures for building a new nuclear power plant in the United States, the first since Three-Mile Island.

Industry has even been sharing costs with the U.S. government to advance this process. In a program called Nuclear Power 2010, government-industry funding goes to projects that demonstrate the process for new reactor licensing in construction and operation, as well as reactor design certification.[8]

From the outset industry representatives were fearful that GNEP would undermine this effort, taking attention away from the short-term goal of getting a new reactor licensed. One company official, quoted anonymously, said early on that the proposal would be "irrelevant" to electricity companies except in a negative way, if it "distracts" from the construction of new reactors. In his view, the new initiative "does nothing to promote near-term reactor construction in the United States."[9]

A related concern expressed early on was that there is no legal or policy infrastructure in place for licensing the types of facilities that GNEP would encompass. Soon after the new initiative was announced, Edward McGaffigan, Commissioner of the U.S. Nuclear Regulatory Commission, said that current NRC regulations are not well-suited to licensing reprocessing plants. He proposed that the NRC staff begin "to provide a conceptual design of a licensing process for a reprocessing facility (and possibly associated co-located facilities) by the end of 2006."[10]

McGaffigan stressed that it would be important to address early on some "thorny issues" peculiar to the facility's design, such as safeguard techniques, security, ease of decommissioning, handling of waste streams, and safety issues. Otherwise, he said, the U.S. was likely to repeat the mistakes of the past: "national experience in operating large-scale reprocessing facilities without extraordinary back-end… costs is unblemished by success."[11]

Despite these concerns, the Department of Energy moved early to begin construction of an industrial facility to reprocess spent fuel without separating plutonium. One assumption by the agency was that the U.S. nuclear industry would be willing to invest in the facility, thus sharing the costs with the government. Industry, however, remained focused on licensing new power plants according to existing designs, rather than beginning investment in a new technology that was essentially untried in commercial-scale operations.

Tensions over this issue were exacerbated in October 2007 when the U.S. National Academy of Sciences published a report, the headline of which was that the reprocessing program should be scaled back in favor of getting new nuclear power plants on line. The National Academies, which are a non-governmental entity with a reputation for independence in scientific assessments, were scathing in their criticism: "…the technologies required for achieving GNEP's goals are too early in development to justify DOE's construction of commercial facilities that would use these technologies... Moreover, there has been insufficient peer review of the program."[12]

NAS called instead for a return to research and a focus on a careful decision process as to whether or not to proceed with deploying reprocessing technologies. The Committee did not reach a consensus on this matter, however, which shows how controversial reprocessing is in the United States. The Committee split into three groups on its recommendations:

"While all 17 members of the committee concluded that the GNEP R&D program, as currently planned, should not be pursued, 15 of the members said that the less-aggressive reprocessing research program that preceded the current one should be. However, if DOE returns to the earlier program, called the Advanced Fuel Cycle Initiative (AFCI), it should not commit to a major demonstration or deployment of reprocessing unless there is a clear economic, national security, or environmental reason to do so. Two committee members recommended that DOE's spending on reprocessing research should be held at pre-AFCI levels and that DOE should not develop commercial reprocessing technologies beyond the early laboratory stage. In addition, three other committee members believe a technology not currently being explored by GNEP would be better suited for reprocessing."[13]

The most important aspect of these recommendations is the cautions that they laid before U.S. national decision-makers. First, the rationale for reprocessing would have to be very clear for a decision to be made to move even to a demonstration phase. Economic, national security and environmental issues should all be taken into account. Second, costs should be strictly held in check as long as these issues continued to be studied. Third, other technologies for reprocessing, not currently in the GNEP program, should also be considered.

Beyond its sharp critique of the GNEP reprocessing initiative, the Academy study team called on the Department of Energy to return to its emphasis on licensing new reactors under the Nuclear Power 2010 program. Reflecting the concerns of the nuclear industry and the Nuclear Regulatory Commission, they recommended resuming full focus on key elements of the 2010 program, such as completing the design engineering of advanced light water reactors and helping the NRC to work out procedures for more efficient licensing of reactor construction and operations. They also noted that the program would need increased funding in order to be able to meet its goals.

Finally, the committee pointed out that the focus on GNEP had caused other key DOE nuclear energy programs, especially the Generation IV (GEN IV) advanced nuclear reactor program, to lose momentum. Gen IV was unlikely to result in a next-generation nuclear reactor in operation by 2017 because of the delays caused by GNEP; likewise, the Nuclear Hydrogen Initiative would slip in scheduling because of its link to Gen IV.[14]

The report, an independent review by the National Academy of Sciences, was actually funded by the U.S. Department of Energy, but the DOE was not particularly pleased by the result. In its official response, the Department stressed that it had already taken steps to remedy the problems that the Academy had pointed out, in particular renewing emphasis on the Nuclear Power 2010 and Gen IV programs, and also backing off from near-term plans to construct an industrial-scale reprocessing plant.

Both the Academy's study and the DOE response seemed to be leaving the GNEP program in limbo as the Bush Administration was drawing to a close. Two points alone seemed clear: nuclear power had gained a wider range of acceptance among American political parties thanks to the high-visibility Bush initiative to advance GNEP. Although previously the Democratic Party had largely resisted nuclear power because of environmental concerns, the Bush initiative sparked wide attention to the potential benefits to address global warming. It is ironic, in fact, that the early Bush resistance even to acknowledging global warming gave way, with GNEP, to embracing global warming as the key rationale for expanding nuclear power worldwide. Although the Democrats did not fully buy into this rationale and continued to insist that other energy sources such as wind and solar must play a role, they also began to accept that nuclear energy could play an important part in the overall equation.

Second, the GNEP program, following the Academy's critique, seemed destined to return to being a research and development program. The proposal to proceed quickly with building a commercial-scale reprocessing plant had been widely criticized even before the study was completed, with many in the U.S. expert community voicing their concerns that such a project was premature. There is wide-scale agreement, however, that research on new nuclear energy technologies, including fast reactors, fuels and reprocessing, should be pursued.[15]

Problem Area # 2: Critiques of Russia

Although the Bush Administration's policies have gone a long way to opening up the possibility of nuclear energy technology cooperation with

Russia, concerns remain in certain circles. The Congress has been especially critical of Russian cooperation with Iran on the Bushehr reactor project. In particular, although the Bush Administration dropped its insistence that Russia halt construction of a reactor at Bushehr, the Congress has never agreed to drop the linkage. As a result, the President may have said that the Bushehr reactor project and its accompanying fuel services contract were helpful to nonproliferation policy, but the Congress does not apparently accept his assessment.

Congressional concern was expressed in 2007 in a law that originated in the House of Representatives. "The Iran Counter-Proliferation Act of 2007," HR. 1400, was passed by the House on September 25, 2007. The bill specified that "no agreement for cooperation between the United States and the government of any country that is assisting the nuclear program of Iran or transferring conventional weapons or missiles to Iran may be submitted to the President or to Congress pursuant to section 123 of the Atomic Energy Act of 1954" unless the President can determine and report to Congress that Iran has either ceased its nuclear programs or the country assisting Iran has suspended all nuclear assistance and conventional weapon sales to Iran.[16]

The country targeted by the legislation is clearly Russia, and in fact Russia is specifically mentioned in the law. In order for the 123 Agreement with Russia to be finalized, the Administration will have to send it to Congress for a review period of 90 days of continuous session. In effect, this period can extend from four to six months, depending on the Congressional calendar. The Congress does not have to vote affirmatively on the agreement, but it does have the opportunity to enact legislation to disapprove the agreement. HR. 1400 makes it virtually certain that such legislation would be enacted against the 123 Agreement with Russia. As one Washington expert commented on the matter, "The Bush Administration is afraid that if they send up the 123 Agreement to the Congress, then it will come back in a body bag."[17]

Unlike previous draft legislation of this kind, HR. 1400 does not give the President the authority to waive the requirements of the law – so from the perspective of the U.S. executive branch, it allows for little flexibility. The draft was referred to the Senate in December 2007, where it awaits the normal process of negotiation between the two bodies before it can finally become law. A similar version, S. 970, was developed in the Senate and had 68 cosponsors at the end of 2007.

The U.S. has fallen behind in fast reactor and other technologies over the past two decades, and cooperation with Russia could bring new life to

U.S. technology programs that have essentially been moribund. The case for U.S.-Russian cooperation is a good one and can clearly be couched in terms of U.S. national interests, especially in the light of U.S. desires to be a leader in nuclear power in the future.

There continued to exist, however, a clear disparity between Congress and the Executive Branch in views about Russia's role in Iran. The Bush Administration accepted, more or less, that Russia was prepared to play a positive role in trying to resolve differences with Iran over its nuclear program. The Congress simply did not believe this, instead insisting that Russia was prepared to aid and abet the Iranian nuclear program. Congressmen and their staffers would often comment that Russia simply does not accept that there is a threat from the Iranian nuclear program.[18]

This profound difference between the Congress and Executive Branch was exacerbated in early December 2007, when the National Intelligence Estimate (NIE) was published that cast doubts on the current existence of an active Iranian nuclear weapons program. Although Russia was not directly involved in the NIE imbroglio, the ensuing recriminations in Washington did nothing to improve the mood regarding Russia and the Bushehr reactor – especially once Russia began shipping fuel to the reactor site later in December. In essence, the Congress has had a long-standing tendency to associate problems with the Iranian nuclear program with Russia, and the NIE did nothing to change this situation.

Breaking the Stalemate

The situation is not inevitably frozen in this negative place. Most critical will be careful work with the U.S. Congress to make the case that technology cooperation with Russia is a factor critical to the future of U.S. success in the nuclear power arena. The United States is currently playing catch-up, struggling to compensate for a 'lost generation' of research work that was sharply curtailed or shut down outright after the Three-Mile Island and Chernobyl accidents over two decades ago. A well-planned program of nuclear energy R&D work with Russia can help the United States to succeed at this game, especially where fast reactors and their fuels, as well as spent nuclear fuel disposition, are concerned.

Key Senate and House of Representatives members and their staffers can make a difference to the mood on Capitol Hill. Important interlocutors are Senator Biden and Senator Lugar, the leadership figures on the Senate Foreign Relations Committee, and their counterparts in the House, especially Congressman Howard Berman, who took over as

Chairman of the House Foreign Affairs Committee after the death of Representative Tom Lantos. Other important figures will be the Chairman of the Senate Energy and Water Subcommittee, Senator Byron Dorgan, and Senator Pete Domenici (the leading Republican on this subcommittee). Likewise, their counterparts in the House of Representatives (Chairman of the Subcommittee, Peter Visclosky, and David Hobson) are important targets, as are Senator Carl Levin, the Chairman of the Senate Armed Services Committee, and his counterparts in the House of Representatives, especially Congressman Ike Skelton, Chairman of the House Armed Services Committee, and Congresswoman Ellen Tauscher, who serves on the Committee. These are all people who can affect Congressional opinion on Russia.

Russia could also take a hand in improving the mood on Capitol Hill, working in cooperation with the U.S. administration. With the election of Dmitry Medvedev to the Russian presidency in March 2008, members of Congress were naturally curious about what differences, if any, his arrival would make to the environment surrounding U.S.-Russian relations. The case can be made that, working together, the two presidents will succeed in a more safe, environmentally sound, economically efficient and proliferation-resistant expansion than if each country goes its own way. For example, if the United States is willing to work closely with Russia on the development of international fuel services through the Angarsk center, then it will have a real answer for countries who say that they cannot be sure that enrichment services will be guaranteed. Since the Angarsk center will also address the back-end of the fuel cycle, the United States will also begin to have an answer to the question about what to do with spent nuclear fuel.

The United States could help with this confidence-building by proceeding to sign the 123 Agreement with Russia, even if the time is not yet ripe to submit it to the Congress. Signing the agreement could in fact be a precipitating step to going to Capitol Hill as a joint team, to make the case for U.S.-Russian nuclear energy cooperation.

Russia, for its part, could more clearly make the case to interested parties in the U.S. for the Angarsk center and other areas where its atomic energy establishment is willing and able to work with the United States. Of course, that establishment has been undergoing a difficult reorganization as the Russian Atomic Energy Agency transforms itself into a state corporation. Nevertheless, many of the key elements are in place for joint cooperation, including working groups for defined aspects of cooperation under GNEP. The Russian experts are in place, in other words, who can make an effective argument for cooperation, even if the bureaucratic superstructure is still undergoing adjustment.

The uncertainties of this period need not hamper development of nuclear energy cooperation, and in fact it could be an optimal time to tackle head-on some of the doubts and misperceptions that have prevented such cooperation from moving forward, especially in the U.S. Congress. Making good use of this period, although it requires some political strength to address the negative mood between the two countries, will pay good dividends in future cooperation to expand nuclear power worldwide.

Notes

[1] See Department of Energy, "Department of Energy Announces New Nuclear Initiative," news release, February 6, 2006, http://www.gnep.energy.gov (accessed May 6, 2006).

[2] Department of Energy, "Republic of Senegal Joins the Global Nuclear Energy Partnership," news release, February 1, 2008, http://www.gnep.energy.gov/gnepPRs/gnepPR020108.html (accessed February 19, 2008).

[3] St. Petersburg and Kennebunkport Bilateral Summit statements.

[4] For more on this episode, see P. Baker, "Russia Plans 5 More Nuclear Plants in Iran," *Washington Post,* July 27, 2002; S. L. Myers and S. Tavernise, "Iran Nuclear Issue Sours U.S.-Russian Talks on Energy," *New York Times,* August 2, 2002.

[5] An agreement for peaceful nuclear energy cooperation is negotiated pursuant to Section 123 of the U.S. Atomic Energy Act of 1953; therefore it is often known in short as a "123 Agreement".

[6] An excellent review of this issue may be found at: "Insight Briefing: New import rules for Russian uranium," *World Nuclear News,* February 4, 2008, http://www.world-nuclear-news.org/print.aspx?id=15246 (accessed on February 18, 2008).

[7] April 2006 Press Conference and December 2007 remarks on the shipment of Bushehr reactor fuel.

[8] R. Michal and E. M. Blake, "GNEP rollout means big jump for fuel cycle," *Nuclear News,* March 2006, P. 64.

[9] Horner, Hiruo and MacLachlan, *Nuclear Fuels,* February 13, 2006.

[10] Ibid.

[11] Ibid.

[12] The National Acadamies, "DOE's Spent Nuclear Fuel Reprocessing R&D Program Should Be Scaled Back; Boosted Efforts to Get New Nuclear Power Plants Online Needed," news release, October 29, 2007, http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=11998 (accessed February 18, 2008).

[13] Ibid.

[14] Ibid.

[15] For a sample of such comments, please see: http:://www.princeton.edu/~globsec/publications/pdf/HouseBriefing10March06rev2.pdf; http://www.puaf.umd.edu/Fetter/Presentations/2006-11-13-NPEC.pdf.

[16] This discussion draws on a paper by O. F. Kittrie, "Realizing the Vision of the 123 Agreement: Vehicles for Future Cooperation" (draft prepared for the National Academy of Sciences project on "The Future of the Nuclear Security Environment in 2015," December 2007). See also: Center for Nonproliferation Studies, Monterey Institute for International Studies, "The Iran Counter-Proliferation Act: Potential Implications for Russian-Iranian Relations and U.S.-Russian Nuclear Cooperation," October 26, 2007, http://cns.miis.edu/pubs/week/071026.htm (accessed February 18, 2008).

[17] Private email exchange with the author.

[18] In February 2008, a new manifestation of this phenomenon occurred when Congressman Dingell of Michigan, Chairman of the House Energy and Commerce Committee, attacked the Department of Energy for cooperative programs with Russian institutes that also were providing some components for the Bushehr power plant. Although none of the institute activities were sanctionable under U.S. law, Dingell sharply criticized the DOE for allowing U.S.-government-sponsored projects to go forward with them. For a reasoned commentary on this episode, see B. Finlay, "Energy Department Links to Iranian Nukes Salacious, but Untrue," The Henry L. Stimson Center, February 25, 2008, http://www.stimson.org/pub.cfm?ID=573 (accessed on March 16, 2008).

Part II

PROLIFERATION OF THE MEANS OF DELIVERY OF NUCLEAR AND CONVENTIONAL WEAPONS

Chapter 4. Missiles and Missile Technology

Sergei Oznobishchev

The threat of missile proliferation arises above all from the greater access to missile technology available to countries previously considered third-world nations, as well as the increasing attractiveness of missiles (and space rockets) as symbols of advanced military capability and international prestige. The nuclear nonproliferation regime's insufficient stability and the fact that missiles can be equipped with nuclear warheads have made them particularly valuable as a 'ticket to the big league' of nuclear powers in the eyes of countries seeking to obtain nuclear weapons, but unable to create a full-scale modern military capability on a par with the world's leading military power centers.

This situation has resulted in the synergy of two military-technical processes in which nuclear proliferation creates a demand for missiles as the most effective means of delivering nuclear weapons, while missile proliferation creates the material base that can give even an entity with a small nuclear potential regional and even global reach. At the same time, missile proliferation has started to pose new threats, not just because missiles can deliver weapons of mass destruction (WMD). As noted in chapter 7, new technology that could well become available to many countries in the foreseeable future would enable the construction of higher-precision missiles and make it possible to carry out strikes against critically hazardous facilities, including nuclear power plants. Given the high concentration of dangerous production facilities in cities, the damage caused by the explosion of even a conventional warhead would be magnified many-fold and would be akin to using WMD if it hit such a facility.

The Missile Technology Control Regime

Seeking to reduce the missile proliferation threat, in 1987 the G7 countries (Great Britain, Germany, Italy, Canada, the U.S., France and Japan) launched an initiative that led to the establishment of the Missile Technology Control Regime (MTCR), which now has 34 member countries, including Russia.

What is troublesome, however, is that countries whose political and military aspirations are the cause of serious concern have not joined the MTCR, although, as noted in the Russian Foreign Ministry documents, "Over recent years, largely at Russia's initiative, contacts with countries not in the MTCR have intensified with the aim of informing them about the MTCR's work and taking practical steps to help prevent the proliferation of WMD delivery systems."[1] As a result, some countries not in the MTCR (China, for example), have officially declared their interest in joining. But the number of countries joining is growing very slowly and is clearly not keeping up with the pace and possibilities of missile and missile technology proliferation.

The MTCR's main documents comprise the Guidelines that set forth the principles for the transfer of missiles and missile technology, the procedural memorandums and the Equipment, Software and Technology Annex, which lists goods under two categories and indicates the respective restrictions. The MTCR is not legally binding; countries that share the goal of missile nonproliferation commit themselves to its provisions voluntarily.

The Guidelines' stated goal is to "limit the risks of proliferation of weapons of mass destruction (i.e. nuclear, chemical and biological weapons), by controlling transfers that could make a contribution to delivery systems (other than manned aircraft) for such weapons. The Guidelines are also intended to limit the risk of controlled items and their technology falling into the hands of terrorist groups and individuals."[2]

Restrictions are imposed on the items listed in the Annex to the Guidelines, and the issue of whether transfers should or should not be allowed is decided on a case by case basis. The document notes that national governments will "implement the Guidelines in accordance with national legislation."[3] All MTCR decisions are made on a consensual basis and must be approved at the MTCR plenary session (Fig. 2).

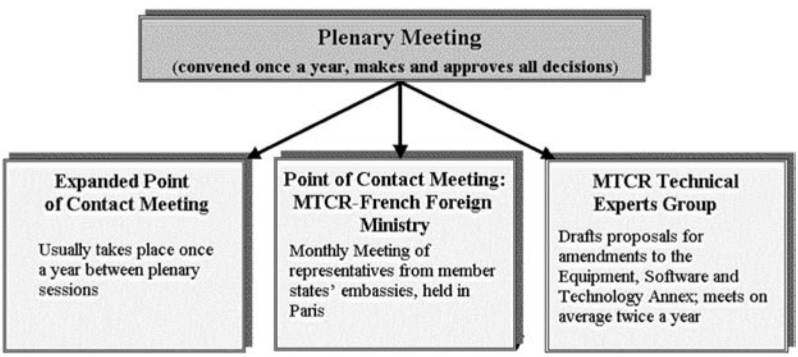

Fig.2. MTCR decision-making process

Special restraint is to be applied to the export of items listed under category I in the Equipment, Software and Technology Annex. This list includes missiles (including ballistic missiles, space launch vehicles, and sounding rockets) able to deliver a payload over 500 kg at a range exceeding 300 km, and unmanned air vehicles (including cruise missiles, radio-controlled target drones and radio-controlled reconnaissance drones capable of delivering a payload over 500 kg at a range exceeding 300 km). These provisions also apply to everything needed to manufacture and use these missiles (test and production equipment, software, technology). The provisions also prohibit the transfer of complete, assembled systems (engines, guidance systems, software, technology) used for delivery systems. Special restrictions are applied to these systems regardless of the stated purpose of the transfer, and the principle of 'rejection as a rule' applies.

Category II is a structured list of restrictions with a large number of important notes that divides all goods into 18 sections. Exports of the items on this list are not subject to such strict limitations as the Category I items.

The MTCR participating countries periodically update the lists. In Russia, for example, recent additions were made by Presidential Decree # 1030 "On Amendments to the List of Equipment, Materials and Technology that can be Used to Make Missiles and to which Export Controls shall Apply," dated August 6, 2007.[4] Restrictions are applied on the basis of regularly updated and approved lists, and for this purpose national technical experts hold regular meetings to clarify and enhance the Equipment, Software and Technology Annex.

The supplier country is responsible for enforcing the restrictions. The Guidelines recommend taking into consideration the goals pursued by the recipient country's missile and space programs, the potential for the delivered items to be used in WMD delivery systems, assessment of the final purpose of the deliveries, the risk of items on the control lists falling into the hands of terrorists and terrorist groups and so on.[5] Point 5 of the Guidelines states that where transfers of missile technology or equipment could be used in WMD delivery systems, the supplier country's government shall authorize such transfers only upon receipt of appropriate assurances from the government of the recipient country. It states that the items delivered must be used only for the stated purpose, that the stated purpose must not change, and that the items themselves may not be modified or replaced without the prior consent of the supplier country's government. Furthermore, it states that no subsequent transfers of items can take place without the supplier country's government's prior consent.[6]

But there are no provisions for sanctions against acts not in compliance with the regime's provisions.

The entire control system is therefore based on each country enforcing its national restriction lists, which are coordinated with the approved list regularly updated at the MTCR plenary sessions. Overall, the MTCR is based on states' voluntary compliance with recognized guidelines on what can be exported and what cannot. But participant countries can obviously have different views in their evaluations of the aims pursued by recipient countries' missile and space programs.

Many years of practice have revealed other shortcomings in the regime. Not all countries share full and timely information on national decisions concerning the national control lists and their restrictions. Adapting these lists to reflect the decisions made at the MTCR plenary sessions is a lengthy process. There are also noticeable differences in how the agreed restrictions are interpreted and implemented at the national level.

The 2006 and 2007 plenary sessions, which took place in Copenhagen (Denmark) and Athens (Greece) respectively, adopted several amendments that sought to bolster the regime but have not succeeded in addressing its shortcomings. At the Copenhagen session in October 2006, delegates emphasized the growing risk of the proliferation of missile-based delivery systems in the context of ongoing nuclear proliferation (this threat is also mentioned in similar terms in the Athens document). They also adopted an understanding that the definition of technology transfer contained in the Guidelines covers the transfer of both material and non-material items. They noted that the MTCR has succeeded over the years of its existence in establishing international export control standards that are being increasingly observed even by non-participant countries, and the participant countries affirmed their desire to develop cooperation on a bilateral and multilateral basis with these countries in order to make the MTCR more effective.[7]

Based on the results of the session, 23 points in the Equipment, Software and Technology Annex (Category II) were amended or supplemented, so as to then be taken into account in adjusting the national control lists. The constantly updated Equipment, Software and Technology Annex as it stands today is a detailed and ever-growing document that has grown to over 70 pages.

The adjustments made in Copenhagen clarify technical and organizational details of the restrictions. Many of them were motivated by the concerns expressed at the Athens plenary session of November 7-9, 2007, regarding restrictions on missiles with a range exceeding 300 km. Specifically, adjustments focused on turboprop and turbofan engines designed for fully unmanned aircraft and missile systems not referred to earlier, with a range of 300 km or more.[8]

The delegates at the Athens plenary session reaffirmed the need to implement the UN resolutions on WMD nonproliferation, which in their view are directly related to export controls. They expressed their firm resolve to implement these resolutions and be vigilant in transferring and preventing the transfer of any items, materials, goods or technology that could contribute to the proliferation of missiles able to deliver WMD.[9] The plenary session's particular emphasis on restricting ballistic missiles reflected, above all, U.S. concerns over Iran's growing missile capability and the need to restrain it.

The national control lists and restriction systems they include are derived from the Equipment, Software and Technology Annex that is regularly approved and updated at the international level. This sometimes results in conflicts over the content and destination of deliveries. One memorable case for Moscow was when the U.S. administration made accusations against it after Glavkosmos signed a contract with India in 1992 to deliver cryogenic booster rocket engines for the Indian GSLV space vehicle. In the end, in 1993, the U.S. managed to get these deliveries stopped. Responding to (unproven) accusations that Russian specialists were helping Iran to develop its missile capability (Shahab missile), Washington imposed sanctions on ten Russian companies in 1998.[10]

For the MTCR to be implemented effectively, supply channels of missile systems and technology have to be detected and shut down. But in this area, too, there are differences in assessing proliferation sources. A 2005 U.S. State Department report on compliance with treaties and obligations relating to arms control, nonproliferation and disarmament said that China was violating the MTCR. The Chinese government was accused of supplying Iran, North Korea and Pakistan with restricted materials and technology contributing "to the development of missile programs in violation of the Chinese government's obligations on missile nonproliferation, adopted in November 2000."[11]

Officials in Washington also cited the activities of a number of Russian companies that, while not directly violating the MTCR, cast doubts on "Russia's ability to implement control of missile-related technology."[12] Chinese and Russian officials did not agree with these assessments.

Russia, for its part, has accused Ukraine of illegally exporting Kh-55 cruise missiles to Iran and China. This case highlighted some of the characteristic features of the MTCR. The Ukrainian foreign minister declared that

Kh-55 missiles were lawfully delivered from Ukrainian territory only to the Russian Federation, but he was forced to admit that earlier, the Ukrainian authorities had discovered evidence that an "international criminal group" was smuggling these missiles to Iran and China, and this was made public at one of the MTCR plenary sessions.[13]

These cases show that countries regularly make claims against each other and these claims require objective examination. The Ukrainian case is a different kind of situation — the unauthorized acquisition of missile systems not by a state, but by a group of individuals. If an international criminal group could get hold of missile systems in order to sell them, this confirms the real danger that missiles could be acquired for the purpose of carrying out terrorist acts. This serious threat to international security requires greater control over all possible forms of missile proliferation.

Military-Technical Cooperation on Missiles and the International Code of Conduct

It is not only the MTCR's shortcomings that create opportunities for missile proliferation. Many countries have established a solid design and production base for producing missiles and have greatly reduced their dependence on imports of missiles and missile technology.

Many countries had already developed strong cooperation in missile building long before the MTCR was born. Technologically developed countries carried out research and development work under contract for countries that had the money but did not have their own research and production base. In order to produce missile systems, the country that develops them usually constructed and equipped the plants that would manufacture the missiles, while the other countries taking part in the project built the final assembly lines. Missiles were tested in whichever of the countries had the right conditions for carrying out such tests.

Beyond the five nuclear powers, the development of missile technology fell into the following main categories.

First of all, there were independent programs based on missile technology that was acquired earlier and that did not have any significant impact on other countries' programs:

- The Indian Prithvi and Agni-type missile program;
- Argentina's Alacran missile program, which uses technology designed within the Condor-2 international program based on legally and illegally obtained American, German, French and Soviet missile technology;

- Egypt's Sakr-80 missile program, which focuses on building a solid-fuel missile based on Soviet and French technology;
- Turkey's missile program, aimed at developing a series of tactical battlefield ballistic missiles (with plans to eventually build medium-range missiles) by adapting modern electronics technology and solid-propellant rocket engines to missile construction;
- South Korea's missile program, which involves developing American missile technology acquired earlier.

Second, there are the relatively independent programs carried out by countries on their own, using foreign missile technology in the initial stages. These programs have a certain impact on other countries' programs:

- The Israeli Jericho missile program, which has built up considerable technical know-how and has had a significant impact on South Africa's Arniston missile program and to some extent on Taiwan's Sky Bow program;
- Iran's missile programs, which used technology and direct supplies from North Korea and some from China and later became increasingly based on domestically developed technology;
- Brazil's programs, based on adaptations of Soviet and American technology, which are transferred to China and via China to other countries.

Third, there are the fundamental programs focused on building missiles for the country itself and for export:

- China's M-series missile programs;
- North Korea's missile programs based on the assimilation (and improvement, with the help of Chinese technical specialists) of liquid-fuel missiles such as the Scud. The North Korean programs have had an impact on the missile programs of Iran, Libya, Syria and others.

Fourth, there are programs that are for the most part independent, but make use of key exported missile technology:

- Taiwan's Sky Bow missile program, carried out by the country's own missile building industry, but with some technical 'infusions' from Israel;
- Spain's Capricomio program, which specialists say uses missile technology developed by the Condor-2 program in Argentina.

Fifth, there are subordinate programs, the implementation of which is almost completely dependent on the success of missile programs in other countries:

- Pakistan's Hatf program, which is essentially a national branch of China's series-M solid-fuel missile program;

- Egypt's programs to modernize the Scud missile and build its own missile systems (Project T), developed with Chinese and North Korean technical assistance and dependent on the North Korean missile programs;
- Libya's Al Fatah (Iltisalt) missile programs to modernize the Scud and other missile types. Work on these programs is carried out primarily by foreign specialists using Chinese, North Korean, German and Soviet technology;
- Syria's missile program, carried out with technical assistance from Chinese and North Korean specialists;
- South Africa's Arniston program, based on Israeli missile technology.

Thus, we see that as countries have increased up their own missile-building capacity, the role of imported missile systems and technology has declined in many countries, though with regard to a lot of the latest technology imports continue to play an important part. This was one of the reasons why the MTCR participant countries came up with an initiative that they presented in the form of a document called the International Code of Conduct against Ballistic Missile Proliferation, or the Hague Code of Conduct (HCOC). The document was adopted in November 2002 in the Hague and was signed by 93 countries. To date, more than 120 countries have signed it.

The HCOC's adoption was seen as a step forward in building on the MTCR's founding principles. It declared the need to prevent and restrain missile proliferation and stated the importance of reinforcing disarmament and nonproliferation regimes and making missile programs transparent.[14] One of its most important provisions is its call to reduce national missile stockpiles in the interests of global and regional peace and security, which is a more radical step than past recommendations to simply limit missile capability and exports. Particularly relevant was the decision to establish an appropriate mechanism for the "voluntary resolution of questions arising from national declarations."[15] The lack of such a mechanism, which has still not been put in place, was cited above as one of the MTCR's main shortcomings.

The HCOC stipulates unprecedented openness of long-term programs to build and modernize ballistic missiles and of current activities involving ballistic missiles and space launch vehicles. It provides for advance notification of launches and tests of ballistic missiles and space launch vehicles. Notifications must include information such as the general class of ballistic missile or space launch vehicle, the planned launch's launch window, launch site and planned trajectory.

The link, underscored by the HCOC, between space exploration programs and the development of ballistic missiles for military purposes, is exceptionally important. The Code declares that "states should not be excluded from utilizing the benefits of space for peaceful purposes, but that, in reaping such benefits and in conducting related cooperation, they must not contribute to the proliferation of Ballistic Missiles capable of delivering weapons of mass destruction." Programs to build space launch vehicles must not be used as a cover for programs to develop military ballistic missiles.

On the grounds that the HCOC, due to the limited number of signatories and insufficient legal basis, cannot yet serve as the foundation for resolving the missile proliferation problem, Russia made a proposal to make the HCOC legally binding, but it failed to get support. American proposals to give the MTCR a number of supranational functions were likewise blocked by Russia.

Making the Missile Nonproliferation Regime More Effective

As it is today, the system of restraints on missile and missile technology proliferation does not make it possible to establish effective barriers to developing potential delivery systems for nuclear and other weapons of mass destruction, especially in countries with unpredictable regimes, both through foreign contracts and by using their own capabilities. But there have been attempts to erect barriers in addition to the MTCR. In 1999, for example, the Russian president put forward the idea of the Global Control System (GCS).

This system's underlying concept was based on a number of transparency provisions, including a voluntary commitment to provide information on planned and staged launches of ballistic missiles and space launch vehicles. As an incentive to encourage countries to restrain or renounce military missile systems, the initiative proposed assisting them in developing their national space programs. Another key point was the provision of security guarantees to countries renouncing the possession of missile systems.[16] But the initiative was proposed as a counterweight to the U.S. plans to develop a national missile defense system (NMS — at that time called the Theater Missile Defense [TMD] system), and this meant that the American attitude towards the proposal was negative right from the start.

There were proposals at various levels over subsequent years to make the MTCR and the HCOC legally binding. Among the more recent initiatives was the recommendation made by several dozen of the world's most influential experts in the Declaration of the International Luxembourg Forum on Preventing Nuclear Catastrophe in May 2007 to convene urgent talks on raising the status of the MTCR and the HCOC.[17]

But serious obstacles still remain on this path. Legally binding international arms limitation treaties and agreements usually have an extensive system in place for verifying compliance with their provisions. Russia/USSR and the U.S. have a lot of experience in this area, built up through the development and implementation of the verification and confidence-building measures that accompanied the START treaties and the Intermediate Nuclear Forces (INF) Treaty. However, this concerns a limited class of missiles with fixed locations, launch installation types, command centers and other missile infrastructure components.

The MTCR differs in that in addition to ballistic missiles, it also covers an extensive list of cruise missiles of all basing modes and unmanned air vehicles (UAV). In the case of UAV, new technology in the fields of materials, engines, guidance, and control systems has given them such immense diversity in terms of type, size and weight (including miniature models) that it appears practically impossible today to establish an acceptable system to limit them, including export controls. The difficulties of verification are one of the main arguments used by those opposed to signing treaties and agreements. Examples of this are the U.S. refusal to sign the proposed treaty on the prohibition of space weapons and the deadlock with the FMCT and also to a certain extent with the Comprehensive Test Ban Treaty (CTBT).

Making the HCOC legally binding could make it easier to draw up and approve a verification system, but there would still be the problem of having to cover different types of missiles and basing options.

Under these conditions, a number of steps could be considered to make the missile nonproliferation regime more effective, from raising the status of the MTCR and the HCOC to drafting a new treaty that would combine these two agreements. Whatever the case, given the aforementioned problems with verification systems, the emphasis of the practical implementation of agreements needs to be shifted from verification systems to confidence-building measures. This means that proof of compliance with treaty (agreement) conditions could be provided primarily through notifications, exchange of information on missile-building programs, launch plans, demonstrations of missiles, launch systems and other missile infrastructure installations, access for observers to installations, and other confidence-building measures.

The new treaty could be made more effective by including restrictions on the production of missile systems and physical safeguard measures to prevent them from falling into the hands of terrorists (this applies especially to cruise missiles and UAV). The treaty could include an annex with a regularly updated list of restricted missile systems and their parameters. This annex could be principally different from the existing Equipment, Software and Technology Annex to the MTCR Guidelines and would include not only restrictions on specific missile system and technology parameters, but also restrictions applying to specific models of existing missile systems or systems under development.

The treaty could include many of the existing concepts that have not yet been applied, for example, provisions on absolutely mandatory notification of any missile and space launches and on the existing ballistic and cruise missiles with particular specifications. The treaty could help make it possible to extend restrictions not only to suppliers, but also to recipients of missile technology.[18]

This new treaty could attract new supporters in addition to the MTCR participant states, as some countries would find it in their interest to adhere to it along with neighbors whose missile potential is currently a cause for mutual concern.

At the same time, it would be good to begin advance work on an eventual treaty that would integrate the provisions of the MTCR, HCOC and GCS to form the foundation of a new global and legally binding missile nonproliferation regime, cemented in an international agreement on the nonproliferation of missiles and missile technology along the lines of the NPT. A regularly updated list of restricted missile systems and their characteristics could be drawn up as an annex to this treaty. It should include all the technical definitions relating to the subject of the agreement, verification and confidence-building measures, and mechanisms for monitoring compliance, detecting violations, imposing sanctions for violations, and resolving disputes.

The problem for the effectiveness of the missile nonproliferation agreement, whether current or future, is that the countries that are the greatest threat to the regime are not signatories to the MTCR and HCOC and are unlikely to simply adhere to a new treaty. Above all, this concerns Iran and North Korea.

Chapter 7 examines the missile threat from Iran. Pressure to limit North Korea's missile program is periodically linked with solving the nuclear crisis within the framework of the six-party talks, which have produced a few positive results in light of North Korea's social and economic difficulties.

But talks on the Iranian nuclear program have not extended to the missile issue. Regardless of Iran's future response to the UN Security Council resolution demanding that it halt uranium enrichment, the agenda for talks with Iran must include the issue of restricting its development and testing of intermediate-range and intercontinental missiles.

This restriction is also extremely important for the prospects of reaching a mutually acceptable agreement between Russia and the U.S. regarding American plans to deploy a strategic missile defense system in Central Europe, because the dispute between the two countries significantly complicates the already difficult undertaking of consolidating efforts to prevent nuclear and missile proliferation. So far, these countries have not even been able to reach a common understanding with regard to missile threats.

North Korea is geographically closer to Russia than to the U.S., and one would have expected a much more acute response from Moscow to North Korea's withdrawal from the NPT in January 2003, numerous missile launches, and the testing of a nuclear device in 2006. But this has not been the case, even though Pyongyang's Nodon-1 missile and the tests of its Taepodong-1 and Taepodong-2 long-range missiles pose a hypothetically greater danger to most of Russia's (and China's) territory than to the U.S.

For the U.S. and Japan, the North Korean regime's very nature and its hostile relations with them have been and continue to be a large part of the North Korean threat. But for Russia and China, which have rather friendly relations with Pyongyang, the North Korean nuclear and missile programs, while a big foreign policy problem, are not seen as a direct threat to national security (the same is true of the U.S. approach to Pakistan's nuclear and missile programs). Commenting on North Korea's missile tests in 2005-2006, a Russian Foreign Ministry spokesperson expressed concern, saying that these kinds of actions do not contribute to stability in the region.[19] At the same time, deputies in the Russian State Duma and many international affairs experts said that North Korea's actions are linked to fears of forced regime change in the country.

As in a number of other major areas of military-technical and military-political development today, the proliferation of missiles and missile technology creates a complex knot of problems for efforts to prevent nuclear weapons proliferation, aside from the fact that missile systems offer a very effective means of delivering nuclear and other types of WMD.

The proliferation of missiles and nuclear weapons discourages the big nuclear powers from continuing the nuclear disarmament process and incites them to withdraw from existing agreements. The U.S. withdrew from the ABM Treaty, and Russia is considering denunciation of the INF Treaty, following an unsuccessful joint attempt with the U.S. to make it multilateral. This policy goes against the nuclear powers' commitments under Article VI of the NPT and encourages non-nuclear states to oppose efforts to strengthen the nonproliferation regime. Russian and U.S. proposals to involve other nuclear and missile powers in the arms control process have run up against the latter's objection to the large arsenals of strategic and tactical battlefield nuclear weapons that Russia and the U.S. continue to maintain, particularly since the latter category is not even covered by any legally binding treaties.

Missile proliferation is encouraging the U.S. to develop missile defense systems, and other countries could follow suit. In a situation where they maintain nuclear deterrent relations, this destabilizes the strategic balance and undermines nuclear arms reduction talks. Upgrading high-precision weapons as one of the main means of destroying other countries' missiles and missile infrastructure has a similar impact on strategic stability. Broader use of satellites as auxiliary systems for using nuclear or conventional weapons, and their possible future use as platforms for missile defense interceptors or means of striking targets on Earth, encourages development of anti-satellite weapons, already demonstrated by the U.S., USSR/Russia, and China, which leads to even greater strategic instability.

The United States' and Russia's continued maintenance and modernization of tactical nuclear weapons is also encouraged in part by missile and nuclear proliferation in the world and creates significant problems for military and political relations between Russia and NATO. Such problems could arise in the future in relations between the U.S. and China, and also between Russia and China.

Furthermore, the deep political and strategic differences in the positions of Russia, the U.S., Japan, and the European Union countries on the missile and nuclear threats from countries with unstable or extremist regimes create major additional obstacles to strengthening the missile nonproliferation regime in the ways outlined above.

The threats and challenges associated with missile proliferation are now growing at such a pace and the nature of their development is such that the world's leading powers need to make a better coordinated and more effective response to them. For this to happen, they need to act quickly to settle their differences on how to ensure the missile nonproliferation regime. Only in this way can they put in place the conditions necessary for strengthening this 'horizontal disarmament' regime so vital for regional and international security.

Notes

[1] "Rossiya i raketnoye nerasprostraneniye," August 8, 2005, http://www.mid.ru/ns-dvbr.nsf/c6bc9d5640647382432569ea003613d9/432569d80022638743256dcc002a6ddd?OpenDocument.

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[12] Ibid.

[13] http://ura.dn.ua/30.06.2006/10857.html.

[14] This includes important provisions declaring the countries' agreement on the need for annual statements setting out policy on ballistic missiles and programs for single-use space launch vehicles, as well as annual reports on the numbers and generic types of the launched ballistic missiles. See: "International Code of Conduct against Ballistic Missile Proliferation: A/57/724," http://www.un.org/News/Press/docs/2004/gadis3286.doc.htm.

[15] Ibid.

[16] Arbatov and Dvorkin, eds., *Nuclear Weapons after the Cold War,* PP. 42-43.

[17] "The International Luxembourg Forum on Preventing Nuclear Catastrophe Declaration," http://www.pnc2007.org/declaration/declaration.

[18] V. Dvorkin, "Missile Proliferation, Monitoring of Launches and Missile Defense," http://www.carnegie.ru/ru/pubs/media/9170Dvorkin-report.doc.

[19] http://www.rian.ru/world/20060705/50914069.html.

Chapter 5. The Counterforce Potential of Precision-Guided Munitions

Yevgeny Miasnikov

Two things came to define the U.S. and Soviet military and political relations as they developed over the decades: mutual nuclear deterrence from the end of the 1950s and nuclear arms reduction talks starting in the late 1960s. There were attempts to transform American-Russian relations in the 1990s, but the model of military and political relations that had formed during the cold war era proved so enduring that, despite declarations of mutual partnership, the political elites in both countries retained many of the approaches inherited from the old system. The events of recent years – a standstill in arms reduction talks, NATO's eastward expansion, U.S. ballistic missile defense system deployment plans – are all arguments for assuming that nuclear deterrence will continue to play a defining, or at least a significant, role in relations between the two great powers in the foreseeable future, even in a multipolar and increasingly globalized world.

Over the coming decades, Russia will scale back its strategic nuclear forces in accordance with its program for their modernization. This will leave Russia within the threshold set by the Moscow Strategic Offensive Reductions Treaty (SORT) of 2002 (not more than 1,700-2,000 nuclear warheads) and give it some more room to spare. It will probably also leave Russia within the limits set by any future arms reduction agreements reached. This is all very much to Russia's advantage, because most of its existing missile systems were built during the Soviet period and their service lives are coming to an end. It would be too great a burden for the Russian economy to replace these strategic arms at the same rate at which the planned reductions will be carried out.

However, the cutbacks in the strategic forces have helped create the opinion among Russian strategists that Russia is becoming more vulnerable as a result and risks losing its needed nuclear deterrent capability. This largely explains Moscow's strong objections to U.S. plans for the deployment of ballistic missile defense system installations in two areas in Europe. As President Putin put it, these plans aim "to neutralize our nuclear missile capability."[1] Some Russian experts have also voiced concerns regarding future survivability of the country's nuclear forces.[2]

If these fears continue to grow, it is very likely that the strategic dialog between Moscow and Washington on further strategic nuclear reductions will slow down or even come to a stop, along with all the ensuing consequences this would have for the NPT.

In this context, we need to analyze additional factors that could potentially affect the survivability of Russia's strategic nuclear forces. These factors include not only the counterforce potential of nuclear weapons and missile defense systems traditionally taken into account in assessing the strategic balance, but also the growing counterforce potential of precision-guided munitions (PGMs).[3] Some Russian experts are inclined to believe that American PGMs are designed to launch a sudden destructive strike against Russia.[4]

Precision-Guided Munitions – Types and Role in Doctrine

The term 'precision-guided munitions' used in military-technical literature generally relates to guided weapons that are usually able to destroy a target with a single warhead.[5] This definition covers a broad class of munitions, from weapons that weigh mere grams to guided air bombs weighing many tons, and from miniature unmanned aircraft launched by hand to intercontinental ballistic missiles.

PGMs are a potential threat to all the components in the strategic nuclear triad: stationary and mobile launch installations of the Strategic Missile Forces, missile-carrying submarines at their bases, and strategic bombers. They differ depending on which component of the nuclear triad they target, and their vulnerabilities and means of attack vary in each specific case and require separate analysis. This chapter focuses primarily on the types of PGMs and their delivery systems that could potentially threaten silo-based strategic ballistic missile systems.

The biggest advance in developing PGMs came at the end of the twentieth century, chiefly in the U.S. Taken together, several objective tendencies reflect a significant change in the role of conventional PGMs in future conflicts. These tendencies include:

- Enhancement of their strike characteristics – capacity and circular error probable (CEP) – at cost levels making series production and mass-scale use economically acceptable;
- Expansion of the range of conditions in which they can be used effectively through deployment and upgrade of the support infrastructure (intelligence, targeting, damage assessment).

Statistics also show that PGMs are playing an increasing role in armed conflicts. Guided air bombs and missiles accounted for only 2% of the total ordnance dropped by American aviation during the Vietnam War in 1972, 8% of the total during the first Gulf War in 1991, around 30% in the Allied Force operation in Yugoslavia in 1999, more than 50% in the Enduring Freedom operation in Afghanistan in 2001-2002, and more than 60% during Operation Iraqi Freedom in Iraq in 2003.[6]

The PGMs in the U.S. armed forces' arsenal today can be used to destroy a wide range of targets, including reinforced installations (underground bunkers, reinforced structures and bridges), and moving armored targets (tanks, armored vehicles and artillery). If provided with relatively precise targeting instructions, existing types of cluster bombs can effectively destroy mobile land-based intercontinental ballistic missiles (ICBMs). PGMs could pose a threat to existing silo-based launchers. Studies show that kinetic and tandem cumulative munitions under development, having a weight of 0.5-1 ton, can pierce a layer of homogeneous steel 2-3 meters thick.[7] Furthermore, in all likelihood, the U.S. armed forces already have PGMs with such capabilities. For example, the BLU-122 warhead is delivered by a modernized version of the Guided Bomb Unit-28 (GBU-28).[8] If their CEP can be brought to within 1-2 meters – the developers' goal – these types of weapons will present a real threat to Russian stationary ICBM launch installations.[9] It is possible that the development of non-nuclear attack weapons will lead to a situation where stationary ICBM installations are also vulnerable to munitions that create a powerful electromagnetic pulse. Delivery precision within a 10-meter radius might be entirely sufficient in such cases.

Using PGMs as a means for a counterforce strike is probably possible only when the attacking country is confident that this kind of large-scale sudden strike will be effective. If the attacking side can be sure that its strike will neutralize the overwhelming majority of the adversary's strategic systems and can rely on its own nuclear capacity and missile defense systems to deter and protect with sufficient reliability against a counterstrike launched by the enemy using its few surviving missiles, the strategy could look very attractive from the aggressor's point of view.

The kinds of decisions being made today in the U.S. concerning strategic programs are only adding to Russia's fears. U.S. Department of Defense program documents give PGMs and the related information technology and infrastructure development a key role. New concepts and principles are emerging, objectively aimed at expanding the range of applications for nuclear weapons, while non-nuclear PGMs are gradually taking over missions that were previously assigned to nuclear weapons.[10]

The American Global Strike military strategy option provides an example of these changes. Global Strike aims to make it possible for the U.S. to carry out high-precision strikes from a great distance against targets in any corner of the globe in a minimum amount of time.[11] This program also envisages reorienting part of the strategic delivery systems towards non-nuclear use. The U.S. already converted some of its strategic nuclear bombers for non-nuclear missions in the 1990s. The U.S. Navy is currently completing the re-equipment of four Ohio-class nuclear ballistic missile submarines, fitting them out to carry non-nuclear long-range sea-launched cruise missiles. It is also public knowledge that the U.S. Air Force and Navy are working on developing more effective conventional warheads that can be installed on strategic ballistic missiles. The only obstacle still in the way of wide-scale deployment of these weapons are the restrictions imposed by Congress.[12]

The Development of PGMs in the U.S.

The U.S. Department of Defense is currently purchasing and developing several dozen different types of PGMs potentially able to destroy silo-based ICBMs. They include munitions designed primarily to be installed on strategic bombers and submarines – guided air bombs (including modular bombs), guided air-to-surface missiles, and long-range air-launched and sea-launched cruise missiles. In the future, ICBMs carrying conventional warheads could also be used as non-nuclear delivery systems for PGMs.

The United States has a program, HDBTD (the Hard and/or Deeply Buried Target Defeat Capability Program), dedicated to working on promising non-nuclear ordnance designed to destroy reinforced or buried targets. The Department of Defense sees this as a priority because it is directly related to the fight against the growing threat of terrorism and the proliferation of weapons of mass destruction in the world. Non-classified literature contains only fragmentary information on advances in developing penetrating PGMs for destroying reinforced underground targets, and so we can only get an approximate picture of the current state of progress. But an analysis of the information available makes it possible to conclude that PGMs do constitute a real threat to silo-based ICBMs.

Table 6 shows the characteristics of U.S. PGMs.

Table 6

Technical Characteristics of U.S. PGMs Designed to Destroy Buried Targets

Type	Weight, kg	Penetrating munitions	Range, km	Guidance system	CEP, m	Delivery systems
Guided air bombs						
Boeing						
MOP (Massive Ordnance Penetrator) *1	13 600	9000 kg Warhead *2		INS, GPS		B-52, B-2
GBU-15	1125	BLU-109	8-25	Teleguidance system, INS, GPS	~ 3	F-15E
GBU-31 (JDAM)	1070	BLU-109	25	INS, GPS	< 6	B-1, B-2, B-52, F-14, F-15E, F-16, F-22, F-117, F/A -18
GBU-32 (JDAM)	450	BLU-110	25	INS, GPS	< 6	
GBU-38 (JDAM)	225	BLU-111	25	INS, GPS	< 6	
Raytheon*3						
GBU-28	2115	BLU-122, BLU-113	5-40	Laser, GPS	< 10	B-2, F-15E
GBU-27	1070	BLU-116, BLU-109	5-40	Laser, GPS	< 10	F-15E, F-16, F-117
GBU-24	1070	BLU-116, BLU-109	5-40	Laser, GPS	< 10	F/A-18, F-14
GBU-10 (EGBU-10)	1070	BLU-109	3-25	Laser, GPS	< 10	B-52, F-14, F-15E, F-16, F/A-18, F-111, F-117
AGM-154B (JSOW)	450	BLU-108	< 130 *4	INS, GPS		
Guided missiles						
AGM-130	1300	BLU-109 *5	> 65	INS, GPS, Teleguided	< 3	F-15E
SLAM-ER	230	WDU-40/B	> 280 *6	INS, GPS, Teleguided	~ 2.5	
JASSM	450		> 320	INS, GPS		
JASSM-ER	450		> 800	INS, GPS		

Long-range cruise missiles						
TLAM	340	WDU-43/B	1600	INS, GPS, Automatic self-guided warhead	~5	
«Tact Tomahawk»	450	WDU-43/B	1600	INS, GPS, Automatic self-guided warhead	~ 5	
CALCM	1430	AUP	> 1000	INS, GPS	~ 2.5 *7	

*1 J. M. Donnelly, "Item in War Request Stokes Fears of Iran Strike," *Congressional Quarterly,* October 2007; A. Butler and D. Barrie, "Dig for Victory," *Aviation Week & Space Technology,* September 11, 2006, PP. 52-55.

*2 K. Kirillov, "Osnovniye programmy razrabotki v SShA novykh UAB," *Zarubezhnoye voyennoye obozreniye,* # 4, 2007, PP. 50-52.

*3 Raytheon, "Paveway Laser and GPS/Laser Guided Bombs," http://www.raytheon.com/products/paveway.

*4 Raytheon, "JSOW: 2006,"
http://www.raytheon.com/products/stellent/groups/public/documents/content/cms01_055754.pdf.

*5 The guided missile equipped with BLU-109 was designated AGM-130C *(Air Force Link Factsheet,* "AGM-130 Missile,"
http://www.af.mil/factsheets/factsheet.asp?fsID=76).

*6 The Boeing Company, "Boeing Conducts First SLAM-ER Flight on F-15," February 20, 2004, http://www.boeing.com/defense-space/missiles/slam/news/2004/q1/nr_040220t.html.

*7 E. A. Miller and W. A. Stanley, *The Future of Ballistic Missiles* (National Inst. for Public Policy, [S. l.], October 2003), # 22.

Guided Air Bombs

Guided air bombs are a class of bombs that have a guidance system ensuring minimum error in striking the target.[13] Guided air bombs have greater impact and penetration capacity than other types of PGMs and are for this reason the main type of weapon used to destroy reinforced and buried targets. But because these bombs' range is usually no more than 30 km (100 km if fitted with wings), the aircraft delivering the weapons are forced to operate within the enemy's anti-aircraft defense zone, which can make them considerably less effective.

U.S. strategic and tactical aviation has several types of guided penetrating air bombs in its arsenal. The most powerful guided penetrating non-nuclear bomb in the U.S. Air Force arsenal today is the GBU-28, which can be delivered by B-2 strategic bombers and F-15E fighter bombers. The GBU-28 was first used during the 1991 Gulf War and has undergone repeated modifications since then (GATS/GAM, GBU-37, GBU-28B, GBU-28C).

The GBU-28 carries a penetrating BLU-113 warhead weighing around two tons that is able to penetrate a concrete wall more than six meters thick.[14] This is probably a low estimate, because even when only the bomb's kinetic energy and blast effects rather than its cumulative impact are taken into account, it achieves a penetration depth of around 5.4 meters in concrete.[15] Assessments of the GBU-28's effects show that the kinetic energy the bomb releases can penetrate a rolled armor plate more than 0.3 meters thick.[16] But there is evidence to suggest that later modifications could have been equipped with shaped charge penetrating warheads that would considerably increase the bomb's effectiveness against armor. A modification of the GBU-28C equipped with a penetrating BLU-122 warhead is currently in production. This warhead is similar in weight and size to the BLU-113, but its penetration capacity is 20% greater and its destructive power is 70% greater than that of the BLU-113.[17] The GBU-28 uses a laser and inertial navigation system (INS) with data adjustment made using the satellite navigation (GPS) system or a combination.

Work is being completed on the MOP (Massive Ordnance Penetrator) bomb, which is more powerful than the GBU-28. This bomb weighs 13.6 tons. Its penetrating warhead weighs around nine tons, and the explosive weighs 3.5 tons.[18] Experts estimate that the bomb can penetrate reinforced concrete at least 30-35 meters thick, and that the explosive charge would have sufficient explosive impact to destroy protected targets through their external structures (entrances, ventilation collectors and so on). The bomb is guided using an INS/GPS system and is designed to be dropped from the inner compartments of B-2 and B-52 strategic bombers at an altitude of not less than 1,200 meters. This bomb is due to enter service in the Air Force in 2009. The news came out in October 2007 that the Pentagon had requested $88 million to speed up work in 2008 on equipping B-2 bombers with MOP-type bombs.[19]

Paveway air bombs (GBU-10, GBU-24, GBU-27) with a semi-active laser guidance system are produced by Raytheon and have been used for more than 30 years now. Practically all types of U.S. strategic and tactical aviation carry Paveway guided bombs. The GBU-10, GBU-24 and GBU-27 use both free-fall Mk-82 explosive warheads and penetration warheads of the BLU-109 type. The BLU-109 is the warhead most widely used in the U.S. arsenal for hitting buried targets. The BLU-109 penetrating warhead is a concrete-penetrating device weighing around one ton, encased in high-strength steel and containing 243 kg of explosive (AFX 70B). Current assessments show that this warhead can penetrate concrete up to 1.5 meters thick from an altitude of 10 km.[20] BLU-109 warheads are in the process of being replaced by BLU-116 warheads, which are of similar dimensions but have twice the penetration depth of the BLU-109.[21]

To deploy this kind of laser-guided bomb, a laser on board the support aircraft is used to light up the target detected by the operator. The seeker device on the bomb registers the light reflected from the target and sends the signals to the bomb's guidance system. Laser-guided bombs have a CEP of around three meters. Seeking to increase the range of conditions in which the bombs can be used, Raytheon developed third generation Paveway bombs (Enhanced Paveway), which are equipped with modules making it possible to adjust the trajectory using GPS. Under cloudy conditions, when laser guidance is unfeasible, these types of bombs have a CEP of around 10 meters.

The GBU-15 glide bomb, which was developed by Boeing and entered service in 1974, can also carry a BLU-109 penetrating warhead. The bomb's flight path is either regulated automatically using INS/GPS or is remote-controlled by the weapons systems operator on board the aircraft using the video coordinator installed on the bomb.[22] The operator usually takes over guidance of the flight path's final phase. The CEP is around three meters.

The early 1990s provided a powerful stimulus to work on the Joint Direct Attack Munition (JDAM) program to develop universal modules for adjusting the flight paths of ordinary gravity bombs using signals received from GPS satellites. The module's main component is an INS guidance system coupled with a GPS guidance control unit and aerodynamic control surfaces. JDAM air bombs can be used in all weather and have a CEP of up to five meters when using the GPS flight path adjustment system.[23] Along with the BLU-109 (GBU-31) penetrating warhead, the smaller BLU-110 and BLU-111 penetrating warheads (weighing 450 and 225 kg respectively) are also used. Priority work to upgrade JDAM in recent years has focused on increasing the interference resistance of existing guidance units and developing new guidance units, as well as using semi-active lasers, infrared imaging and radar guidance systems during the final phase of the flight path in order to hit moving targets.

Boeing also has a program to develop a smaller guided bomb (Small Diameter Bomb) weighing 120 kg to strike stationary (GBU-39) and moving (GBU-40) targets at a range of up to 100 km. The bomb can penetrate reinforced concrete casing up to two meters thick and can be launched from an aircraft's inner compartments or from external pods, while the aircraft travels at a speed of Mach $M = 1.7$ and has a CEP of not more than three meters.[24]

Guided bombs currently in the arsenal are being equipped with aerodynamic wings in order to bring their range up to 100 km (making it possible to launch them without having to enter the enemy's targeted air defense zone). This work is being carried out in particular as part of the JDAM-ER (Extended Range) and Paveway programs.

The AGM-154 (Joint Standoff Weapon – JSOW) air guided bomb, which uses an INS/GPS guidance system, was originally designed as a glide bomb destined for the U.S. Navy. It could carry a maximum payload of 450 kg for a maximum range of 130 km. There have been several modifications of the JSOW since its creation.

The AGM-154A and AGM-154B cluster bombs are designed to blanket territory and strike armored vehicles. The AGM-154C modification has a single explosive/fragmentation or penetrating warhead. Unlike the other glide bombs, it is also equipped with an infrared targeting sensor for guidance during the final phase of the flight path. Production of the AGM-154C began in December 2004. Overall, the U.S. Navy plans to buy 7,000 AGM-154C bombs.[25] The latest modification, designated AGM-154C-1, will be capable of being retargeted in flight and hitting moving targets. Production is expected to begin in 2009.

Air-to-Surface Guided Missiles

Guided air-to-surface missiles can be used to strike reinforced buried targets. Unlike guided bombs, guided missiles can be used outside the enemy's targeted anti-aircraft defense range and at lower altitudes, thus substantially increasing the delivery system's survivability. Cruise missiles are also more maneuverable than guided bombs, and the guidance system is more resistant to errors in setting the coordinates during launching.

The U.S. Air Force's F-15E, F-16 and F-111 tactical aircraft can all carry AGM-130 guided missiles, using a modular installation design – the GBU-15 guided bomb equipped with a solid-propellant missile accelerator.

The SLAM-ER (AGM-84H) guided missiles currently in service in U.S. naval aviation (F/A-18, P-3, S-3, F-15), can deliver a 230-kg WDU-40/B-type explosive penetrating demolition munition at a range of more than 270 km to destroy targets at sea and on land.[26] The missile's flight path is controlled using an INS/GPS guidance system. An infrared camera with an automatic target tracking system guides the missile in the final phase of the flight path. The missile can also be guided to the target in the final phase of the flight path by the pilot, who corrects the missile's flight path using video imagery. The missiles can be re-targeted in mid-flight, and there are plans to start work soon on improving the SLAM-ER guided missile's ability to hit moving targets on land.[27] Serial production of the SLAM-ER began in 2000. For the most part, the missile is the result of work to upgrade the SLAM guided missile. The U.S. Navy currently has around 500 SLAM-ERs.[28]

The U.S. Air Force is also working on the JASSM (AGM-158 A) guided missile, which has a similar range to the SLAM-ER, but can carry a bigger payload. It carries a 450-kg high-explosive or penetrating warhead. Strategic bombers of all types and F-16C/D fighter planes carry this missile. In the future, there are plans to also equip F-15E fighters with them. Serial production began in fiscal year 2002, and by the summer of 2007, 611 of the 942 missiles purchased had been delivered.[29] The fate of the remaining missiles is unclear at the moment because of rising costs and the missiles' insufficient reliability.[30]

At the same time, Lockheed-Martin, the company that developed the JASSM guided missile, is also working on increasing the missile's range to 800 km and up (the JASSM-ER) and making it possible to retarget the missile in mid-flight. Serial production of the JASSM-ER is expected to begin in fiscal 2008. 2,400 JASSM and 2,500 JASSM-ER missiles are expected to be purchased by 2009.[31]

Long-Range Cruise Missiles

The sea-launched Tomahawk cruise missile has undergone several modifications over the course of its development (Block I—IV). The latest modification, Block IV (Tactical Tomahawk),[32] differs from past models principally in that it has a longer range (up to 1,600 km) and can be retargeted in flight.

As of 2006, Raytheon had produced around 4,200 Block I-III Tomahawks, of which around 1,900 were used in U.S. military operations in 1991-2003.[33] Serial production of the Block IV Tactical Tomahawk began in 2002.[34] There are currently around 1,000 of these missiles in the arsenal and plans to buy another 2,500 by 2015.[35] [36] In particular, orders were placed for 355 and 394 such missiles in fiscal 2007 and 2008 respectively, and there are plans to make 200-240 of these missiles a year over the coming years.[37]

The Tomahawk can carry a nuclear or conventional warhead.[38] The Block III modification,[39] which constitutes the bulk of long-range sea-launched cruise missiles in service, is equipped with a WDU-36/B high-explosive/fragmentary-type warhead or a CEB (Combined Effects Bomblets) cluster bomb with self-targeting BLU-97/B strike components. Reports say that some of the Block IV Tomahawks will carry a WDU-36/B warhead,[40] while the others will carry a WDU-43/B penetrating warhead.[41]

The long-range air-launched ALCM (AGM-86) cruise missile is built by Boeing. It originally made around 1,700 of these missiles to deliver nuclear warheads only, but starting in 1988, around 500 of them were re-equipped with conventional warheads.[42] In its non-nuclear variant the missile was designated Conventional Air-Launched Cruise Missile (CALCM) or AGM-86C/D. The CALCM can deliver a high-explosive/fragmentary or penetrating (Advanced Unitary Penetrator) warhead at a range of more than 1,000 km.[43] The power of the high-explosive/fragmentary warhead is equivalent to around 1,300 kg of TNT. The penetrating warhead weighs around 540 kg.[44] The CALCM uses an INS/GPS guidance system.

The CALCM was widely used in military conflicts from 1991 to 2003, with a total of around 360 such missiles used.[45] Consequently, there are currently no more than 140 such missiles in service today. In 2007, the U.S. Air Force announced plans to make substantial cutbacks to its nuclear air-launched cruise missiles. There are plans to dismantle around 500 ALCM missiles, and this will leave the Air Force with only 528 nuclear ALCM missiles in operational readiness.[46] Some of them could be used to make CALCMs. The 460 nuclear ALCMs (AGM-129), which are to be fully withdrawn from service, could perhaps also be reconverted to carry non-nuclear warheads.[47]

The Future Make-up of U.S. Strategic PGM Delivery Systems

B-52H, B-1B and B-2 heavy bombers form the backbone of the U.S. Air Force's strategic attack capability. Until the start of the 1990s, the strategic bombers could deliver only nuclear weapons and free-fall conventional bombs. But modernization programs over the last decade have made it possible to arm the bombers with precision-guided bombs, guided missiles, and air-launched cruise missiles with GPS-adjusted flight paths. At the start of 2007, the U.S. Air Force had 94 B-52H, 67 B-1B and 20 B-2 bombers.[48] The Air Force plans to maintain the fleet of B-2 and B-1B aircraft in the medium term but reduce the fleet of B-52H bombers to 56, of which 44 will be kept at a high level of combat readiness.[49] There are no current plans to buy new strategic bombers. Research and development work is underway to build the next generation of planes of this class, and they are expected to enter service no later than 2035.[50] All of the U.S. Air Force's strategic bombers are based on U.S. territory. In times of armed conflict however, airfields belonging to U.S. allies can also be used. One example was during the NATO military operation against Yugoslavia in the spring of 1999, when B-52H and B-1B planes were based on British territory (the RAF Base at Fairford).

U.S. Air Force tactical fighters (F-15E, F-16C/D, F-22, F-117 and F-111) can also use precision-guided weapons, primarily to carry out strikes against targets on land. Their range and payload capacity is substantially lower than those of the strategic bombers, but the fact that they are based at the air force bases of America's NATO allies in Europe, and in the future could eventually be based under certain circumstances in Trans-Caucasian and Central Asian countries, as well, could make them a threat for Russia's ICBMs.

The four Ohio-class ballistic missile submarines will soon have a high attack potential. Work to convert them to conventionally-armed cruise missile submarines was completed in 2007.[51] The first two converted submarines returned to service in the Navy that same year, and the remaining two will re-enter service in 2008. Each of the submarines can carry up to 154 Tomahawk cruise missiles. Los Angeles-class submarines, built before 1985, can launch cruise missiles only from reloadable torpedo launchers. However, starting with the submarine Providence SSN-719, all submarines of this class have been equipped with 12 vertical launchers specially designed for sea-launched cruise missiles. Virginia-class submarines have a similar capability. The Seawolf-class submarine does not have vertical launchers, but the number of its torpedo launchers has been doubled, and the submarine can carry up to 50 weapons. At the end of 2006, the U.S. Navy had 55 attack submarines, including two Virginia-class submarines, three Seawolf-class submarines and 31 Los Angeles-class submarines with cruise missile vertical launchers in service.[52] There are plans to maintain a fleet of around 50 attack submarines until 2015 and at the same time build up to 12 new Virginia-class submarines. In the longer term, the number of attack submarines may decrease to 44.[53]

Navy ships usually operate as part of aircraft carrier strike groups and, unlike submarines, cannot launch attacks on land targets without being detected. U.S. Navy ships able to launch Tomahawk cruise missiles from Mk-41 or Mk-44 vertical launchers include the DDG-51 Arleigh Burke-class and DD-963 Spruance-class destroyers, as well as CG-47 Ticonderoga-class cruisers. At the end of 2006, the Navy had 88 cruisers and destroyers.[54] The CG-47 has 127 vertical launchers, and the DDG-51 and DD-963 destroyers have 90 and 61 respectively.[55] The ships' vertical launchers are used not just for cruise missiles, but also for anti-submarine and anti-aircraft defense. Therefore, the number of cruise missiles actually deployed in them is usually from one third to one half of the maximum.

In 2008, the Navy had 11 aircraft carriers in service, and it plans to maintain this number through 2015. There are plans to build two new nuclear aircraft carriers, the CVN-77 George H. W. Bush, and the CVN-78 Gerald R. Ford, which will replace the CV-63 Kitty Hawk and CV-65 Enterprise.[56] F/A-18C/D (Hornet) and F/A-18 E/F (Super Hornet) fighters serve as the attack aircraft. Aircraft carriers usually carry 36 aircraft of these types.[57]

The data presented in Table 7 illustrates the U.S. potential conventional counterforce capability by 2015. It assumes that only hard-to-detect delivery systems will be used to carry out neutralizing strikes (stealth-type planes, submarine-launched and air-launched cruise missiles). The potential for using air bombs and air-to-surface tactical guided missiles against strategic targets is limited by their range, which does not exceed 300 km. Given that delivery systems for such weapons would have to operate within zones well protected by enemy anti-aircraft defenses in order to attack strategic targets, among existing delivery systems the strategic 'invisible' B-2 bomber would seem to be the only most effective one.

If the U.S. Navy and Air Force carry out their programs to deploy ballistic missiles with conventional warheads, the number of weapons able to pose a threat to Russia's strategic nuclear forces (SNF) would increase by at least 100-200.[58] The potential spectrum of PGM delivery systems able to threaten strategic installations would increase many times if Russia's anti-aircraft and naval capability falls to a level where the adversary could gain air supremacy over Russia's territory and in its coastal waters. In such a case, B-1B strategic bombers, cruise missiles deployed on ships, U.S. naval aviation and NATO tactical aviation (based in the Baltic or Trans-Caucasus countries) could theoretically also be used to carry out a neutralizing strike.

Table 7

Potential Number of PGM Delivery Systems and their Payload Capacity

Type of PGM delivery system	Potential number of delivery systems (by 2015)	Maximum number of PGMs deployed
B-2	20	320
Los Angeles-class submarine (SSN-688)	7	56
Providence-class submarine (SSN-719)	31	620
Virginia-class submarine (SSN-774)	10-12	200-240
Ohio-class ballistic missile submarine	4	616
B-52H	56	1120
Total	*128-130*	*2932-2956*

The strategic B-1B bombers alone would be capable of delivering more than 1,600 PGMs to their targets.

PGMs in the Strategic Context

In making a thorough study and analysis of the potential dangers arising from the development of PGMs, we should not go to the other extreme and exaggerate their impact on the survivability of the nuclear deterrent. For a start, unlike a nuclear counterforce strike, the mass use of PGMs to neutralize strategic forces would require quite lengthy preparations (even operations against much weaker adversaries, such as Iraq, Yugoslavia and Afghanistan, required several months). It would be impossible to hide these preparations, and if the other side did not get satisfactory explanations, it would have time to put its strategic nuclear forces, missile attack warning systems, command systems and general forces onto heightened alert.

Second, operations using PGMs take much longer to carry out (at least several days rather than several hours). This gives the other side an opportunity to use its surviving strategic nuclear forces during the operation in accordance with its stated military doctrine. Of course, it is much more difficult to make the decision to launch a nuclear strike in response to a strike using only conventional weapons than in response to a nuclear strike, all the more so if the aggressor could follow with a nuclear strike. But the aggressor can never be sure that its attack using only PGMs would not provoke a nuclear strike in response, not to mention the fact that the missile attack warning systems would not be able to distinguish initially between a non-nuclear and a nuclear attack. The United States' differing approaches in its operations against Yugoslavia and Iraq on one hand, and against North Korea following its 2006 nuclear test on the other, is very illustrative in this respect (not to mention hypothetical scenarios for a conflict pitting the U.S. against China or Russia).

Third, the role of the silo-based ICBMs, the most attractive target for a PGM strike, is on the wane in Russia's strategic nuclear forces, with the emphasis now shifting to mobile ICBMs. The silo-based and mobile ICBMs provide backup for each other. If the missile attack warning system signals an attack completely out-of-the-blue, the silo-based ICBMs can carry out a launch-on-warning strike. If the warning comes with enough time to still act, dispersed, camouflaged mobile missiles protected by anti-aircraft defenses can act as backup in the case of rapid strikes against silos by PGMs with short flight times or using stealth technology. The time it takes to deploy mobile ICBMs and equip them with multiple independently-targeted re-entry vehicle (MIRV) warheads can be rapidly increased if necessary.

Furthermore, an additional source of uncertainty for the potential aggressor comes from the sea and air-based strategic nuclear forces and tactical nuclear weapons, which are much harder to find and destroy rapidly, and which could be used to attack the U.S. allies and the forward-based troops and forces they need to carry out operations making wide use of PGMs. It should not be forgotten that to carry out an effective strike against strategic nuclear forces, the aggressor would first have to suppress the adversary's anti-aircraft defenses, air force and navy, and this would also take time and use up large stockpiles of PGMs.

Fourth (and most important), the huge risk of nuclear escalation set off by attacking a nuclear power using PGMs is completely out of proportion with the real or imagined advantages to be gained from the operation. This is especially visible with the cold war now over, and in a world in which the great powers are ever more economically and politically interdependent, whatever the particular international contradictions that divide them.

The growing counterforce capability of PGMs in the U.S., and, in perspective, probably in other countries, too, stems objectively from the development of attack and information capabilities and technology, which are practically impossible to stop or substantially limit, particularly when one considers the great diversity of their possible uses. These capabilities can indeed threaten the survivability of Russia's strategic nuclear forces, and the Russian leadership will take this into account in assessing its nuclear deterrent needs. With the nuclear deterrent still a force to be reckoned with, the direct military threat of PGMs and the likelihood of their being used in a massive attack against Russia should not be exaggerated. However, if this threat remains, even if only at the hypothetical level, it will create serious obstacles to further reductions of nuclear arms and related efforts to strengthen the nuclear nonproliferation regime.

In this sense, for all the technical differences between them, PGM systems can be compared to missile defense and space systems in terms of their military and political consequences. Originally developed to combat enemies more effectively at the regional and local level and to counter WMD proliferation and international terrorism, these weapons have begun to have a destabilizing effect on military and political relations between the U.S., Russia and other great powers. In so doing they are starting to undermine the nuclear nonproliferation regime and the prospects for cooperation between countries to combat other common security threats. This was inevitable in a situation where the great powers maintained relations based on mutual nuclear deterrence, while at the same time developing new weapons systems (and using them locally) on a unilateral or bloc basis.

Along with the prospective development of missile defense and space weapon systems, the development of PGMs will create even greater obstacles on the road to full nuclear disarmament. Complete disarmament has once again been at the center of the American public's and professional community's attention of late as the main avenue that would end and reverse the proliferation of nuclear weapons.

But if the parties concerned show political will, they can resolve or reduce the problems created by PGMs through a range of possible agreements and legal means. In particular, it would make sense in the new strategic nuclear forces reduction treaty between the U.S. and Russia, which is supposed to replace START-1 after 2009 and SORT after 2012, to maintain the principle of counting warheads on strategic delivery systems as nuclear, irrespective of whether they are nuclear or conventional, which would facilitate the verification procedures.

Other possibilities could include a ban on basing attack aviation (in addition to a ban on deploying nuclear weapons) on the territories of the new NATO member states. Russia could make similar commitments with respect to its allies in the Collective Security Treaty Organization (CSTO) and the CIS, as well as probable new partners on other continents. (This ban should also be maintained with regard to deploying strategic nuclear forces outside national territory and should subsequently be extended to tactical nuclear weapons, too.)

Another measure could be to limit the areas which submarines carrying cruise missiles can patrol, in order to prevent the possibility of the large-scale deployment of U.S. submarines near Russian territory and vice versa. At the same time, this would resolve other problems raised on numerous occasions by Russia during strategic arms reduction talks: a ban on concealed anti-submarine activity in areas where ballistic missile submarines are deployed or patrolling, and the prevention of collisions between nuclear submarines. Given that this ban would cover submarines carrying both nuclear-armed and conventionally-armed ballistic missiles (because of the difficulties in distinguishing between the different types of submarine when underwater), an agreement of this kind would have an even greater stabilizing effect. It would limit the capability for launching a counterforce strike with a short flight time, and it would reduce incentives to keep strategic nuclear forces on high alert for a launch-on-warning strike upon receiving information from the missile attack warning system.

Of course, verifying compliance with such an agreement would be very difficult, given that stealth is the main advantage of submarine fleets. But with the required will, solutions can be found in this area, too. For example, the parties could agree to make it possible for submarines to surface in response to a request from the other party, and there could be an agreed annual quota for such requests. With the help of reconnaissance satellites, the parties will know approximately which of the other party's submarines are away from their base at any given moment in time. This means that if one party addresses a request to the national command center of the other that the other party's submarine be ordered to surface, the risk of violations being discovered is quite high if the order comes and the other party's submarine surfaces in a prohibited area or does not surface at all. Such an agreement could be necessary in any case, given the development of submarine fleets by other countries and the danger of a provocative strike from underwater.

The threats posed by a massive deployment of PGMs to the nuclear nonproliferation regime are not limited to the problems examined here. Overwhelming superiority of one country or bloc in these effective types of weapons may encourage threshold states to speed up their efforts to acquire nuclear weapons as an asymmetrical form of defense. The only way to reduce this incentive is to limit the development, deployment and use of PGMs on a unilateral or bloc basis in order to avoid destabilizing military and political relations between the great powers and strengthen their cooperation on the whole range of nonproliferation issues.

Notes

[1] V. Putin (Remarks at press conference following talks with President of Ukraine Viktor Yushchenko and the Second Session of the Russian-Ukrainian Intergovernmental Commission, February 12, 2008), http://www.kremlin.ru/appears/2008/02/12/2027_type63380_160013.shtml.

[2] Russian experts' reaction to the article by Kier Lieber and Daryl Press in the journal *Foreign Affairs* at the start of 2006 is quite symptomatic in this respect (K. A. Lieber and D. G. Press, "The Rise of U.S. Nuclear Primacy," *Foreign Affairs,* 85, #2 [March-April 2006]: PP. 42-54.) The article concludes that the U.S. now has the capability to deprive Russia of the possibility of launching a retaliatory strike. One can debate as to whether the authors are right or are going too far in their conclusions, but the article provoked discussion in Russia on the survivability of its nuclear forces.

[3] Y. Myasnikov, *Vysokotochnoye oruzhiye i strategichesky balans* (Dolgoprudny: Tsentr po izucheniyu problem razoruzheniya, energetiki i ekologii pri MFTI, 2000), P. 43.

[4] See for example: M. Volzhensky, "PRO: zamaskirovana pod zashchitu, sozdana dlya napadeniya," *Izvestia,* May 28, 2007.

[5] In particular, the issue of defining PGMs is studied in detail in the work: V. Tsymbal, "Vozrastaniye strategicheskoy roli vysokointellektualnogo oruzhiya i problemy kontrolya za ego razvitiem i rasprostraneniem," *Yader. kontrol,* June-July 1997, PP. 39-43.

[6] B. D. Watts, "Six Decades of Guided Munitions and Battle Networks: Progress and Prospects" (Center for Strategic and Budgetary Assessments, [S. l.], March 2007), P. 20.

[7] Myasnikov, *Vysokotochnoye oruzhiye i strategichesky balans.*

[8] A. Butler and D. Barrie, "Dig for Victory," *Aviation Week & Space Technology,* September 11, 2006.

[9] Myasnikov, *Vysokotochnoye oruzhiye i strategichesky balans.*

[10] "Obzor sostoyaniya i perspektiv razvitiya yadernykh sil SShA," *Zarubezhnoye voyennoye obozreniye,* # 4, 2002, PP. 2-20.

[11] Gen. James E. Cartwright, Commander, U.S. Strategic Command (Statement before the Senate Armed Services Committee Strategic Forces Subcommittee on Strategic Forces and Nuclear Weapons Issues in Review of the Defense Authorization Request for Fiscal Year 2006, April 4, 2005).

[12] A. Dyakov and Y. Myasnikov, *"Bystry globalny udar" v planakh razvitiya strategicheskikh sil SShA* (Dolgoprudny: Tsentr po izucheniyu problem razoruzheniya, energetiki i ekologii pri MFTI, 2007), P. 9.

[13] S. Semenov, "Sovremenniye upravlyaemiye aviatsionniye bomby," *Zarubezhnoye voyennoye obozreniye,* # 4, 2005, PP. 45-51.

[14] A. Grigoryev, "Novaya amerikanskaya upravlyaemaya bomba," *Zarubezhnoye voyennoye obozreniye,* # 2, 1992, P. 46.

[15] Myasnikov, *Vysokotochnoye oruzhiye i strategichesky balans.*

[16] Ibid.

[17] Maj. M. Lauden, "BLU-122 Warhead Program," (Precision Strike Technology Symposium, October 19, 2005).

[18] K. Kirillov, "Osnovniye programmy razrabotki v SShA novykh UAB," *Zarubezhnoye voyennoye obozreniye,* # 4, 2007, PP. 50-52.

[19] J. M. Donnelly, "Item in War Request Stokes Fears of Iran Strike," *Congressional Quarterly,* October, 2007.

[20] Myasnikov, *Vysokotochnoye oruzhiye i strategichesky balans.*

[21] "BLU-116 Advanced Unitary Penetrator (AUP),"http://www.globalsecurity.org/military/systems/munitions/blu-116.htm; Butler and Barrie, "Dig for Victory," PP. 52-55.

[22] Air Force Link Factsheet, "AGM-130 Missile," http://www.af.mil/factsheets/factsheet.asp?fsID=105.

[23] Air Force Link Factsheet, "Joint Direct Attack Munition GBU-31/32/38," http://www.af.mil/factsheets/factsheet.asp?fsID=108.

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[29] T. Capaccio, "Raytheon Tomahawk Might Replace Errant Lockheed Missile," *Arizona Daily Star,* June 12, 2007.

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[31] S. H. H. Young, "Gallery of USAF Weapons," *Air Force Magazine,* May 2007.

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[33] Watts, "Six Decades of Guided Munitions," PP. 238, 246.

[34] This modification received the designation RGM-109E (version for launchers on board ships) and UGM-109E (version for launchers on board submarines).

[35] Production of the lot of sea-launched cruise missiles for which the orders were placed during fiscal years 2002-2005 was planned to be completed by August 2007 (U. S. Department of the Navy, *Fiscal Year [FY] 2009 Budget Estimates, Weapons Procurement,* Exhibit P-21 [February 2008]).

[36] U. S. Department of the Navy, *Fiscal Year (FY) 2008/2009 Budget Estimates, Weapons Procurement* (February 2007).

[37] Ibid.

[38] According to published data, the U.S. Navy has around 320 sea-launched nuclear-armed cruise missiles ("NRDC Notebook: US Nuclear Forces, 2007," *Bul. of the Atomic*

Scientists, January-February 2007, PP. 79-82). But in accordance with the unilateral statements made by President George H. W. Bush in 1991, all nuclear-armed cruise missiles are stockpiled. Then President of the USSR Mikhail Gorbachev responded with similar initiatives regarding sea-launched nuclear weapons in 1991.

[39] The Block III modification can carry a working payload of around 340 kg.

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[50] Ibid.

[51] Brian R. Green, Deputy Assistant Secretary of Defense for Strategic Capabilities (Statement for the Senate Armed Services Committee Strategic Forces Subcommittee Hearing Regarding Global Strike Issues, March 28, 2007).

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[53] Ibid.

[54] R. O'Rourke, "Navy DDG-1000 Destroyer Program: Background, Oversight Issues, and Options for Congress," *CRS Report RL32109,* Updated October 25, 2007.

[55] GlobalSecurity.org, http://www.globalsecurity.org/military/systems/ship/index.html.

[56] U.S. Navy Fact File, "Aircraft Carriers," http://www.navy.mil/navydata/fact.asp.

[57] V. N. Shunkov, *Avianesushchiye korabli i morskaya aviatsiya* (Minsk: OOO Popurri, 2003), P. 576.

[58] Current U.S. Navy plans involve the deployment of up to four conventional warheads on each of its 28 Trident SLBMs (2 SLBMs on each of the 14 submarines). The U.S. Air Force plans to deploy several dozen Minuteman-2 or MX ICBMs. See Dyakov and Myasnikov, *"Bystry globalny udar" v planakh razvitiya strategicheskikh sil SShA.*

Chapter 6. Nonstrategic Nuclear Weapons

Alexander Pikayev

Strategic nuclear weapons were the central pillar of the military balance of power and the main focus of negotiations between the great powers throughout the cold war and remained so even after the cold war came to an end. But politicians and experts around the world have been paying increasing attention of late to nonstrategic nuclear weapons and forces – medium-range and tactical nuclear weapons.

The development of these weapons by new countries increased the weapons' role in arsenals and the proliferation of nuclear weapons. What's more, as the nuclear powers, particularly Russia and France, cut back their strategic nuclear weapons, nonstrategic nuclear weapons account for an ever-greater share of the nuclear arsenal. Nonstrategic nuclear weapons are seen as presenting a greater risk in that it is easier for them to fall into the hands of terrorists. The great powers' new offensive and defensive weapons programs are primarily concerned with countering the threat posed by other countries' nonstrategic nuclear weapons. Continued reductions and limitations of offensive and defensive systems will inevitably raise the question of what to do about other countries' nuclear weapons. The prospects for extending the nuclear disarmament process from Russia and the U.S. to other nuclear powers will in turn raise the issue of control over medium-range and tactical systems. These weapons make up the bulk of the other nuclear powers' arsenals (with the exception of Great Britain), and these countries are unlikely to be willing to discuss them unless measures also apply to the two nuclear superpowers' own weapons of this kind.

Nonstrategic Nuclear Arsenals

Nonstrategic nuclear weapons (NSNWs) make up a large part of the nuclear powers' arsenals, but there are practically no direct arms limitation or reduction agreements covering them. There is not even a clear definition of the term 'nonstrategic nuclear weapon.' When the USSR and the U.S. began strategic arms limitation talks at the end of the 1960s, they had to come up with some way of delineating within their diverse nuclear arsenals at the time which systems and weapons would be the subject of negotiations and treaties. They decided to make the ability to reach each other's territory the main criterion for selecting these types of nuclear weapons. Based on this criterion, intercontinental ballistic missiles were counted as strategic weapons (a range exceeding 5,500 km was later agreed on). This criterion was in many respects simply a convention, given that a tactical missile launched from Alaska could fly the several dozen kilometers across the Bering Strait and reach targets in Soviet Chukotka and vice versa.

Nuclear submarines carrying ballistic missiles (SLBMs) were also counted as strategic weapons. Missile range was not taken into account in this case, because submarines act as mobile platforms for the missiles and can approach the adversary's coast undetected in order to come close enough for a ballistic missile to hit targets on enemy territory.

The criteria for categorizing heavy bombers were also based primarily on flight range. Bombers able to fly from U.S. territory to the USSR's main military and industrial zones (and return to their bases) and vice versa were counted as strategic. This criterion was also based on convention. American intermediate-range bombers and tactical attack aircraft based in Western Europe and East Asia could hit targets in Soviet territory and return to their bases. The U.S., for its part, had concerns in the 1970s about Soviet intermediate-range Tu-22M Backfire bombers. Washington said the bomber's range was sufficient for it to reach U.S. territory. In order to address these concerns, the USSR agreed not to equip these planes with mid-air refueling systems in the 1979 SALT-2 Treaty between the U.S. and the USSR.

In accepting these criteria for defining strategic and nonstrategic nuclear weapons, Moscow was essentially agreeing to the U.S. position. The Soviet Union's sole means of striking U.S. territory was with the weapons now defined as strategic and subject to limitations under the bilateral treaties. However, the U.S. could strike targets in Soviet territory (and planned such strikes in its operations guidelines) using not only strategic weapons, but also the nonstrategic weapons it had deployed around the Soviet Union's borders. The U.S. consistently opposed Soviet attempts to include American weapons deployed at forward bases in the scope of U.S.-Soviet nuclear arms control. The American position was that the purpose of these weapons was to neutralize the Warsaw Pact's considerable superiority over NATO in conventional weapons and armed forces. The technical difficulties of control over such weapons were also cited as an argument; this issue will be examined in more depth below.

The conventional nature of the distinctions between strategic and tactical weapons gradually gave rise to mutual concerns about the emergence of weapons that fell into a gray area. Aside from the case of the Tu-22M Backfire intermediate-range bomber, there was also the issue of long-range sea-launched cruise missiles in the 1980s. These were not ballistic missiles and had a range of more than 600 km (but less than 3,000 km), but since they were based on ships and submarines they could strike targets on Soviet territory. Differences over these missiles did much to complicate negotiations on the START-1 Treaty.

If the criteria used in the U.S.-Soviet strategic arms control agreements are extended to other countries, Great Britain's entire nuclear arsenal, most of France's arsenal, and a small part of China's would be defined as strategic. All of Great Britain's nuclear warheads currently in service are deployed on submarine–launched Trident-2 ballistic missiles, purchased in the U.S. and defined as strategic. The bulk of France's nuclear forces consists of its own SLBMs. France also includes in its strategic forces a small number of nuclear-armed tactical aircraft based at airfields or on aircraft carriers. These planes could theoretically deliver nuclear bombs to targets in the European part of Russia.

China has a small number of intercontinental ballistic missiles (around 20) that would be counted as strategic and could strike targets in the U.S. or the European part of Russia. China has also been attempting to deploy submarines with SLBMs, but it has not been entirely successful in this area so far. Nonstrategic nuclear weapons – medium-range and tactical missiles and aircraft – form the basis of China's nuclear forces, but these weapons, too, are able to strike targets on Russian territory at various distances from the Russian-Chinese border in the Asian part of the country.

The entire nuclear forces of the three unrecognized nuclear powers – India, Pakistan and Israel – are tactical. Israel and probably India are assumed to have the technological capability to build strategic intercontinental ballistic missiles but refrain from doing so in order to avoid unnecessary difficulties in relations with the United States and Russia. North Korea has developed a large number of tactical missiles and has tested, unsuccessfully so far, medium-range missiles. Pyongyang also tested a nuclear explosive device in 2006, but it has not yet managed to turn it into a warhead that could be used to arm a missile.

It should also be noted that what qualifies as nonstrategic weapons under the definitions in the U.S.-Soviet arms control treaties are in fact strategic for a number of the countries that possess them. Pakistan, for example, sees India as its strategic adversary, and its nonstrategic nuclear weapons do not require intercontinental range to fulfill a 'strategic' function. The same applies to Indian missiles directed at Pakistan. This is also true for Israel, which is confronted by the Arab world and Iran. Israel does not need missiles of strategic range to be able to hit targets in this region.

With the exception of Great Britain, no nuclear country provides official data on its nonstrategic nuclear capability. Publicly accessible data is based on unofficial estimates made by various organizations and experts. It is therefore not necessarily reliable and should be treated with reasonable caution. Estimates of countries' nonstrategic nuclear arsenals are presented in table 8.

Table 8

Nonstrategic Nuclear Arsenals of Different Countries in 2007

Country	Number of tactical warheads
Russia	2200
U.S.	500
China	100-200
Israel	60-200
France	60
Pakistan	60
India	50
North Korea	6
Great Britain	0
Total	*3036-3276*

Source: *World Armaments, Disarmament and International Security: SIPRI Yearbook 2007,* [S. l.] (Oxford Univ. Press, 2007) PP. 514-551.

According to data presented by the Stockholm International Peace Research Institute (SIPRI), the U.S. had 500 nonstrategic nuclear weapons deployed at the start of 2007. Of this total, around 400 gravity bombs were deployed at eight air force bases in six European countries (Great Britain, Germany, the Netherlands, Belgium, Italy, and Turkey). These arms could be delivered to their targets not only by American fighter-bombers, but also by other NATO member countries' aircraft, in particular by Belgian and Dutch F-16 fighters, and by German and British Tornado bombers.

Estimates of the number of American tactical nuclear weapons (TNWs) in Europe over recent years have increased substantially. It was estimated that the U.S. had 150-200 such weapons in Europe at the start of the decade. Given the lack of transparency, it is not clear whether the increased estimates reflect the real number of warheads deployed, or whether there are political motivations behind the increased figures.

The U.S. also has around 100 W80-0 warheads designed for the Tomahawk sea-launched cruise missile, plus another 190 such warheads for these missiles in reserve. These weapons can be deployed on Los Angeles and Virginia-class nuclear submarines. They are currently stockpiled on land, but they can be deployed on the submarines within 30 days if the order comes. All of the Tomahawk sea-launched cruise missiles are stockpiled at the Kings Bay (Georgia) and Bangor (Washington) naval bases.

Aside from the 500 tactical nuclear warheads currently deployed, the U.S. also has 1,155 tactical warheads in reserve, which can be rapidly deployed if necessary. Furthermore, in 2007, the Bush administration decided to rebuild the U.S. capability to manufacture nuclear warheads. The U.S. had stopped industrial-scale production of nuclear warheads after the end of the cold war, assembling only a few every year.

SIPRI's estimates of Russia's TNWs remain high. This is probably because there is no one making national estimates of TNW capability in Russia itself, whereas in the U.S. there are several research centers making such estimates, and their data forms the basis of the unofficial international reports on American stockpiles of nuclear weapons.

Whatever the situation, according to SIPRI, Russia had around 2,200 deployed nonstrategic nuclear warheads at the start of 2007. Almost half of them (around 1,000) can be deployed on approximately 500 Tu-22M medium-range bombers and Su-24 tactical bombers. Some 200 more warheads can be deployed on more than 100 land-based aircraft belonging to the Russian Navy. Approximately 260 warheads can be delivered by submarine-launched cruise missiles, and about 150 warheads can be carried by anti-submarine and anti-aircraft missiles. Judging by the data presented in the estimates, the remaining warheads could be used to arm missiles and torpedoes on battleships and attack submarines. It is interesting that, according to the SIPRI report, the Russian warheads for tactical missiles and also nuclear artillery shells and land mines are not currently operational.

However, the report cites information that the Russian Navy does have deployed tactical nuclear warheads for missiles and torpedoes on battleships and attack submarines. This does not tally with statements by Russian Foreign Minister Igor Ivanov in 2000, who said that all of the Russian Navy's nuclear warheads were stockpiled at centralized storage facilities, but the ground forces' warheads could remain actively deployed (see below).[1] This makes it hard to trust SIPRI's estimates of the size and structure of Russia's TNWs. Regardless, the figures given by the institute show that the number of tactical warheads deployed by Russia has undergone an almost ten-fold reduction since 1991 (see table 8).

After the end of the cold war, Great Britain gave up its nonstrategic nuclear weapons (air bombs and anti-submarine weapons). Instead, it converted some of its Trident missiles, classified as 'strategic,' to carry out 'nonstrategic' missions, that is, strikes against tactical targets. It should also be noted that British bombers can carry American nuclear air bombs stationed in Great Britain.

Around 15-16% of France's nuclear warheads are defined as nonstrategic. Around 50 warheads can be deployed on air-to-surface missiles carried by medium-range land-based Mirage-2000N bombers. An additional 10 warheads can be deployed on similar missiles carried by the Super-Etendard bombers stationed on board the aircraft carrier Charles de Gaulle. France is the only NATO country that still deploys nuclear weapons on naval ships. Like Russia, the U.S. and Great Britain, after the cold war ended France began reducing its nonstrategic nuclear forces. It has completely abandoned land-based ballistic missiles, including intermediate- and short-range missiles.

China's nonstrategic nuclear forces comprise around 50 single-warhead medium-range Dong Feng-3A and Dong Feng 21A ballistic missiles. The Dong Feng-21A is a relatively new version, first deployed in 1991. China also has an unknown number of short-range ballistic missiles, the Dong Feng-11 and Dong Feng-15, which can carry nuclear warheads, and around 40 air bombs that can be delivered by aging medium-range Hong-6 bombers and Jian-5 fighter planes. Under the Western classification, all of these weapons are defined as strategic, except for short-range ballistic missiles, though they do not fit the criteria for strategic arms as developed by the U.S.-Soviet arms control treaties. Using these criteria would give China the third biggest nonstrategic nuclear arsenal in the world in terms of numbers, after Russia and the U.S. However, Beijing has also shown restraint since the end of the cold war, has hardly increased its nuclear capacity over this time, and has carried out modernization at a rather moderate pace.

Only in the four unrecognized nuclear powers – India, Pakistan, Israel, and North Korea – has there been a trend to increase nuclear capability over the last ten years. The arms race on the Indian subcontinent has resulted in India and Pakistan having a nonstrategic nuclear weapons capability comparable to that of France.

India's nuclear capability is estimated at 50 warheads, all produced after India carried out a series of nuclear tests in 1998. They can be delivered by the short-range Prithvi-1 and intermediate-range Agni-1 and Agni-2 ballistic missiles. India also has the Dhanush sea-launched ballistic missile and is developing the Sagarika submarine-launched ballistic missile. India's medium-range Mirage-1000H Vajra bombers and, in part, the Jaguar IS Samsher fighter-bombers can also be used to deliver nuclear weapons. The Russian-made MiG-27 Bahadur and Su-30 MKI fighters could theoretically carry nuclear weapons. The Su-30 MKI is equipped for mid-air refueling from an Il-78 tanker aircraft.

According to SIPRI, Pakistan has around 60 nuclear warheads, all produced after the country conducted nuclear tests in 1998 and able to be delivered by ballistic missiles and fighter aircraft. Pakistan has three types of short-range ballistic missiles (the Hatf-2 Abdali, Hatf-3 Ghaznavi, and Hatf-4 Shaheen-1) and a medium-range ballistic missile, the Hatf-5 Ghauri. It is currently in the process of testing the medium-range Hatf-6 Shaheen-2. With the exception of the Abdali, these are all land-based mobile, solid-fuel systems. They have been deployed since the middle of this decade, and provide evidence of the strong efforts former President Pervez Musharraf's government has put into building missiles. North Korea, and in the past China, are believed to have actively assisted Pakistan in developing its missile program. Aside from ballistic missiles, Pakistan can also use its American-produced F-16 A/B fighters to deliver nuclear weapons. Nuclear weapons could also theoretically be deployed on the French-made Mirage-V and Chinese-made A-5 fighters.

Estimates of Israel's nuclear capability range from 60 to 200 warheads. If the higher estimates are true, Israel's nuclear capability is comparable to China's nonstrategic nuclear capability. Israel has 50 medium-range Jericho-2 ballistic missiles that can reach targets at a range that includes southern Russia. Israel has also developed the Shavit space launch vehicle that can be converted into an ICBM and can carry a useful payload of 770 kg over a range exceeding 4,000 km. But as was noted above, Israel has refrained so far from taking such steps for political reasons. Israel can also deliver its nuclear weapons using its 205 American-produced A, B, C, D and I-modification F-16 fighters. The country also has three German-made Dolphin diesel-powered submarines, and it placed orders for two more in 2006. It is believed that their torpedo tubes were converted into sea-launched cruise missile launchers. There have been reports that Israel has succeeded in building a nuclear-capable sea-launched cruise missile on the basis of the American Harpoon missile.

North Korea exploded a nuclear device in October 2006, but some experts say the test was not entirely successful. Nevertheless, Pyongyang could have several nuclear explosive devices potentially capable of producing a nuclear blast. These devices could be delivered by planes or submarines. In the latter case, they would have to be exploded either on board the submarine or, after being secretly unloaded, on the enemy's coast. Another option would be to deliver the nuclear device by truck through a tunnel dug beneath the demilitarized zone separating North and South Korea, but this is an unlikely scenario, given the high risk that the tunnel would be discovered. It is commonly believed that North Korea has not yet managed to miniaturize its nuclear explosive devices to the point where they could be used to arm ballistic missiles. North Korea is believed to have hundreds of short-range Hwaseong ballistic missiles and several dozen Nodong intermediate-range ballistic missiles. Tests of the Taepodong intercontinental ballistic missile have been unsuccessful so far.[2]

Multilateral Regimes Limiting TNWs

Although the five recognized nuclear powers have made significant cutbacks in their tactical nuclear weapons since the cold war ended, this has mostly been through unilateral initiatives rather than being part of disarmament negotiations and treaties. Nevertheless, despite the widespread belief to the contrary, nonstrategic nuclear weapons, like nuclear weapons in general, are covered by a whole network of formal international arms control regimes. As is the case with strategic weapons, the deployment of NSNWs is regulated simultaneously by several regimes designed to limit horizontal, and to a lesser extent, vertical nuclear proliferation.

To a greater extent, these regimes apply precisely to nonstrategic nuclear weapons. Military-technical history shows that proliferation begins by acquiring NSNWs and only then do the acquiring countries decide whether or not they also need strategic weapons. As noted above, in a number of cases they see no need to acquire strategic weapons.

The cornerstone in the arms control regime is the 1968 Nuclear Nonproliferation Treaty (NPT) – a universal international agreement to which all countries but the four unrecognized nuclear powers are parties. All signatory countries, with the exception of the five recognized nuclear powers, have voluntarily renounced the possession of nuclear weapons, including

NSNWs. Only one country, North Korea, has ever withdrawn from the NPT. All other countries have so far complied with their commitments.

The deployment of nuclear weapons, including NSNWs, is prohibited in some areas – for example, on the seabed, in outer space, and on the Moon and other celestial bodies. The corresponding provisions are stipulated by global international agreements. Other international agreements prohibit deployment of nuclear weapons in specific geographical zones: Antarctica (the Antarctic Treaty), Latin America (the Treaty of Tlatelolco), the South Pacific (the Treaty of Rarotonga), Africa (the Treaty of Pelindaba), Southeast Asia (the Treaty of Bangkok), Mongolia (which has declared itself a nuclear weapons-free zone), and Central Asia (with certain reservations).

It is often said that the conclusion of multilateral treaties establishing nuclear-free zones has made the entire southern hemisphere free of nuclear weapons. This is not quite so, because not all of these treaties have come into force (the Treaty of Pelindaba, for example). Furthermore, the treaties do not apply to international waters and airspace, which remain open for ships and aircraft carrying nuclear weapons. But the very fact that these zones have been established is evidence that most countries are committed to their non-nuclear status and directly concerns nonstrategic nuclear weapons.

Unfortunately, the great military powers often adopt a skeptical attitude towards the nuclear-free zones and tend to see them primarily through the prism of their own military and political interests and strategies, giving priority to their national interests rather than to the task of making progress in horizontal nuclear disarmament. NATO's leadership, for example, effectively blocked the creation of a nuclear-free zone in Central and Eastern Europe, because the membership of several countries that were also NATO members in this zone would have complicated the organization's nuclear planning and given rise to asymmetrical military commitments for the various member states. At the same time, NATO gave its full support to the establishment of a nuclear-free zone in Central Asia. A ban on the deployment of Russian nuclear weapons in Central Asia theoretically made it more difficult to provide the region's countries with security guarantees through the Collective Security Treaty Organization (CSTO), which consequently would have created a certain ambiguity in their military and political relations with Russia. Following this logic, Moscow initially expressed reservations to the establishment of a nuclear-free zone in Central Asia, although in practice it did not plan to deploy nuclear weapons of any kind in the region.

As for regimes limiting vertical proliferation, the cornerstones are the international treaties limiting and prohibiting nuclear tests. The 1963 Limited Test Ban Treaty prohibits tests of nuclear weapons, including NSNWs, on land, in the atmosphere, and underwater. In 1996, the Comprehensive Test Ban Treaty (CTBT), which bans all nuclear tests, was opened for signature. This treaty did not enter into force primarily because of obstruction from the Bush administration, which revoked the U.S. signature. But since 1998, all countries (with the exception of North Korea), have observed a voluntary moratorium on carrying out tests. This moratorium has restricted the modernization of nuclear weapons in the countries most actively involved in deploying TNWs. Unlike the five recognized nuclear powers, these countries had not built up a base of information from past tests, and this makes it very difficult for them to carry out computer simulations in place of actual tests.

The Fissile Material Cutoff Treaty (FMCT) could have made a significant contribution to stopping the growth of the unrecognized nuclear powers' nonstrategic nuclear arsenals and to deterring non-nuclear countries' attempts to gain nuclear status. Talks on the treaty were conducted as part of the UN Disarmament Conference in Geneva, but they have been in a deadlock since the beginning of the decade. The treaty, were it to actually take effect, would have the largest impact on countries most actively increasing their TNW arsenals at present, because of the limits it would place on stocks of weapons materials. The ban on the production of weapons materials in all countries would have made it possible to set comparatively low ceilings on their arsenals. The sooner this regime could be brought into force, the lower the number of warheads countries would possess.

Overall, existing and prospective nuclear weapons nonproliferation regimes could have a major impact on NSNW capability. It could be possible to cement the agreements with North Korea on its renunciation of its nuclear program by having North Korea return to the NPT as a non-nuclear state. Entry into force of the CTBT and signature of the FMCT would provide the international legal instruments for, most importantly, restricting the increase and modernization of the NSNW arsenals of the unrecognized nuclear powers, which are currently not parties to any nuclear arms control agreements (except Israel, which has signed, but not ratified, the CTBT).

Furthermore, making these treaties universal would make it extremely difficult for non-nuclear countries to acquire nuclear weapons (above all NSNWs). They would not be able to legally produce the fissile materials needed to make such weapons. Moreover, with the possible exception of Israel, no country has acquired nuclear status without carrying out nuclear tests.

The INF Treaty

The main treaty that applies to NSNWs is the Intermediate-Range Nuclear Forces Treaty (INF Treaty), concluded between the USSR and the U.S. and signed in Washington in December 1987.[3] This treaty, which is of indefinite duration, was the first ever agreement in which the parties, the Soviet Union and the United States, undertook the mutual and verified elimination of two whole classes of nonstrategic nuclear weapons and missiles – land-based ballistic and cruise missiles with ranges from 500-1,000 km and from 1,000 to 5,500 km. The ban applied not only to deployed missiles, but also to the production and testing of stockpiled weapons. The treaty stipulated a verification system unprecedented in its intrusiveness, including on-site inspections and constant monitoring of installations.

The reductions stipulated by the treaty had been carried out by June 1991, that is, before the Soviet Union collapsed. In accordance with the treaty's provisions, the Soviet Union eliminated 1,846 medium- and shorter-range missiles: the RSD-10 (known in the West as the SS-20), R-12, R-14, RK-55, OTR-22, and OTR-23. The United States eliminated 846 missiles: the Pershing-2, the Tomahawk land-based cruise missile, Pershing-1A, and Pershing-1B.

After the Soviet Union fell apart in December 1991, the 12 CIS countries became legal successors to its obligations under the INF Treaty. In reality, only six of these countries had real obligations regarding on-site inspections in accordance with the treaty provisions. They were Russia, Ukraine, Belarus, Kazakhstan, Uzbekistan, and Turkmenistan. The relevant decisions were approved in July and October 1992.

The Baltic States formally seceded from the Soviet Union in September 1991. In their view, they were annexed illegally by the Soviet Union in 1940 and therefore could not comply with legally binding obligations made during their time within the Soviet Union, including obligations under the INF Treaty. The parties to the treaty accepted this point of view and the former Soviet installations on these countries' soil remained outside the verification regime.

Naturally, the 1987 treaty did not stipulate verification measures on the territory of allied countries. Following the collapse of the Soviet Union, Moscow could have had an interest in carrying out verification measures at former Soviet installations in Central and Eastern Europe, including the Baltic States, to ensure that these countries had completely eliminated their entire medium- and shorter-range missile infrastructure, but Russia did not raise this issue at the beginning of the 1990s.

The treaty's terms stipulated that inspections would be carried out for 13 years following the treaty's entry into force, that is, until 2001. In 2001, Russia and the United States made a declaration ending the inspections.

After the shift in the U.S.-Russian nuclear balance brought about by the American unilateral withdrawal from the ABM Treaty in 2002 and the Baltic States' accession to NATO, reports began spreading that Russia might withdraw from the INF Treaty. As far as is known, Russia first raised this possibility during a meeting of the Russian and U.S. defense ministers in 2004. Russian military officials were next in line to suggest that Russia might take such a step. Finally, at a meeting with U.S. Secretary of State Condoleezza Rice and U.S. Defense Secretary Robert Gates in October 2007, President Putin said it was unacceptable to have a situation in which only Russia and the U.S. observed a ban on possessing medium- and shorter-range missiles, while other countries were not bound by such limitations. In November 2007, the UN disseminated a joint statement by Russia and the U.S. calling on all countries to join a global ban on medium- and shorter-range missiles.

China, Pakistan, India, Israel, and North Korea all have missiles capable of reaching the territory of Russia and its allies. They could eventually be joined by Iran and a number of Arab countries. Furthermore, the NATO countries, Japan, and South Korea are not bound by any international legal restrictions prohibiting them from developing medium- and shorter-range missiles.

Nonetheless, all of the United States' non-nuclear allies that have missile-building potential are parties to the NPT and have renounced the development of nuclear weapons that could arm their missiles. As already noted, Great Britain and France made unilateral decisions to renounce the possession of land-based shorter-range and medium-range missiles.

Such a renunciation on the part of the Asian countries is unlikely. These weapons form the backbone of China's nuclear forces, and Beijing is ready to join the nuclear disarmament process only when the other nuclear powers' arsenals have been cut back to a level similar to that of China. Pakistan sees shorter-range and medium-range missiles as a vital security guarantee that neutralizes India's superiority in conventional weapons and armed forces. India, for its part, directs its nuclear deterrent not only against Pakistan, but to an even greater degree against China. Israel considers it essential to be able to keep its sights on Tehran and on Arab capitals more than 500 km away. For these countries, joining a global moratorium on shorter-range and medium-range missiles would require them to give up a key component of their national security, while Russia and the U.S.

would still have thousands of nuclear warheads deployed on strategic delivery systems, on medium- and tactical-range aviation, and as part of their TNWs with a range of less than 500 km.

There has not been any significant worsening in the situation with Asian countries that have nuclear and missile capability since the signing of the INF Treaty in 1987. China has the biggest nuclear and missile capability of these countries. Its capability remains at a similar level to what it was at the end of the 1980s, but its forces' strategic component is gradually increasing. At the same time, there has been a noticeable improvement in relations between Moscow and Beijing over this period. Israel had already developed its Jericho intermediate-range missile at the time the INF Treaty was signed. North Korea has not yet developed nuclear warheads with which to arm its missiles. It is difficult to imagine any scenario for nuclear confrontation between Russia and India, who are longstanding strategic partners. There are some concerns with regard to Pakistan, but the dangers associated with this country are linked less to the Pakistani authorities potentially sanctioning the use of its nuclear arsenal, than to the prospect that these weapons could fall into the hands of Islamists. The withdrawal of the U. S. and Russia from the INF Treaty would not help to prevent this kind of situation (other issues associated with the INF Treaty are examined in detail in chapter 8).

Unilateral Initiatives in 1991-1992

In 1991 and 1992, the U.S. and Soviet/Russian presidents put forward unilateral parallel initiatives to withdraw a large part of the TNWs in both countries from service and partially eliminate them. In Western literature these initiatives became known as the Presidential Nuclear Initiatives (PNIs). These initiatives were voluntary, not legally binding, and not formally bound to any reciprocal measures by the other side. It seemed at the time that this approach would make it possible to carry out the measures quite rapidly without getting bogged down in a long and complex negotiating process. At the same time, the absence of a legal framework simplified the withdrawal from unilateral obligations, if such became necessary, without having to go through the legal procedure of denouncing an international treaty.

The first PNIs were announced on September 27, 1991, by U.S. President George H. W. Bush. Soviet President Mikhail Gorbachev followed on October 5 with reciprocal measures and proposals. His initiatives were taken further and given more specific form in the proposals put forward by Russian President Boris Yeltsin on January 29, 1992. The measures announced by the U.S. President included:

- Withdrawing all tactical nuclear warheads used to arm ground-launched delivery systems (nuclear artillery shells and warheads for the Lance tactical missile) to U.S. territory, including those in Europe and South Korea, with their subsequent dismantling and elimination;
- Withdrawing all tactical nuclear weapons and naval aviation depth bombs from service on surface vessels and submarines, removing them to U.S. territory for storage, and destroying approximately half of them;
- Halting the program to develop the SRAM-T short-range missile designed for tactical attack aircraft.

The Soviet Union and then Russia responded with the following proposals:

- All tactical nuclear weapons for land forces and anti-aircraft defenses would be relocated to depots at nuclear warhead assembly plants and stockpiled in central storage sites;
- All warheads for land-based systems would be destroyed;
- A third of the warheads for tactical sea-launched delivery systems would be destroyed;
- Half of the nuclear warheads for air defense missiles would be destroyed;
- Half of the stockpile of airborne tactical nuclear warheads would be destroyed;
- On a joint basis with the United States, nuclear munitions for attack aviation would be withdrawn from tactical attack aviation units and taken to centralized storage sites.[4]

It is very difficult to overestimate the actual numbers these proposed reductions involved. Unlike the case with strategic nuclear forces, Russia and the U.S. did not publish official data on their stockpiles of tactical nuclear weapons. According to unofficial published estimates, the U.S. was to destroy around 3,000 tactical nuclear warheads (1,300 artillery shells, more than 800 warheads for Lance missiles, and around 900 naval munitions, mostly depth charges), while retaining their free-fall bombs for the Air Force. The total number of free-fall bombs was estimated at 2,000 at the start of the 1990s, of which 500-600 were stockpiled in Europe.[5] An overall estimate of the current size of the American TNW arsenal is given above.

According to estimates presented in an authoritative Russian study, Russia's PNI measures involved the reduction of 13,700 tactical nuclear warheads, including 4,000 warheads for tactical missiles, 2,000 artillery shells, 700 devices (nuclear demolition munitions) of the Engineer Forces, 1,500 warheads for air defense missiles, 3,500 warheads for front-line aviation, 1,000 warheads for naval ships and submarines, and 1,000 warheads for naval aviation. Together, this comprised almost two thirds of the TNWs in the former Soviet Union's arsenal in 1991.[6]

It is hard to overestimate the scale of the reductions the PNIs entailed. This was the first time the decision had been made to dismantle and destroy not only the nuclear delivery vehicles, as has been done with strategic offensive weapons in accordance with arms control agreements, but also the nuclear warheads themselves. Several classes of TNWs were to be completely eliminated: nuclear artillery shells and mines, nuclear warheads for tactical missiles and nuclear demolition munitions.[7] Furthermore, the scale of the reductions significantly exceeded the indirect limitations set by the START treaties. Under the START Treaty in effect in 1991, Russia and the U.S. were to withdraw 4,000-5,000 nuclear warheads each from service, for a total of 8,000-10,000 warheads. The PNIs opened the door for the possible destruction of more than 16,000 warheads total.

However, right from the start, implementing the PNIs ran into serious difficulties. Initial difficulties in 1992 were linked to Russia's withdrawal of tactical nuclear warheads from the territory of the former Soviet republics. The withdrawal of these weapons was anticipated in the provisions of the basic agreements that ended the Soviet Union's existence, signed by the leaders of the new independent states in 1991. However, a number of former Soviet republics began obstructing these measures. In particular, Ukrainian President Leonid Kravchuk prohibited the withdrawal of tactical nuclear munitions to Russia in February 1992. Only joint pressure by Russia and the U.S. obliged him to allow the transportation of these weapons to resume. All tactical nuclear weapons were withdrawn by the spring of 1992. The withdrawal of nuclear munitions for strategic delivery systems was completed only in 1996.

The other problem was that, faced with economic collapse in the 1990s, Russia had great difficulties finding the money for decommissioning and dismantling its nuclear weapons, while disarmament measures were hampered by the lack of storage facilities. As a result, existing storage facilities were overloaded, which, in turn, undermined their security.[8] The risk of unauthorized access to nuclear munitions during transportation and storage forced Moscow to accept international assistance in ensuring nuclear security. Assistance came primarily from the U.S. through the Nunn-Lugar Program, but other countries, including France and Great Britain, also made a contribution. For secrecy reasons, Russia refused direct assistance in dismantling the nuclear warheads, but it accepted foreign aid in less sensitive areas, for instance, the provision of containers and rail cars for the secure transport of nuclear weapons, protective equipment for nuclear storage facilities, etc. This made it possible to put together the funds needed for destroying the warheads.

The provision of foreign aid ensured partial unilateral transparency that the PNIs had not envisioned. The donor countries, above all the U.S., insisted on access to facilities to which they were sending assistance, in order to ensure that the equipment delivered was indeed being used for the declared purpose. Long and complicated negotiations finally resulted in mutually acceptable solutions that respected secrecy demands, while at the same time providing the necessary access to facilities. Similar limited transparency measures also covered other important facilities, such as plants assembling and dismantling nuclear weapons under the jurisdiction of Rosatom, the Russian nuclear energy agency, and nuclear weapon storage facilities under the Defense Ministry's jurisdiction.

The last official information on Russia's fulfillment of the PNIs came from Russian Foreign Minister Igor Ivanov in a speech at the NPT Review Conference on April 25, 2002. In his words, "Russia… is continuing consistent implementation of its unilateral initiatives on tactical nuclear weapons. These weapons have been entirely removed from surface ships and attack submarines, as well as from land-based naval aviation, and have been placed in centralized storage sites. A third of the nuclear warheads for sea-based tactical missiles and naval aviation have been destroyed. Destruction of nuclear warheads for tactical missiles, artillery shells, and also nuclear land mines, is near completion. Half of the nuclear warheads for air defense missiles and half of nuclear air bombs have been destroyed."[9] Table 9 below presents estimates of Russia's fulfillment of the PNIs.

Thus, in 2000, Russia had for the most part fulfilled its PNI commitments. As was planned, all naval weapons were taken to centralized storage sites, and a third of the warheads were destroyed (divergent official statements make it unclear as to whether all of these munitions were indeed taken from naval bases to the centralized storage depots). Some tactical nuclear warheads remained in service by the Ground Forces, Air Force and Air Defense. In the case of the Air Force, this did not contradict the PNI because, in accordance with President Yeltsin's January 1992 initiative, Russia and the U.S. were to withdraw tactical warheads from service and destroy them jointly. The U.S. did not do this, but Russia fulfilled its com-

Table 9

Russia's Unilateral TNW Commitments 1991-1992 (number of warheads)

Type of weapon	Number deployed in the USSR in 1991	Number to be reduced under the PNIs	Level of fulfillment by 2000
Ground forces:			
1. Missiles	4000	4000	Being completed
2. Artillery	2000	2000	Being completed
3. Engineers	700	700	Being completed
Air defense	3000	1500	1500
Air force	7000	3500	3500
Navy:			All munitions taken to centralized storage sites
1. Ships, submarines	3000	1000	1000
2. Naval aviation	2000	700	700
Total	*21700*	*13400*	

Sources: A. Arbatov, "Sokrashcheniye nestrategicheskikh yadernykh vooruzhenii, takticheskoye yadernoye oruzhiye," in *Yaderniye vooruzheniya i bezopasnost Rossii* (Moscow: IMEMO RAN, 1997), P. 56; Igor Ivanov (Speech, Review Conference of the Parties to the Treaty on the Nonproliferation of Nuclear Weapons, April 25, 2000), *Diplomatichesky vestnik,* May 2000, http://www.mid.ru/dip_vest.nsf/99b2ddc4f717c733c32567370042ee43/25de7700e9ba953ec32568ef0027c951?OpenDocument.

mitments to destroy Air Force warheads by 2000. PNI commitments on the destruction of warheads for Air Defense weapons were fulfilled, but not obligations for the complete withdrawal of TNWs from Air Defense forces. Thus, during the 1990s, Russia fulfilled its PNI commitments on Air Force warheads, possibly naval warheads, and part of the Air Defense warheads. In the Ground Forces, some of Russia's tactical nuclear warheads remained in service and were not destroyed, though the PNIs called for their full removal to centralized storage sites and their complete destruction. The fact that not all of these munitions were destroyed can be explained by financial and technical difficulties.

Fulfillment of the PNIs was one of the demands to come out of the 2000 NPT Review Conference. It was also made part of the 13 Steps, an action plan for the nuclear powers to fulfill their obligations under article VI of the NPT Treaty. The 13 Steps plan was adopted by the NPT Review Conference by consensus, that is to say, the Russian and U.S. representatives gave it their approval, too.

But 19 months later, Washington announced its unilateral withdrawal from the U.S.-Soviet ABM Treaty of 1972 on limiting anti-ballistic missile defense systems. The ABM Treaty was viewed as the cornerstone of strategic stability. This decision ran counter to the U.S. commitments under the 13 Steps plan, which called for compliance with the ABM Treaty. The American withdrawal from the ABM Treaty in June 2002 upset the delicate balance of Russian and U.S. mutual nuclear disarmament commitments, including those regarding TNWs. Clearly, the fact that one NPT party was violating its commitments relating to a number of the decisions adopted by the 2000 Review Conference (including the 13 Steps plan) made it unlikely that other parties would fully observe these commitments.

The 2005 NPT Review Conference adopted no provisions on the 13 Steps plan, which effectively signaled that it was no longer in effect. This has inevitably had an effect on the fulfillment of the PNIs.

On April 28, 2003, addressing a meeting of the NPT Review Conference's preparatory committee, the head of the Russian delegation said, "Russia's position is that the issue of tactical nuclear weapons cannot be examined in separation from other types of weapons. It is precisely for this reason that the Russian disarmament initiatives of 1991-1992 are comprehensive in nature and, furthermore, concern tactical nuclear weapons and other important issues that have a significant impact on strategic stability."[10]

Russia's official reference to PNIs concerning not just TNWs, but also other issues of importance for strategic stability, clearly has its roots in the vision of a link between the fulfillment of the 1991-1992 initiatives and the fate of the ABM Treaty as a cornerstone of strategic stability. Moreover, the affirmation that TNWs cannot be examined separately from other types of weapons carries a clear implicit reference to the situation regarding the entry into force of the adapted Treaty on Conventional Armed Forces in Europe (CFE Treaty).

The CFE Treaty was signed back in 1990 and was based on maintaining a bloc-based balance of power in Europe with regard to five types of conventional weapons (tanks, armored vehicles, artillery, combat helicopters and planes). The collapse of the Warsaw Pact and the Soviet Union itself, followed by NATO's eastward expansion, left the treaty completely obsolete. In order to preserve a system of limitations on conventional weapons, the parties to the treaty held talks on its adaptation, culminating in the signature of the adapted CFE Treaty in Istanbul in 1999. This adapted treaty better reflected the actual military-political situation that emerged in Europe after the end of the cold war and gave Russia some security guarantees, limiting possibilities for NATO to deploy troops along Russia's borders. But the NATO countries came up with various pretexts for refusing to ratify the document.

With the Baltic States joining NATO, an increasing imbalance in conventional weapons that was not in Russia's favor, and the West's refusal to ratify the adapted CFE Treaty, in December 2007 Russia announced that it was unilaterally suspending its obligations under the base CFE Treaty (the adapted treaty, built upon the base treaty, had still not come into force). The role of nuclear weapons, especially tactical weapons, as a means of neutralizing the imbalance that had emerged also took on sudden new relevance for Russia. NATO's eastward expansion, in the absence of adequate security guarantees fixed in international law, clearly raised doubts in Russia as to the wisdom of fulfilling the PNIs in their entirety, all the more so given the political and legally non-binding nature of these commitments.

Judging by the lack of further official statements on the fate of the PNIs, they were not implemented in full. This clearly illustrates both the merits and shortcomings of informal arms control regimes. On one hand, the PNIs resulted in significant reductions in tactical nuclear weapons, including the destruction of thousands of nuclear warheads. At the same time, the lack of verification measures did not allow the parties to know for certain how the reductions were carried out in reality. The lack of legally binding status made it easier for the parties to abandon the fulfillment of their commitments without even announcing the fact.

In other words, the 'informal' approach to disarmament has tactical benefits, but it is not sufficiently steady in the long run to play the part of a stabilizer amidst changing political and military relations between the parties. Moreover, these kinds of initiatives easily fall victim to such changes and can turn into a source of added distrust and tension. It is another matter that after the end of the cold war, the former adversaries could afford to conclude much more radical and rapid, not to mention less technically complex and costly, disarmament agreements.

The Outlook for Arms Control

The issue of TNWs in Europe became more acute after the Baltic States joined NATO. The buffer dividing Russia from NATO vanished, the Kaliningrad Oblast was surrounded by NATO member states' territory, and the Baltic States are only a short distance from Moscow, and even closer to St Petersburg. The small depth of defense, very short flight time for missiles and attack aviation if deployed in Latvia and Estonia, and the sizable overall imbalance in NATO's favor in conventional weapons and armed forces have inevitably increased Russian interest in NSNWs as a means of neutralizing the West's numerical, geo-strategic and operational superiority.

So far, NATO's eastward expansion has not been accompanied by the deployment of nuclear weapons and the most destabilizing nuclear weapons delivery systems on the soil of the new member states. Brussels has observed the provisions of the 1997 NATO-Russia Founding Act, which clearly states that NATO does not plan to deploy nuclear weapons on the territory of new member states. This document is not legally binding, but it continues to have important political significance as a factor contributing to security.

Furthermore, as NATO has expanded, it has taken on the new members' conventional weapons quotas under the CFE Treaty and has made reductions in the numbers of troops and military equipment actually deployed on the continent (in some cases, such as those involving the U.S. and Germany, reductions have occurred more than once). The result is that the total size of the 26 NATO members' forces and equipment deployed in Europe is considerably lower than the ceilings set by the base CFE Treaty and lower, too, than the total NATO forces in Europe in 1990, when the CFE Treaty was signed, and when NATO had 16 member states (except on the southern flank).

In this situation, the likelihood of Russian countermeasures, including taking tactical nuclear warheads from centralized storage sites and returning them to service and deploying nuclear-armed Iskander missiles along Russia's western border, would aim to deter the U.S. and its allies from potentially violating the 1997 Founding Act and from the large-scale deployment of conventional forces in Eastern Europe. But if undertaken before rather than after such steps by NATO, the deployment of Russian TNWs (or shorter- or medium-range missiles, as mentioned above) would provoke the West into taking steps of its own, in particular deploying nuclear-armed missiles in the Baltic States, thus gaining the ability to carry out surprise disarming strikes (with minimal warning) against vital Russian command and communication systems and other targets.

Knowing the West's sensitivity to nuclear issues, Moscow should make it very clear at the highest official level just what consequences would follow any potential decision by Washington to expand its nuclear infrastructure towards Russia's borders, in violation of its commitments, or any decision by NATO to carry out a large-scale deployment of troops in the east.

In the mid-1990s, the U.S. said that under certain conditions it would be ready to accept legally binding commitments not to deploy nuclear weapons on the soil of new NATO members, if Russia agreed to reciprocal restrictions. In the Helsinki Declaration issued at the end of the American-Russian summit in 1997, the two countries agreed to a provision on starting consultations on limiting tactical nuclear weapons, but subsequent differences over the ABM Treaty stopped the two parties from making any further progress in this area.

In accordance with Article VI of the NPT, all of the nuclear weapons states have an obligation to hold nuclear disarmament talks in a spirit of goodwill. NSNWs are no exception to this. Russia has declared its willingness in principle to continue the dialog with the other interested parties on further nuclear disarmament, including NSNWs. As a precondition for starting talks on TNWs, Moscow has suggested that other countries could follow its example and renounce the deployment of their nuclear weapons outside their own national territory. This refers to the 400-500 American air bombs stockpiled in six Western European countries, five of whom are non-nuclear parties to the NPT.

Current estimates show that outdated free-fall bombs comprise America's nuclear weapons in Europe. It is possible that they are not equipped with lock-out devices to prevent unauthorized access to them. The potential danger that these weapons could fall into the hands of terrorists is becoming more serious, given how active various extremist groups, including groups linked to Al Qaeda, have become in Europe.

Particularly problematic in this respect is the case of Great Britain, where British citizens of Muslim origin have committed major terrorist attacks in recent years. 'Domestic' terrorists, fueled by radical Islamist ideology, have greater opportunities for planning and carrying out attacks than do terrorists of foreign origin. Domestic terrorists know their own country better, know the location and vulnerability of particularly vital installations, and have better contacts, who can help them gain access to these installations and help organize attacks. The new dimension that radical Islamist ideology has brought to domestic terrorism is also very important, because unlike traditional domestic terrorism, it encourages its followers to seek out the most destructive terrorist tactics, including nuclear attacks.

The reluctance of the U.S. and its NATO allies to finally abandon cold war relics and withdraw the several hundred outdated nuclear warheads from Europe that also happen to be a nuclear terrorism risk is particularly depressing when set against the unique security conditions that have emerged in Europe since the end of the cold war. Given NATO's considerable superiority over Russia in all of the main types of conventional weapons, it is hard to imagine a situation where the European NATO members would require American nuclear weapons for protection. The new military and political situation on the continent rules out the argument that the presence of these weapons, along with plans to deliver them to their targets using the arms of non-nuclear NATO members, is dictated by the higher interests of European countries' security and NATO's unity, and that it is an alternative to their having independent nuclear status.

On a non-governmental level, there have been various proposals for limiting NSNWs in Europe, and such proposals continue to be put forward. Noteworthy in this respect was the 2006 report by the influential international commission led by Hans Blix. The commission's recommendations echoed Russia's positions. In the commission's view, all countries that possess nuclear weapons should commit themselves to not deploying nuclear weapons of any type on foreign territory. At the same time, the Blix Commission proposed strengthening the reciprocal PNI agreements. Russia and the U.S. should not simply fulfill their commitments, but also completely destroy nuclear mines, artillery shells and warheads for short-range missiles. They should also agree on withdrawing all NSNWs to centralized storage facilities on national soil, where they would be kept until their complete destruction. These commitments should be reinforced with agreements guaranteeing verification, transparency and irreversibility.[11]

Although Russia is rather interested in developing the international legal regime for limiting NSNWs, especially in Europe, there are substantial objective difficulties. First of all, Russia's NSNWs are all located on its own soil, but American NSNWs would need to be transported across the ocean to U.S. territory. Furthermore, Russian TNWs, as Russian military officials admit, are incorporated into the nuclear deterrent strategy in the south and east of the country.

Another problem is that control of NSNWs implies control of the nuclear warheads. Practically all non-strategic delivery vehicles are dual purpose systems that also play an important part in conventional weaponry. Setting ceilings for them would require long and complicated negotiations. Thus, the approach used in U.S.-Soviet strategic arms control, which limited not the warheads, but an agreed list of delivery systems, would not be suitable for TNWs. Nuclear arms control history does not yet have experience in the control of the nuclear warheads themselves. The fact that strategic and nonstrategic warheads are often stockpiled together only further complicates the situation.

Finally, at a time when American-Russian strategic nuclear arms control is going through difficult times and the multilateral arms control regime governing conventional arms and armed forces in Europe is in the process of decay, it is hard to expect any progress in the area of NSNWs.

These difficulties are certainly not easy to resolve, but they are probably not insurmountable. In this context, we should also note the proposals by Russian specialists, included in part in the Blix Commission's recommendations. As a first step they proposed that Russia and NATO make a reciprocal commitment not to deploy TNWs in any form in Central and Eastern Europe. This zone would include the territory of the countries that have joined NATO since 1997, Belarus, other former Soviet republics in Europe, and Russia's Kaliningrad region. The complete absence of TNWs is much easier to monitor than numerical restrictions, because the storage facilities at air force and naval bases are highly protected and strictly guarded installations, the external appearance and locations of which are well known to the parties. In addition, the parties could agree to prohibit the storage of TNWs and strategic arms together and stipulate provisions for carrying out on-site inspections in suspicious cases.[12]

If political relations develop favorably and progress is made in reducing and limiting conventional arms and forces in Europe, the next step could be to conclude an agreement on the complete withdrawal of TNWs by Russia and the U.S. to national territory and on stockpiling them exclusively in centralized storage sites outside troop deployment areas. This would greatly lower the level of combat readiness and enhance the level of security over TNWs (but not necessarily lead to their destruction). These measures could be monitored in the same way as the aforementioned prohibition on the deployment of TNWs in Central and Eastern Europe.[13]

As for the reduction of nuclear weapons through their destruction, in the case of TNWs this implies the destruction not of the delivery systems, but of the nuclear warheads themselves (removed from nuclear land mines, bombs, warheads for missiles, torpedoes and artillery shells). These measures are senseless and unverifiable without first bringing into force the Fissile Materials Cutoff Treaty and establishing verification measures and measures for reducing existing stocks of weapons-grade nuclear materials and warheads in storage. In this respect, destroying TNWs would be technically no different than destroying the warheads through reductions in strategic nuclear forces. Yet forty years of arms control talks and the SALT, START, INF and SORT treaties have made no provisions for their destruction. Clearly, the problem is much broader than simply destroying TNW and takes us to a more remote and radical stage of nuclear disarmament.

But as far as implementing agreements on TNW is concerned, even carrying out the first steps described above, which are realistic in practice and useful in terms of reciprocal security, would require considerable political will and interest from the parties involved, as well as the revival of the professional corps of specialists, administrative personnel and analysts, who make disarmament talks possible.

Notes

[1] Igor Ivanov (Speech, Review Conference of the Parties to the Treaty on the Nonproliferation of Nuclear Weapons, April 25, 2000), *Diplomatichesky vestnik,* May 2000, http://www.mid.ru/dip_vest.nsf/99b2ddc4f717c733c32567370042ee43/25de7700e9ba953ec32568ef0027c951?OpenDocument.

[2] Sh. N. Kile, V. Fedchenko and H. M. Kristensen, "Appendix 12A: World Nuclear Forces, 2007," in *World Armaments, Disarmament and International Security: SIPRI Yearbook 2007,* [S. l.] (Oxford Univ. Press, 2007), PP. 514-551.

[3] For more detail see: A. Arbatov and V. Vladimirov, "Zapret na rakety srednei i menshei dalnosti," in *Razoruzheniye i bezopasnost 1997-1998: Rossiya i mezhdunarodnaya sistema kontrolya nad vooruzheniyami: razvitiye ili raspad* (Moscow: Nauka, 1997), PP. 105-110.

[4] *Rossiiskaya gazeta,* January 30, 1992. See also O. Amirov, "Sokrashcheniye nestrategicheskikh yadernykh vooruzhenii," in *Rossiya v poiskakh strategii bezopasnosti: Problemy bezopasnosti, ogranicheniya vooruzhenii i mirotvorchestva* (Moscow: Nauka, 1996), PP. 56-64.

[5] Amirov, P. 61 (note ii).

[6] A. Arbatov, "Sokrashcheniye nestrategicheskikh yadernykh vooruzhenii, takticheskoye yadernoye oruzhiye," in *Yaderniye vooruzheniya i bezopasnost Rossii* (Moscow: IMEMO RAN, 1997), PP. 51-57.

[7] Ibid., PP. 54, 56.

[8] Ibid., P. 54.

[9] NPT Review Conference.

[10] Russian Federation delegation (Speech at the Preparatory Committee session, April 28, 2003), *Diplomatichesky vestnik,* June 2003, http://www.mid.ru/dip_vest.nsf/99b2ddc4f717c733c32567370042ee43/1716f45b69467ca8c3256d6b004b6b8d?OpenDocument.

[11] *Weapons of Terror: Freeing the World of Nuclear, Biological and Chemical Arms* (Stockholm, 2006), P. 97.

[12] A. Arbatov and V. Dvorkin, *Beyond Nuclear Deterrence: Transforming the U.S.-Russian Equation* (Washington, DC: Carnegie Endowment for International Peace, 2006), PP. 141-162.

[13] Ibid.

Part III

STRATEGIC SYSTEMS, DISARMAMENT AND NONPROLIFERATION

Chapter 7. Missile Defense at a New Stage of Development

Vladimir Dvorkin

The effect of missile defense programs on strategic stability started to become apparent at the end of the 1960s and was initially formulated by then U.S. Secretary of Defense Robert McNamara in his famous speech in San Francisco in 1967.

That was the first attempt at the official level to outline the main conceptual principles that continue to define the way specialists and politicians around the world view these military-technical and military-political issues: mutual nuclear deterrence on the basis of the reciprocal ability to cause unacceptable damage to each other through a second (retaliatory) strike, the destabilizing effect of missile defense systems that could increase the likelihood of a first (disarming, counterforce) strike, and the wisdom of holding talks to make the nuclear balance more stable on the basis of strategic arms reductions.

Over the next 30 years, talks between the nuclear superpowers were built primarily upon this strategic philosophy and resulted in a number of historically significant major agreements. But once the cold war was over, attempts to discard this conceptual foundation and proclaim new principles for strategic relations (without fundamentally changing their material basis) resulted in total failure and have recently led to greater tension in military and political relations and to the disintegration of the international treaty system in this area, with all the ensuing negative consequences, especially for nuclear weapons nonproliferation.

Russia and the U.S. faced a crisis in their relations over missile defense, caused by the Bush administration's plan to deploy a missile defense radar station in the Czech Republic by 2011-2013 to track Iranian missiles and guide interceptors, as well as a base with 10 interceptor missiles in Poland.[1]

There have been several crises or serious complications in the history of military and political relations between the U.S. and the USSR/Russia. The first such incident occurred at the end of the 1960s, when the USSR initiated the march towards missile defense, deploying a missile defense system (the

A-35 system) around Moscow, which gave the U.S. great cause for concern; this incited the U.S. to respond by deploying its own missile defense system (Sentinel-Safeguard) and bringing into service ICBMs and SLBMs with multiple independently targeted re-entry vehicles (MIRV). The second crisis came in the early 1980s, when U.S. President Ronald Reagan launched the Strategic Defense Initiative (Star Wars/SDI) program. Complications arose for a third time in the mid-1990s over the U.S. non-strategic missile defense program and were settled by an agreement in 1997. The fourth round of problems began with the Bush administration's decision to withdraw from the ABM Treaty in 2002 and its approval of a program to build a missile defense system with its first bases in Alaska and California. The events taking place now are therefore the fifth 'missile defense crisis'.

Missile Defense and the Bilateral Strategic Balance

Talks between the Soviet Union and the United States began shortly after McNamara made his speech in San Francisco. The two parties soon ended up switching roles, because the U.S. began deploying its own missile defense system, and the USSR was quick to show interest in putting limits on it. The U.S. insisted on tying missile defense to the issue of the increasing number of Soviet ballistic missiles. The desire to restrain the strategic arms race eventually resulted in the signature and entry into force of the ABM Treaty in 1972 and the Protocol to the Treaty in 1974.

In accordance with the Treaty's provisions, the U.S. deployed one missile defense site, protecting the ICBMs based at Grand Forks (North Dakota). Some calculations concluded that, theoretically, this missile defense system's capability could reduce the effectiveness of a Soviet strategic nuclear counterforce attack on the U.S. missile silos by no more than 3%, since America's principal nuclear deterrent forces were, and still are, deployed on missile-carrying submarines, which are not targets for ballistic missile attack and are not covered by missile defense systems. In 1975, all 100 nuclear-armed missile defense missiles were 'mothballed' following a decision by the Senate. This decision was motivated not only by the missile defense system's minor contribution to a potential retaliatory strike, but also by the danger that the nuclear warheads might explode over American (or Canadian) territory. This motive might be of secondary importance under the scenario of a massive nuclear exchange, but it has presently become quite relevant for the contingencies of attacks by a single or a few missiles from third nuclear powers or 'rogue states'.

The Soviet Union decided to build a missile defense system around Moscow using nuclear-armed interceptor missiles to protect government offices and the central command centers for the armed forces and strategic nuclear forces. The Moscow missile defense system, given the code name A-135, is still in service today, with its operations under the command of the Missile and Space Defense Forces.

The U.S.-Soviet ABM Treaty was signed at the same time as the Interim Agreement on the Limitation of Strategic Offensive Arms (SALT-1). It was the restrictions on strategic missile defense systems that made subsequent agreements to limit and reduce strategic offensive weapons possible. These agreements restrained the growth of the Soviet and U.S. nuclear arsenals, and the entry into force of START-1 in 1994 launched the process of also reducing delivery vehicles and nuclear warheads.

The biggest threat to the ABM Treaty arose after the U.S. declared the start of work on SDI at the beginning of the 1980s. It is interesting that the two parties again changed places. During the final stages of drafting the ABM Treaty in 1972, the Soviet Union insisted that the protocol include the 'common understanding' that the two countries would be allowed to continue research on developing anti-missile systems based on new physical principles (lasers and others). At the start of the 1980s, the Reagan administration, citing this provision, launched SDI as a broad program of research and tests of various missile defense systems based on new physical principles, including systems for basing them in outer space. The Soviet Union responded with research and development on symmetric and asymmetric countermeasures, including the development of new strategic and tactical missile systems. Subsequently, as U.S.-Soviet relations improved, the arms control process accelerated, and under increasing pressure from the U.S. Congress, most of the SDI programs were stopped and a new spiral in the nuclear arms race was avoided.

Missile Defense after the Cold War

The situation with regards to the influence of missile defense on nuclear weapons proliferation changed after the end of the cold war, especially after the U.S. withdrew from the 1972 ABM Treaty in 2002, almost 30 years to the day after the Treaty was signed. The link between the development and deployment of strategic and tactical missile defense systems and nuclear proliferation is becoming ever-more complex and contradictory. In the past, missile defense programs, if not restricted, could have led to the increase of nuclear arsenals, especially in the USSR, U.S., Great Britain, France, and China. In other words, they could have fueled the 'vertical' proliferation of nuclear weapons. Now, we can affirm that these programs have an impact on both 'vertical' and 'horizontal' proliferation. In other words, they also incite new countries to seek possession of nuclear weapons. Today, the offensive and defensive weapons of actual and potential nuclear states form a tangled knot together with the latest non-nuclear systems and probable space strike and support systems. Untangling this knot through negotiations is becoming ever more difficult, and in the future it might turn out to be completely impossible.

American plans to deploy strategic and non-strategic missile defense systems on its own territory, in Central and Eastern Europe, and in East Asia could have had a big impact on the 'vertical' proliferation of strategic and tactical nuclear weapons in Russia and China, and later under certain scenarios in India, Pakistan and other countries as well, inciting them to build up and modernize their nuclear arsenals. These plans could have also encouraged 'threshold' states, especially Iran and North Korea, to change their military policy, which would contribute directly to 'horizontal' proliferation, potentially increasing the number of countries possessing nuclear weapons and their means of delivery.

To a large extent, all of this was linked to the capabilities of existing missile defense systems and the systems the U.S. plans to deploy in other regions, as well as to the prospects for further increases in strategic and tactical missile defense systems, their expected scale, structure and capacity to defend U.S. territory, American troops abroad, and American allies from attacks by ballistic missiles of various types through interception at all stages of the flight trajectory (boost, mid-course and terminal).

Any assessment of the missile defense systems' capabilities and their effect on the proliferation of nuclear weapons and their delivery systems under the new conditions should also take into account the considerable change in the concept of what constitutes acceptable damage in the event of a nuclear strike. At the height of the cold war, the Soviet Union and the U.S. used the concept of unacceptable damage, measured in the devastation caused by several hundred nuclear explosions resulting from the other's strike against one's territory. After the cold war ended and the grounds for armed conflict (and especially a major war) between Moscow and Washington disappeared, the advanced countries came to see the effects of even one nuclear explosion in a big city as being completely unacceptable. The possibility of preventing this threat depends on the effectiveness of missile defense systems and on the predicted scale of hypothetical missile attacks.

U.S. Strategic and Non-strategic Missile Defense Capabilities

The U.S. currently has a strategic missile defense base in Alaska (Fort Greely), with 26 ground-based interceptor (GBI) missiles and ground-based radar (GBR) installations, and plans to have 40 anti-ballistic missiles in the state by 2011. Besides the GBIs in Alaska, the U.S. also has four GBIs at the Vandenberg Air Force Base in California. In addition, ten interceptor missiles and radar installations could be deployed in Central Europe by 2013, the plan being to move them there from Kwajalein Atoll in the Pacific Ocean.[2]

With the necessary intelligence information support, these anti-ballistic missiles could potentially intercept attacking missiles' warheads at a range of 4,000 km and up and an altitude of up to 1500 km. A more detailed presentation of the characteristics of the American strategic missile defense system, with the two-stage interceptors planned for deployment in Poland, and the three-stage interceptors deployed in Alaska and California, is given in the Appendix, put together using material from a presentation by Theodore Postol, Professor at Massachusetts Institute of Technology, made at the Carnegie Moscow Center in December 2007, and from various American studies, publications in journals and other sources.

Tests of the ground-launched mobile THAAD missile defense system and the sea-launched Standard-3 missile defense system, which can be deployed in any region, are in the completion phase (in February 2008, a 'dead' U.S. satellite was shot down at an altitude of 247 km above the Pacific Ocean by a Standard-3 missile launched from an American ship). The close range air defense/missile defense PAC-3 system, which can destroy battlefield/tactical missiles, is already in service.

The THAAD missile defense system is designed to protect troops and military and civilian installations by destroying the attacking warheads during the descent phase of their trajectory, but if the geographical conditions are right, it can also be used to destroy missiles during the boost phase of the trajectory. The maximum interception range is up to 200 km; interception altitude is up to 150 km; minimum altitude is 30-40 km; and maximum speed is up to 4,000 m/s. This single-stage missile weighs only 600 kg; its engine fires for around 15 seconds; and the interceptor vehicle weighs about 40-45 kg. The interceptor takes this stage into strike range and the vehicle then homes in on the target and hits it. It can use its engines to maneuver and home in on the offensive warhead.[3]

The Standard-3 interceptor missile has a maximum interceptor range of more than 500 km, a maximum interception altitude of over 250 km, and a maximum speed of up to 4,500 m/s. This three-stage missile weighs around 1,500 kg, while the interceptor vehicle weighs 15-18 kg.[4] This system is constantly being modernized to increase its interception range and altitude. There is information that it could reach a maximum range of 1,500 km, which would bring its capability close to that of strategic missile defense systems.[5]

The Standard-3 is currently deployed on American ships and also on two Kongo-class Japanese destroyers. There are plans to deploy this system on two more Japanese destroyers.[6]

The U.S. missile defense system is designed as an 'open-ended' system that can be developed by incorporating new stages and also by increasing the number of components in each stage. The objective is to have an integrated missile defense system that will encompass ground-, sea-, air- and space-based information systems, interceptors for the boost, mid-course and terminal phases of ballistic missiles' trajectory, and combat command and communications systems. Most of these systems were developed earlier during work on the strategic National Missile Defense and Theater Missile Defense programs.

During the active phase of the trajectory, missiles can be intercepted with the help of air-based systems using laser weapons, sea- and ground-based interceptor missiles, and space-based systems. There are plans to install laser weapons on Boeing-747 aircraft, which would patrol at an altitude of 10-12 km. The system uses a chemical continuous wave laser and is capable of destroying the target only if the missile itself (the missile body) is under intense thermal and force tension. Laser weapons are a lot more effective against liquid-fuel missiles, which have a longer boost phase and a less robust body than solid-fuel missiles.

Planes carrying laser weapons can be operationally deployed at airfields close to the adversary's missile bases. This would require deploying several attack aircraft, tankers and escort aircraft and maintaining them on combat alert. It is very unlikely that such aircraft-based systems could be used to intercept missiles launched from bases deep in a large hostile country's territory and protected by effective anti-aircraft defenses. But patrolling over ocean areas where missile-carrying submarines are deployed could create a real threat to ballistic missiles launched by them if the regions in question are sufficiently well identified by submarine detection systems.

The possibility of using the sea- and ground-launched Standard-3 and THAAD interceptors to destroy missiles during the boost phase of the trajectory depends on resolving the issue of how to deploy them relatively close to launch sites within the sector of the targets' trajectories and providing the required intelligence information support. In this respect, ballistic missiles launched from submarines and missiles launched from ground-based launchers relatively close to coastal areas would be more vulnerable to sea-based interceptor missiles.

In the more distant future, space-based laser weapons could eventually be developed to destroy missiles during their boost phase. The Star Wars program envisioned the deployment of laser systems in various circular orbits. Up to six spacecraft could be placed in a single circular orbit at an altitude of approximately 1,200 km.

The main interception systems used to destroy missiles in the mid-course (high) phase of the trajectory will be the ground-based strategic missile defense systems described above, using GBI missiles and GBR installations, and in some cases the Standard-3 and THAAD systems.

Plans for intercepting missile warheads in the terminal (descent) phase of the trajectory involve using the ground- and sea-based THAAD and Standard-3 systems, as well as the PAC-3 missile defense system, which, as noted above, can destroy only battlefield/tactical missiles. But the PAC-3 could be potentially effective against maneuverable gliding homing ICBM warheads, which in the final phase of their trajectory reduce their speed and move through the atmosphere for a reasonably long time period.

Fig. 3 presents the general structure of the potential U.S. missile defense system.

Even if their design effectiveness is actually achieved, the two strategic U.S. missile defense sites in Alaska and California and the proposed third site in Poland and the Czech Republic have practically no impact on Russia's strategic nuclear deterrent capability, that is, its ability to deliver a full-scale retaliatory strike, despite the theoretical possibility that they could intercept a few Russian ICBM warheads. This is due to the highly-effective BMD penetration aids that are installed on Russia's missiles for use during all vulnerable stages of the trajectory.

A more rational explanation for Moscow's vigorous objections to U.S. plans to establish a third missile defense site in Central Europe was the fear that the U.S. will continue unrestrained quantitative and qualitative development of its missile defense systems as described above. In this case, if Russia stays with its current modernization and weapons deployment programs for its nuclear triad, its nuclear deterrent capability will decline. Furthermore, assurances from the U.S. administration and Pentagon officials that the interceptors in Poland would not even theoretically be able

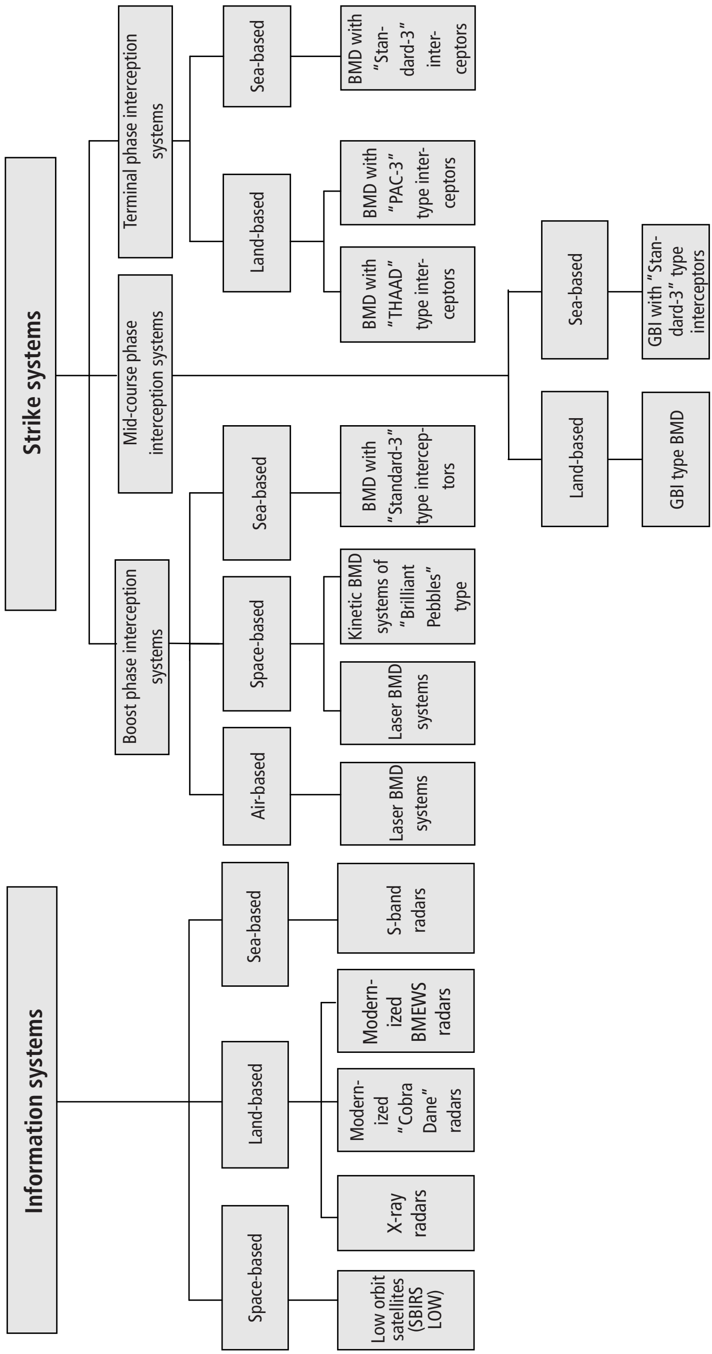

Fig. 3. Projected structure of the U.S. integrated ballistic missile defense system

to intercept Russian warheads were not quite true (see Appendix) and created additional suspicion and mistrust.

The U.S. current and future missile defense programs have far greater possibilities for countering real missile threats coming from China's ICBMs and SLBMs, and even more so from the missiles of North Korea, Iran and other 'threshold' missile and nuclear states.

Missile Defense and the Vertical Proliferation of Nuclear Weapons

This type of proliferation concerns the nuclear powers: the U.S., Russia, Great Britain, France, China, India, Pakistan, and Israel. It also has a regional dimension: an increase in Israel's missile defense capabilities, for example, could incite Iran and Syria to build up their missile capabilities and eventually arm their missiles with nuclear and chemical weapons.[7] North Korea and China could act in similar fashion to develop their missile capabilities if Japan continues enhancing its missile defense systems.

The main factor that could spur a build-up in Russian and Chinese nuclear capability in the short and medium term are the U.S. plans for unilateral deployment of strategic and non-strategic missile defense systems. An increase in China's nuclear arsenal would probably incite India to build up its missile forces, and this in turn would trigger a response from Pakistan, which could only further encourage moves in this direction by Iran and Israel.

In this situation, Russia has the capability to increase the production and deployment of stationary and mobile Topol-M ICBMs with MIRV warheads. Russia could also potentially carry out a thorough modernization of the liquid-fuel UR-100N UTTKh silo-based ICBM (known as the SS-19 in the West) or develop new versions of it. Pressure for such steps could come from those in the military-industrial complex who have long insisted on the advantages of liquid-fuel silo-based ICBMs with MIRV warheads, arguing that Russia already has the facilities and considerable experience for their production, and that they are more cost-effective. A return to the production of liquid-fuel missiles using highly toxic fuel components, which were abandoned in favor of safer solid-fuel missiles, is unlikely as long as Russia and the U.S. revive stable cooperative relations — that is, unless the U.S. goes ahead with unilateral plans for its missile defense build-up.

One of the most destabilizing steps that would risk seriously undermining the nuclear weapons nonproliferation regime would be Russia's withdrawal from the INF Treaty. This could set off an avalanche of building missile defense systems in Europe, end Britain's and France's policy of reducing deployed nuclear weapons levels, and encourage the U.S. to take countermeasures similar to those taken in response to the deployment of Soviet Pioneer (SS-20) intermediate-range missiles (see chapter 8). In the event that Russia did actually withdraw from the INF Treaty, no imaginable assurances on its part to the effect that short- and intermediate-range missiles would not be nuclear-armed or would be deployed in limited numbers, would reduce the negative impact of the withdrawal from the INF Treaty.

Furthermore, if Russia were to deploy mobile intermediate-range missiles, this would inevitably draw a response from China, whose actions would also be influenced by the growing missile defense capability of Japan. Currently Japan has plans to deploy, in addition to the destroyers carrying the Standard-3 system, about 30 batteries of modernized Patriot-type missiles at 11 bases on its territory by 2010.[8]

China has great potential for building up its nuclear missile capability. It could focus its efforts on completing the development of the new ground- or rail-based mobile solid-fuel DF-31 ICBM,[9] on the sea-based SLBM JL-2 missile system, and also on increasing the number of DF-5A ICBMs with MIRV warheads.[10] Also, there are no foreseeable obstacles to a two- or three-fold increase in the number of deployed DF-21A intermediate-range missiles (up to 40-60 missiles).

In such a situation, India and Pakistan would probably not sit idle and would take measures to improve their own nuclear arsenals. Reports suggest that besides increasing the numbers of the new Agni-1 and Agni-2 missiles and completing development of SLBMs, India could also start developing a national missile defense system to protect its main cities from intermediate-range missiles.[11] In this situation, it seems clear that Pakistan would increase its nuclear and missile arsenals by speeding up tests of the Shaheen-2 missile and increasing the numbers of Shaheen-1 and Ghauri-1 missiles, which entered service in 2003.[12]

If a process of unilateral or alliance-based decisions and actions (by NATO and U.S. allies in the Far East) to develop and deploy missile defense systems does indeed take place as forecasted, the nuclear weapons states of the NPT would not only continue to rely on nuclear weapons as a guarantee of their security (contrary to their obligations under Article VI of the Treaty), but would actually increase this reliance. In such a situation, the chances for resuming nuclear arms reduction talks would be minimal. These factors were the main reasons for the failure of the last NPT Review Conference in 2005.

India's and Pakistan's reluctance to place voluntary limitations on their nuclear programs would make it impossible to begin the process of giving indirect legitimacy to their nuclear status by having them adhere to the CTBT, FMCT negotiations, the 1997 Additional Protocol, the MTCR, and the nuclear materials and technology control regimes. All of this could result in an ultimate collapse of the nuclear nonproliferation regimes.

This pessimistic forecast is based on extrapolation of 2007-2008 trends, marked by the lack of visible change in U.S.-Russian strategic relations. Although the cold war has ended and both countries periodically declare themselves partners in combating new threats, they maintain a state of mutual nuclear deterrence. This state of affairs will not simply resolve itself without serious negotiations to limit and reduce nuclear arms. On the contrary, if left as it is, it will become more unstable, unpredictable, and politically destructive.

The plans to build missile defense bases in Europe did significant damage to the U.S.-Russian relationship. This degradation of relations was one of the main obstacles to closer cooperation in areas such as overcoming the crisis in the WMD nonproliferation regime, combating terrorism and drug trafficking, and preventing regional crises, environmental disasters and other threats. These challenges gradually faded into the background, while the center stage was taken by mutual accusations and claims in the spirit of a new cold war. Without real change in the relationship, and without agreements limiting and reducing strategic weapons and jointly developing and implementing missile defense systems, it would be practically impossible to stop vertical and horizontal nuclear proliferation.

Several of the authors of this book have proposed solutions to the missile defense crisis on earlier occasions,[13] which have been presented at meetings of the Russian Foreign Ministry and Security Council, and later in the U.S. Senate, State Department, and Department of Defense. According to these proposals, the U.S. would undertake not to build new missile defense sites in Europe and not deploy interceptor missiles in Poland until a real missile threat from Iran became apparent. In this case, Russia would agree not to view as an alternative to missile defense in Europe its official proposals to use the missile launch early-warning radar station in Azerbaijan, the new radar station in Armavir in southern Russia and the revived center for data exchange on launches of missiles and space launch vehicles in Moscow, and to create a new similar center in Brussels.

Moscow and Washington brought their positions a little closer together in this direction at the meeting of the heads of the Russian Foreign Ministry and U.S. State Department and the heads of the Russian Ministry and the U.S. Department of Defense (the 2+2 summit) in Moscow in 2007. American officials even declared afterwards that if the Iranian nuclear and missile issues were successfully resolved, the missile defense site in Eastern Europe could be dismantled. At the next 2+2 summit in March 2008, the U.S. presented its written proposals for allaying Russia's concerns, acknowledging that there were grounds for these concerns, which Moscow viewed as a step forward.

At the same time, the potential for cooperation between Russia, the U.S., and the leading European countries in the field of missile defense is not limited to the proposals made by President Putin in 2007. Cooperation is possible in a whole number of different areas. Aside from including Russia's latest S-400 systems in a joint missile defense system and using Russia's testing grounds and other infrastructure for launching the space craft needed for the BMD system's information support, it would also make sense to use the existing, modified through conversion strategic RS-20 (SS-18) missiles and other launch vehicles. There is every reason to believe that a global missile defense system built through common effort would be a lot more effective and less costly. Earlier publications present a more detailed analysis of the possibilities for this kind of cooperation.[14] Russia's official representative at the Munich Conference on Security in February 2008 voiced similar ideas.[15] Implementing these ideas in practice would not only resolve the missile defense crisis, but would also eventually bring about a radical transformation of the mutual nuclear deterrent relations that persist between Russia and the U.S. This would make confrontation between them impossible and not only stop vertical and horizontal nuclear proliferation, but could even reverse it.

At the same time, efforts would be needed to address the fully justified concerns of China, which could view the emerging partnership between Russia and the U.S. as a threat to its own nuclear deterrent and might consequently start building up its missile and nuclear capability, triggering similar steps in India and Pakistan. This is an issue that requires separate thorough analysis. Here, we note only that a solution could lie in tripartite talks between the U.S., Russia and China on limiting strategic weapons and providing security guarantees for China's nuclear deterrent forces, and eventually integrating China into the global missile defense system, if Beijing is interested.

Missile Defense and the Horizontal Proliferation of Nuclear Weapons

The potential positive or negative impact that strategic and non-strategic missile defense systems can have on the proliferation of nuclear weapons should also be analyzed with regard to the threshold states, which at the moment means first of all Iran and North Korea. There is some optimism for settlement of the North Korean nuclear and missile crises, but the situation with the Iranian nuclear and missile programs is a clear threat to the nuclear nonproliferation regime and to regional and global stability.

A U.S. intelligence report has assessed Iran's real capability for crossing the nuclear threshold and acquiring missiles and nuclear weapons that could potentially threaten Europe, Russia and the U.S. The report concluded that Iran stopped work on a nuclear weapon in 2003.[16] The report was seen around the world as giving a pause that made it possible to undertake several years of diplomatic efforts to resolve the Iranian nuclear crisis.

But a closer study of the report reveals a more ambiguous situation. First of all, judging by the information openly available, the report does not cite concrete facts to back up its conclusion, which is based on assumptions and hypotheses. Of course, this could be motivated by the need to protect information sources, the argument U.S. administration officials used when asked to provide proof that Saddam Hussein's regime had weapons of mass destruction. But there are many different means of covering up the ways in which one has obtained information that provide reliable protection for the real information sources. The report is therefore more likely evidence of the U.S. intelligence community's desire to cleanse itself of blame for past mistakes, including conclusions on weapons of mass destruction in Iraq, and to avoid charges of providing false information in the event of any future U.S. military operation against Iran.

Second, the report shows that the Iranian authorities deceived the IAEA for longer and to a much greater extent than previously believed, affirming that Iran was not developing a nuclear weapon. Third, there is a possibility that the conclusion that Iran stopped its nuclear weapons program in 2003 implies that the work on the main components of a nuclear weapon, that is, missiles (air bombs), the design of the warhead and the nuclear explosive device, had been for the most part completed.

Iran has been working on building ballistic missile systems since the start of the 1980s and has made these programs a priority for the modernization and development of its armed forces. The missile-building industry is one of the country's fastest growing sectors. Iran has set itself the goal of having the most powerful missile arsenal in the region by 2015. At the same time, the Iranian leadership refuses to recognize the MTCR.

Iran began work on the Shahab missile program in 1992 with the objective of developing several types of liquid-fuel missile systems. Co-operation with North Korea has enabled Iran to develop the single-stage liquid-fuel Shahab-3 missile (using North Korean Nodong-1 technology). But this is not a copy of the Nodong-1, which was based on Scud missile technology and used four Scud engines. As far as can be ascertained, instead of using four engines, the Shahab-3 uses a single powerful engine, developed by Iran itself, that makes it possible to increase the useful payload from 1,000 kg to 1,300 kg with a range of 1,500 km. This would make it possible to threaten targets in Turkey, Israel, Saudi Arabia, and part of Russia (including the cities of Volgograd, Rostov-on-Don, and Astrakhan).

Reducing this missile's useful payload to 500 kg increases its range by approximately 800 km, creating an added threat to the European part of Russia and the south of the European Union. There are no substantial obstacles in the way of increasing the missile's range by lengthening the fuel tanks. The notion that countries such as North Korea and Iran can produce no more than missiles based on Soviet Scud missile technology is a common error, as can be seen from materials from the leadership of Russia's Armed Forces' General Staff.[17] The Soviet Union developed medium-range missiles capable of delivering nuclear warheads at ranges of up to 2,000 km and 5,000 km back in the late 1950s. It would be a dangerous mistake to think that other countries have still not yet managed to get hold of this technology. Indirect proof that other countries do have this technology comes from test reports of the new Iranian Ghadr and Ashura missiles, which have ranges of 1,800 and 2,000 km.[18]

The 2-stage Shahab-4 missile, work on which has gone on for more than 12 years, consists of a first stage based on the Shahab-3 missile and second stage based on a Scud-type missile. If this project is successful, which is entirely possible in the near future, the missile will be able to hit targets in Europe at a range of more than 3,000 km. Information has also been obtained concerning work on the intercontinental Shahab-5 missile, based on the North Korean Taepodong-2, the single launch of which, in July 2006, ended in an accident.

Of just as much concern are Iran's space projects, such as the Omid, the launch of the Kavoshgar space rocket,[19] and the opening of a space center,[20] which provide evidence of Iran's possibilities for using longer-range military missiles.

Thus, it is possible that Iran's missiles could in the future pose a threat to all of Europe. If the current Iranian regime's policy remains unchanged for the foreseeable future, and the regime is assured stable succession, within another 10 to 12 years Iranian missiles could also be able reach U.S. territory.

For many years, there were no obstacles or restrictions in Iran on the development of a warhead and nuclear explosive device. An experiment that took place a long time ago in the U.S., in which two physicists, with no previous connection to nuclear weapons development, used publicly available information and cottage facilities to make a nuclear explosive device, is just further confirmation that carrying out this kind of work would not present any real difficulty to Iran's research and development organizations.[21]

Iran's categorical refusal to stop enriching uranium, despite five resolutions from the UN Security Council and the possibility of obtaining nuclear fuel from international centers under IAEA control, says a lot about the Iranian leadership's real aims. The Iranian president has said many times that even if dozens of resolutions are issued, uranium enrichment will continue. Iran plans to increase its number of centrifuges from the current 4,000 to up to 50,000.

It is possible that Iran already has a limited amount of weapons-grade uranium, and the U.S. intelligence report directly indicates this possibility. Iran could have acquired it on the black market for nuclear technology and materials, similar to that created by Abdul Qadeer Khan, the 'father' of Pakistan's nuclear bomb. Available information shows that Iran had intensive contacts with Khan's military nuclear technology transfer network dating back to 1986, and this was something known to then Pakistani President Zia ul-Haq, and later to Premier Benazir Bhutto.[22]

Thus, a missile threat from Iran is entirely possible in the near future, and there are therefore some grounds for developing the means to protect against it. But the effect that the development of strategic and non-strategic missile defense could have on the ambitions of Iran and other threshold countries to acquire nuclear weapons is far from clear. On one hand, the deployment of missile defense systems to intercept missiles at various stages in their trajectory could influence the threshold countries to make a political decision to freeze their programs to develop and deploy nuclear-armed intermediate-range and intercontinental missiles.

On the other hand, if this kind of deterrent is carried out in unilateral fashion by the U.S. and leads to vertical nuclear proliferation among nuclear weapons states, it will have little worth. In such a case, we could expect to see Iran start increasing the number of its intermediate-range missiles in order to 'saturate' missile defenses, while equipping its missiles with means to penetrate missile defense systems to counter the U.S. unilateral deployment of missile defense systems in Central Europe. Without Russia's cooperation, the American program would not only create a political climate favorable for Iran's countermeasures, but would itself have a number of technical weak points that Tehran would surely take advantage of (see the Appendix for details).

If a country or region that may be a potential target of a missile attack puts in place a sufficiently effective missile defense system, the state that had been planning the missile attack would most probably start developing other technical and tactical means for using nuclear weapons to inflict damage on the enemy. Such means could include cruise missiles, planes flown by kamikaze pilots, ships of various types, sabotage groups with nuclear devices, etc.

There are no purely technical solutions, such as missile defense, for preventing proliferation. Extensive prevention measures addressing the whole range of threats are needed, and this requires cooperation among the great powers and their allies. Multilateral development and deployment of missile defense systems could help put in place the conditions for restraining the proliferation of nuclear materials, nuclear weapons and missiles. Of course, this would not rule out the possibility that countries would try to develop alternative means of delivering nuclear weapons, but it would be much easier to deal with these threats on the basis of strategic cooperation among leading powers in countering common security threats. This would entail acting on a consolidated basis to make far more effective decisions to settle nuclear crises, strengthen the NPT, turn the MTCR into a legally binding international agreement, and bolster collective counter-proliferation measures.

Since the end of the cold war, the link between the development and deployment of strategic and non-strategic missile defense systems and the proliferation of nuclear weapons and their delivery systems has undergone a substantial transformation. Unilateral or alliance-based missile defense programs will continue to have a negative effect on the vertical proliferation of nuclear weapons. The level of increases to nuclear arsenals will depend on the density of missile defense systems and on whether or not there are limits on strategic nuclear weapons established in agreements between the parties. In this case it is possible that Russia will withdraw from the INF Treaty, and that China, India and Pakistan will focus on increasing the mobile components of their nuclear missile forces. As the U.S. makes its missile defense system more effective through the development of the ground-, sea-, air- and space-based components, this will give added impetus to vertical nuclear proliferation. This, in turn, will lead to another crisis in the nuclear nonproliferation regime and add to threshold countries' incentives to acquire nuclear weapons; in other words, it will contribute to horizontal proliferation, too. An effective, layered missile defense system with good chances of being able to intercept single and group missile launches would encourage the search for alternative means to deliver nuclear weapons.

At the same time, if the U.S., Russia and NATO work together on developing and deploying strategic and non-strategic missile defense systems and get other nuclear and non-nuclear countries involved in the process, this would mark the start of a completely new stage of global strategic partnership. Getting to this stage requires overcoming serious differences between Moscow and Washington and will not be easy. But the current situation still provides hope for solutions based on mutually acceptable compromises.

Paradoxical though it may seem, the last missile defense crisis, because it was resolved, has offered a unique opportunity for developing strategic cooperation that would radically transform mutual nuclear deterrence relations between Russia and the U.S. and stop and reverse vertical nuclear proliferation. More important still, only in this way can the major powers reach a consolidated position for putting effective pressure on the threshold states, ensuring strict compliance with all the provisions of the nuclear nonproliferation regime and the UN Security Council's resolutions on limiting nuclear and missile programs. The great powers would also have much stronger political positions for insisting on the nonproliferation of the nuclear fuel cycle and on compliance with strict export control measures.

Notes

[1] See Henry Obering, head of the U.S. Missile Defense Agency, "RLS i protivorakety SShA v Evrope stanut na dezhurstvo do 2013," interview in *Nezavisimaya gazeta*, April 20, 2007.

[2] See Appendix.

[3] See: U.S. Department of Defense: Missile Defense Agency, "Terminal High Altitude Area Defense (THAAD)," http://www.mda.mil/system/thaad.html.

[4] United States Navy, "Fact file: Standard Missile," http://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=1200&ct=2.

[5] V. Baskakov and A. Gorshkov, "Protivoraketnaya oborona VMS SShA," *Nezavisimoye voyennoye obozreniye*, December 19, 2003.

[6] V. Skosyrev, "Shchit protiv KNDR i Kitaya: SShA i Yaponiya sbili maket boyegolovki ballisticheskoy rakety," *Nezavisimoye voyennoye obozreniye*, December 19, 2007.

[7] M. Binder, "Explosion at Syrian Military Facility: A Chemical Weapons Accident?," November 2007, http://www.wmdinsights.com/I20/I20_ME1_ExplosionAtSyrian.htm.

[8] P. Goncharov, "Protivoraketnaya oborona kak neizbezhnost?," December 25, 2007, http://www.rian.ru/analytics/20071225/94106631.html.

[9] Bin Li, "Tracking Chinese Strategic Mobile Missiles," *Science & Global Security: The Technical Basis for Arms Control, Disarmament, and Nonproliferation Initiatives* 15, # 1 (January 2007).

[10] "Yaderniye sily Kitaya," *Vooruzheniya, razoruzheniye i mezhdunarodnaya bezopasnost: Yezhegodnik SIPRI 2006* (Moscow: Nauka, 2007).

[11] "Yaderniye sily Indii," *Vooruzheniya, razoruzheniye i mezhdunarodnaya bezopasnost: Yezhegodnik SIPRI 2006* (Moscow: Nauka, 2007).

[12] "Yaderniye sily Pakistana," *Vooruzheniya, razoruzheniye i mezhdunarodnaya bezopasnost: Yezhegodnik SIPRI 2006* (Moscow: Nauka, 2007).

[13] A. Arbatov, "Pyatiy protivoraketny krizis," *Nezavisimoye voyennoye obozreniye*, November 2, 2007; V. Dvorkin, "V protivoraketnykh bitvakh prishlo vremya realnykh kompromissov," *Nezavisimaya gazeta*, July 10, 2007. See also "Kompromiss po PRO blizok," *Vedomosti*, November 23, 2007.

[14] V. Dvorkin, "Partnyorstvo v borbe s ugrozami: chto ostalos?" *Rossiya v globalnoy politike*, # 6, November-December 2005.

[15] V. Solovyev, "Moskva i Vashington obmenyalis lyubeznostyami," *Nezavisimoye voyennoye obozreniye*, February 15-21, 2008.

[16] "Iran: Nuclear Intentions and Capabilities," *National Intelligence Estimate*, November 2007.

[17] Theses of a speech by the Chief of the General Staff of Russia's Armed Forces at a press conference at *RIA Novosti* on December 15, 2007.

[18] "Iran obyavil o sozdanii novoy ballisticheskoy rakety," *ITAR-TASS*, December 8, 2007.

[19] "Iransky apparat 'Issledovatel' dostig kosmosa," *Lenta.Ru*, February 19, 2008.

[20] "Ispytaniye Iranom novoy rakety yavlyaetsya lishnim argumentom v polzu razvertyvaniya PRO v Evrope," *PRIME-TASS*, February 6, 2008.

[21] A. Pikayev and Y. Stepanova, "Nonproliferation and Nuclear Terrorism," in *Nuclear Weapons after the Cold War,* ed. A. Arbatov and V. Dvorkin, Carnegie Moscow Center, PP. 310-357 (Moscow: ROSSPEN, 2006).

[22] H. D. Sokolski, "Pakistan's Nuclear Future: Worries Beyond War," January 2008, http://www.StrategicStudiesInstitute.army.mil.

Chapter 8. Missile Defense and the Intermediate-Range Nuclear Forces Treaty

Alexei Arbatov

Recently on a number of occasions Russian political and military leadership has raised the prospect of the country's unilateral withdrawal from the Intermediate-Range Nuclear Forces Treaty, signed by the Soviet Union and the United States in 1987, with Russia inheriting the USSR's Treaty obligations.[1] This step would have very serious military, strategic, financial, economic and political repercussions, particularly since the INF Treaty is one of the few central nuclear disarmament agreements still in force after several years of the Bush Administration's destructive policies, which put an end to the 1972 ABM treaty, the 1994 Treaty between the U.S. and Russia on Strategic Arms Reduction (START-2), the 1997 START-3 framework treaty and the Agreement on the delineation of strategic and tactical missile defense systems, while leaving the 1996 CTBT and the talks on the FMCT in a deadlock and making it impossible to complete work on a new SORT treaty (2002) or extend the validity of START-1 (after 2009).

The History of the INF Treaty

Historically, this Treaty has its roots in the deployment in a number of European NATO member countries at the start of the 1980s of American intermediate-range Pershing-2 ballistic missiles, with a range of up to 1,800 km, and ground-based nuclear-armed cruise missiles, with a range of up to 2,500 km. The U.S. argued that this step was a response to the Soviet Union's deployment of RSD-10 (Western classification SS-20) ballistic missiles with MIRV warheads at the end of the 1970s and at the beginning of the 1980s.

The American missiles could strike targets deep in Soviet territory: launched from their bases in West Germany, the Pershing-2 missiles could reach as far as the Moscow region, while the ground-based cruise missiles could reach as far as the Urals. Soviet missiles could not reach targets in the United States. It was even more important that the flight time of the

Pershing-2 missiles to their targets was approximately three times shorter than that of intercontinental ballistic missiles launched from U.S. territory. The cruise missiles had a much longer flight time – several hours – but they were hard to detect because of their low trajectory and technical characteristics that reduced their detection by radar.

Therefore, Moscow had every reason to seek an agreement that would prohibit these missiles. Washington had no desire for such an agreement but came under strong pressure from its NATO allies, who feared an increase in nuclear tension in Europe.

Five years of difficult off-and-on negotiations finally led to the conclusion of the INF Treaty, which had no time limit and stipulated the complete worldwide destruction of two classes of Soviet and U.S. ballistic and ground-based cruise missiles.

The completely closed Soviet totalitarian decision-making system played a cruel joke on the Kremlin. In their efforts to whip up a campaign about national security threats, raise tension and get more money for their military programs at the same time, the Soviet generals went too far in frightening the old gentlemen of the Communist Party with tales of the American missiles' short flight time (six to seven minutes it was said), which would not even give the leadership time to take shelter in underground or air-based command centers, let alone decide on a counterstrike. Furthermore, the parties had an asymmetrical level of interest in the Agreement, since the missile systems under discussion were a direct threat to the Soviet Union, but not to the U.S. Finally, because Moscow insisted on the destruction of all of the U.S. missiles, it had to agree, after stubborn resistance, to destroy all Soviet arms of a comparable type, and because of the way Soviet military practice and the essentially uncontrolled military-industrial complex worked, it had many more of these weapons.

The INF Treaty therefore resulted in the Soviet Union having to destroy two times more missiles than the U.S. (1836 and 859 respectively), including 200 of its newest extremely high-performance OTR-23 Oka battlefield and tactical missiles (NATO designation SS-23 Spider), which had a tested range slightly below the agreed limits (500-1000 km for short-range missiles and 1000-5500 km for intermediate-range missiles).[2] The designers of this missile, classified under the INF Treaty as a short-range missile, to this day have not forgiven the last Soviet President, Mikhail Gorbachev, and his Foreign Minister Eduard Shevardnadze, for agreeing to this concession. Giving up the OTR-23 was the price to pay for obtaining the destruction of the U.S. Pershing-1 missiles, which could hit the Kaliningrad Oblast from West Germany. The United States also gave up its Lance-2 ground-based tactical missiles and SRAM-2 air-to-surface missiles, which if launched from West Germany or from tactical strike aircraft could hit targets in the territory of the USSR's Warsaw Pact allies. Russia's military designers and engineers did recoup their losses for the OTR-23 by recently developing a new dual purpose battlefield/tactical missile that entered service in 2007 and was for some reason given the Persian-Arabic-Turkish name of Iskander.[3]

Motives for Withdrawal from the Treaty

The Treaty was implemented in full within the deadlines and remains in force. But now, 20 years later, the totalitarian communist Soviet Union's successor, democratic capitalist Russia, has declared that it might withdraw. This is possible under the terms of Article XV.2 with six months' notification if one of the parties decides that "extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests." Let us now take a closer look at the motives for Russia's possible withdrawal from the Treaty and the likely consequences of such a step.

For a start, the nature of the threats to Russia's 'supreme interests' is not entirely clear. In his speech in Munich in February 2007, then President Putin noted that other countries (Iran, Pakistan, India, China, North and South Korea) are developing medium-range missiles, while Russia and the United States are prohibited from having these types of weapons.[4] Former Defense Minister and then Russian First Deputy Prime Minister Sergei Ivanov has made the same point on a number of occasions. A little later, then Chief of the General Staff of the Russian Armed Forces, army general Yury Baluyevsky, cited U.S. plans to deploy components of a missile defense system in Poland and the Czech Republic as motivation for Russia's possible withdrawal from the INF Treaty.[5]

Without going into their substance for now, we note that these very different and unrelated motives do not clarify the real reasons for taking as serious a step as denouncing one of the few remaining central nuclear arms control treaties. It seems very strange that different ministries, agencies and officials in the created 'executive vertical' power system diverge in their interpretation of a subject as important as 'extraordinary events' that could jeopardize Russia's 'supreme interests', since the existence of said 'extraordinary events' is the only grounds that can justify withdrawal from the INF Treaty in accordance with Article XV.2.

Missile Threats from Third Countries

The development of medium- and short-range missiles by third countries is often not an aim in itself, but a natural step on the way to developing the missile technology needed to build ICBMs and space launchers. It is entirely possible, however, that some countries, based on their military objectives or technical and economic capabilities, could renounce the development of long-range missiles. Around 40 countries currently have ballistic missiles of various types. Five countries have ICBMs and/or SLBMs – the U.S., Russia, Britain, France, and China, and seven have medium and intermediate-range missiles (1,000-5,500 km) – China, India, Israel, Iran, North Korea, Pakistan, and Saudi Arabia. The others have battlefield/tactical missiles with ranges up to 1,000 km. In addition to the seven countries already mentioned, they include Egypt, Syria, Libya, Yemen, Turkey, and South Korea. This group also used to include Brazil, Argentina, South Africa and Iraq.[6] In terms of geography, all seven of the countries with medium and intermediate-range missiles are within striking distance of Russian territory (including China, India, Israel and Pakistan, with their nuclear-armed missiles), and some of them (China, North Korea, Turkey) could theoretically reach Russia's outer areas with short-range missiles.

This could be seen as a potential threat, given that not all of the countries named above are Russia's allies or reliable partners, and some of them have an internal political situation that makes them quite unstable and unpredictable. The practice of military (including nuclear) deterrence is applied to these countries by creating a credible threat of a devastating retaliatory (second or response) strike against them if they ever launch a missile or nuclear-missile attack. Anti-missile and air-defense systems and/or the ability to use nuclear or precision-guided conventional weapons are necessary to protect against regimes that may not be deterred by the prospects of tremendous human and material losses.

If this situation were examined in complete isolation from all past agreements and obligations, new medium and intermediate-range and battlefield/tactical missiles based on the latest technology would probably look like an attractive option as part of the response to this threat. But this issue has a long history and complex military-strategic, economic and political aspects, and in this respect a number of questions can be raised. What other military means could Russia use to ensure it is able to carry out a retaliatory or preemptive strike against countries that possess medium- and short-range missiles? Are the new Russian medium and short-range missiles the optimum weapons, taking the economic situation into account?

Would the program to develop such means justify the withdrawal from the INF Treaty, in light of the possible military and political consequences this step could have?

If, as Russia's political leadership says, Russia does not intend to compete 'missile for missile' with the U.S. at the strategic level, but will if necessary respond with asymmetrical measures, the idea of competing against third countries in medium and short-range missiles seems even stranger. If the threat they pose is seen as serious, Russia has the capability of responding (more successfully than with regard to the U.S.) with asymmetrical means that are cheaper and no less effective, by targeting these countries with the appropriate means. Such means include: ICBMs, which can fly a shortened trajectory to strike targets at intermediate range; submarine launched ballistic missiles; and medium and heavy bombers with nuclear and conventional bombs and cruise missiles (in particular the Tu-160 with the new precision-guided air-to-surface X-101 dual purpose cruise missile). Tactical attack aircraft with nuclear bombs could be used against some countries in closer proximity, and nuclear and conventionally armed missiles launched from ships and submarines could be used against maritime countries.

Overall, Russia's strategic nuclear forces currently have around 700 delivery systems and 3,000 warheads deployed, of which many dozens and even hundreds could be directed at targets in Eurasia. The latest versions of Russia's nuclear strategy envisage the possibility of using the strategic nuclear forces to carry out selective nuclear strikes that allegedly could be directed not only against the United States, but also against other countries, possessing medium and short-range missiles. An example of this is an operation to "de-escalate aggression… threatening to or actually carrying out strikes of various scale using conventional and/or nuclear weapons." Another potential mission worthy of attention is that of the "selective use in combat of individual components of the strategic deterrent forces."[7]

Data on pre-strategic nuclear weapons (medium-range and battlefield/tactical weapons) is confidential, but unofficial estimates suggest that Russia has about 2,000-3,000 deployed operational and tactical nuclear warheads,[8] of which probably the greater portion is able to strike targets in regions close to Russia's borders.

If need be, instead of a new medium-range missile program, it would be a lot cheaper to deploy several additional Topol-M ICBM regiments or develop a precision-guided conventional warhead for existing ballistic and cruise missiles not prohibited by the INF Treaty. Deployment of the Topol-M with a single warhead or MIRV nuclear (or conventional) warheads is not in any way restricted by the 2002 Moscow Treaty on strategic offensive reductions (SORT), and the ceilings it sets on nuclear warheads (1,700-2,200) leave a comfortable margin for deploying this system.

Response to Missile Defense

The George W. Bush Administration had plans to deploy missile defense radar stations in the Czech Republic by 2012-2013 in order to track Iranian missiles and guide interceptor missiles, ten of which were to be based in Poland.[9] These plans were clearly destabilizing and politically provocative with regards to Russia, which may have been among the factors driving some of the policymakers in Washington, Prague and Warsaw. Moreover, as with the entire U.S. strategic missile defense program as a whole, there were doubts that the project would be sufficiently militarily and technically effective against the Iranian threat to outweigh the significant military and political costs incurred in relations with Moscow. In addition, the plan, on which Moscow was not consulted, violated the spirit of the U.S.-Russian Declaration on the New Strategic Relationship of 2002, which provided expressly for cooperation between the two countries on the development of such systems.[10]

Whether in terms of the numbers of planned interceptor missiles or the trajectory, speed and other technical characteristics, from a military/technical point of view this system has very little effect on Russia's nuclear deterrent capability. All of Russia's ICBM bases are located a lot farther to the northeast than the proposed base in Poland (this is all the more true of the Northern Fleet's sea-based missiles), and their trajectories are programmed following northern azimuths across the Arctic circle. The American GBI interceptor missiles, planned for deployment, cannot intercept ICBMs during the active (boost) phase of the trajectory. Purely theoretically, in the rarest cases and with the best possible combination of circumstances they would be able to 'catch up' with ICBMs launched from Russia's most western or southern bases, and then only if the ICBMs in question were targeted at the U.S. East Coast (Boston, New York, Washington). But the interceptor missiles have never been tested under such conditions, and Russia deploys only a small number of its strategic nuclear forces at these bases.[11]

If Russia were to withdraw from the 1987 INF Treaty and deploy new medium and intermediate-range missiles, these could theoretically be intercepted by the previously planned American missile defenses in Europe, but this would depend on their numbers and technical characteristics. However, at the moment, Russia does not possess missiles that could be intercepted by the missile defense systems in Poland and the Czech Republic. Absent medium and intermediate-range missiles, Russia could possibly reorient part of its strategic nuclear forces towards targets in Europe. Europe is home to two nuclear powers – France and Britain – whose nuclear deterrent is partly targeted at Russia. There are also as many as 500 U.S. tactical nuclear air bombs (the exact number is classified) in Europe, to be delivered by NATO strike aircraft, held in storage facilities in six different countries. Planned missile defenses in Europe could theoretically intercept Russian ICBMs targeted at the continent, but the capability of such a defense system is nonetheless paltry compared to the size of Russia's existing nuclear forces. Furthermore, it is unrealistic that NATO would attack Russia without U.S. participation, and against the U.S. Russia can rely on its powerful nuclear deterrent based on the strategic nuclear forces.

Among the possible responses to U.S. missile defense in Europe discussed in Moscow was the deployment of a division of new Iskander missiles in the Kaliningrad Special Military District and two or three in the North Caucasus Military District. Unlike the Iskander-E export version, a ballistic missile with a range of 280 km, Russia planned to bring into service the Iskander-M cruise missile. This missile system, tested in May 2007 with a range of 500 km, could have its range increased to up to 1,000 km at little cost, but its deployment as discussed would require Russia to withdraw from the INF Treaty. One Russian military commander, Colonel-General Vladimir Zaritsky, said, "If a political decision is made to withdraw from this treaty, we will enhance the system's military characteristics, including its flight range."[12] These missiles would then be able to strike missile defense targets in Poland, the Czech Republic, and perhaps Georgia, and not just with nuclear warheads, but also probably with the especially attractive option of conventional precision-guided warheads.[13] Europe's anti-missile defenses are not able to intercept cruise missiles.

All of this seemed to make military sense at first glance. But if the issue is examined not in the isolated context of operational justifications for a new high-technology weapons system, but within the logical strategic framework of considerations, the sense of such a response to missile defense plans is quite dubious.

Certainly, it would make sense to carry out a strike against missile defense sites in Europe to stop them from intercepting Russian ICBMs launched against the United States and its allies in a retaliatory or first strike (which Russia's present military doctrine envisions, as well). These ICBMs are equipped with nuclear warheads. In other words, this is a nuclear war scenario, in which case, in a return-counterstrike or retaliatory action, Russia's ICBMs would be launched after a strike by U.S. (NATO) nuclear forces against Russian territory. The question is: what is the sense in this hypothetical situation of trying to destroy missile defense installations using precision-guided conventional weapons? It would be a lot simpler, cheaper, and more reliable to do so using the strategic nuclear forces or existing battlefield/tactical nuclear weapons mentioned above. In this case, it looks as though it is not the weapons system that is being proposed to carry out particular military missions, but the contrary – missions are being thought up in order to provide the justification for developing a particular weapons system, in which the military-industrial complex and defense ministry have powerful interests, and also possibly to provide the arguments for withdrawing from the INF Treaty for other reasons, including purely political.

For these reasons, withdrawal from the INF Treaty, which would allow Russia to develop medium-range missiles, does not fit very well with the discussed threat of planned American missile defense in Europe.

But even if the planned missile defense system in Europe would have only a negligible effect on Russia's nuclear deterrent, it could not be ignored. After all, to use the U.S.'s own terminology, the missile defense program is 'open-ended'. In other words, the U.S. and its allies could not provide sufficient assurances that they would stop at one radar installation or one base with 10 GBI interceptor missiles. There was no guarantee that the U.S. would not eventually deploy 100 or 1,000 interceptors at other bases, closer to the expected trajectories of Russian ICBMs and SLBMs, and that they would not be enhanced with systems to intercept missiles during the boost phase of the trajectory, or add sea-, air- and space-based layers, including the use of systems founded on new physical principles (lasers, etc.).

Of course, the timeframe here would be not four years, but decades. However, military-technical response measures also require time, and in the political respect it is better to voice one's firm and clear opposition to such programs right from the start. In this sense, Moscow has learned about the importance of timely and clear responses from NATO's eastward expansion, which began in 1997 as a one-time measure to bring in three new member states in Central Europe, but went on to cover twelve countries, with discussions underway on potential NATO membership for Ukraine, Georgia, Azerbaijan and Kazakhstan.

But over this timeframe, the nature of the threat and how to respond to it are much broader issues. If it becomes necessary to threaten these BMD facilities, Topol-M ICBMs can be targeted against them, and Russia's Strategic Missile Forces command has made an official statement to this effect.

Even flight tests of an ICBM at medium-range would not constitute a formal violation of the INF Treaty's provisions, because the Treaty defines a missile's range as "the maximum range to which it has been tested" (Article VII.4). In the future, if plans to build up the American missile defense system do go ahead, Russia could respond with a broad range of asymmetrical countermeasures, starting with increasing its strategic nuclear forces' capability to penetrate missile defense systems and ending with various strike systems against potential BMD ground-, air-, sea- and space-based layers.

Missile Defense or Medium-Range Missiles?

Another unofficial argument against a missile defense system in Europe was that American interceptor missiles with an effective radius of up to 4,000 km could also be used as offensive medium-range missiles, particularly since the plan was to base them in silos. In this respect, Article VII.3 of the INF Treaty states clearly that if a ballistic missile "is of a type developed and tested solely to intercept and counter objects not located on the surface of the earth, it shall not be considered to be a missile to which the limitations of this Treaty apply." In other words, the GBI system does not violate the INF Treaty. As for being launched from silos, modern strategic interceptor missiles (including those of the Moscow A-135 BMD in Russia) are silo-based, while as far back as the 1970s-1980s, offensive medium-range missiles were deployed on ground-based mobile launchers, and, if the Treaty is denounced, would probably continue to be deployed in this way.

Military and Political Consequences of Potential Withdrawal from the INF Treaty

One consideration potentially motivating Russia's withdrawal from the INF Treaty and development of medium-range missiles could be a desire to symbolically 'punish' in a military-political sense the European countries that have agreed to have American missile defense installations on their soil or that could do so in the future. However, there is no doubt that the possible effect of such a step would be outweighed by a whole series of negative consequences for Russia's security and for international stability. Five main conclusions support this argument.

One. Whatever the Polish and Czech authorities' desire to upset Russia and earn points with the United States, the main initiator of the missile defense project in general and its deployment in Europe in particular was across the ocean – beyond the reach of any medium-range missiles Russia could build after withdrawing from the INF Treaty. These missiles would be able to reach targets in Europe and Asia. Punishing European countries for American policy, including Germany, France, Italy and others, with whom Russia has good relations and who were not joining the missile defense system, would be too 'asymmetrical' a response.

If Russia really wants to take this road, a far worthier response would be to withdraw from the 2002 Treaty on Strategic Offensive Reductions. This would be more logical in political and military terms. Despite an original agreement, the U.S. did not take steps towards reaching agreement on the Treaty's counting rules for strategic force warheads, verification measures, and destruction procedures. The Treaty will lose much of its strategic sense once the START-1 treaty, which provides for at least indirect monitoring of strategic nuclear reductions, expires in December 2009. Further, the Bush administration's plans to build a missile defense system in Europe, as was already noted, were not in keeping with the spirit of the Joint Declaration signed simultaneously with the Strategic Offensive Reductions Treaty in 2002.

Two. Developing, testing, producing and deploying a new medium-range missile system would require a lot of money. In the case of the Iskander-M, most of the development cost allocations seem to have already been made. But increasing its range, carrying out additional tests, producing and deploying missiles, conducting training and building the requisite infrastructure would all be quite costly. Some defense industry firms and Defense Ministry agencies no doubt stood to benefit from this, but other parts of the budget would inevitably suffer as a result. Would the money be deducted from the program to develop the strategic nuclear forces (production of Topol-M ICBMs at the slow pace of six to seven missiles a year, construction of the Yury Dolgoruky 955-class submarines, the first of which is already more than ten years behind schedule, and development of the Bulava-30 SLBM)? Or it would be extracted from the funding for the general forces' technical modernization, raising officers' living standards, making the transition to a professional army, housing construction or improving combat preparedness?

All of these expenditures are not less important, but much more so. If it is possible to find additional funds for financing a medium-range missile program, would it not make more sense to spend them on, say, increasing production of the Topol-M from five to six a year to at least 10-20 a year? This would make all the more sense as the Topol-M can carry out all the functions of a medium-range missile and at the same time is the best means of strengthening the strategic deterrent with regard to the U.S. and any other nuclear or missile power.

Three. Withdrawal from the INF Treaty and development of medium- and short-range missiles would imply that Russia takes the military threat from the U.S. and NATO very seriously and suspects them of having evil plans. But within the framework of this very logic, if Russia were indeed to deploy new medium-range missiles, the other side would most likely follow with measures in response. This could include revival of the Pershing-2 and ground-based cruise missile programs or development of new, improved U.S. medium-range missiles and their deployment in Europe, which would probably make the new NATO members overjoyed.

American deployment of medium-range missiles was seen as a huge threat in the Soviet Union at the start of the 1980s, and for Russia today the consequences would be worse still. Today, the two sides have a different balance of nuclear and conventional forces, a different line-up of military alliances, and different geostrategic situations. The U.S. Pershing-2 missiles deployed back then were barely able to reach the Moscow Region, but if deployed in the future in the new NATO member states (Poland, the Baltic States), similar missiles with a shortened flight time could cover the whole of Russia's territory to the Urals and even far beyond. This really would jeopardize Russia's nuclear deterrent capability (unlike the missile defense installations in Poland and the Czech Republic), forcing Russia to completely restructure its nuclear forces and command and warning systems at enormous cost.

Four. Withdrawal from the INF Treaty would once again unite NATO on an anti-Russian basis, including such issues as expanding the alliance to engage new members in the countries of the former Soviet Union, increasing military spending, and coordinating the development of offensive and defensive weapons, including possibly expanding the missile defense system to NATO's entire European territory.

Five. Washington's policy of dismantling the nuclear disarmament treaties during the Bush administration has earned it fierce criticism from most UN members, especially the parties to the NPT. If Russia withdrew from the INF Treaty it would inevitably become the scapegoat, taking all the flack, and the U.S. would be granted remission for its sins. Furthermore, this step would only further undermine the NPT, because it would be seen as a direct violation of the nuclear weapons states' nuclear disarmament obligations stipulated in the Article VI of the Treaty. Further proliferation of nuclear weapons would seriously undermine Russia's national security, because it is located a lot closer to the unstable regions than the U.S. and its European allies.

It was probably for some of the above-mentioned reasons that the Pentagon reacted with outward indifference to Russia's suggestions that it could withdraw from the INF Treaty, and some in the previous administration might even have welcomed such a step. With hard work, the current U.S. administration and the Russian leadership may succeed in finding comprehensive and constructive solutions to the issues raised above, preserve the INF Treaty, and even enhance it with a series of important new agreements.

Notes

[1] See for example V. Myasnikov, "Minoborony vykhodit iz Dogovora o raketakh srednei i menshei dalnosti," *Nezavisimoye voyennoye obozreniye*, # 31 (489), September 1, 2006; D. Litovkin, "Adekvatny Iskander," *Izvestia*, February 21, 2007, http://www.izvestia.ru/russia/article3101392/index.html; I. Safranchuk, "Putannitsa voyenno-diplomaticheskikh azimutov," *Nezavisimaya gazeta*, February 26, 2007.

[2] On the INF Treaty see J. Dean, "The INF negotiations," *SIPRI Yearbook 1988: World Armaments and Disarmament* (Oxford: 1998).

[3] Y. Kotenok, "Rossiya ustroit iz PRO resheto," http:/www.utro/ru/articles/2007/06/04/652965.shtml.

[4] V. Putin (Speech and Discussion at the Munich Conference on Politics and Security Issues, February 10, 2007), http://www.kremlin.ru/appears/2007/02/10/1737_type63374type63376type63377type63381type82634_118097.shtml.

[5] See Litovkin, "Adekvatny Iskander"; Safranchuk, "Putannitsa voyenno-diplomaticheskikh azimutov."

[6] See V. Mizin, "Missiles and Missile Technology," in *Nuclear Weapons after the Cold War,* ed. A. Arbatov and V. Dvorkin, Carnegie Moscow Center, PP. 274—277 (Moscow: ROSSPEN, 2006).

[7] Russian Federation Ministry of Defense, *Aktualniye zadachi razvitiya Vooruzhennykh Sil Rossiiskoy Federatsii* (Moscow: Russian Federation Ministry of Defense, 2003), P. 42.

[8] The Center for Arms Control, Energy and Environmental Studies of the Moscow Inst. of Physics and Technology, *Non-Strategic Nuclear Weapons: Problems of the Control and the Reductions* (Dolgoprudny: The Center for Arms Control, Energy and Environmental Studies of the Moscow Inst. of Physics and Technology, 2004).

[9] See Henry Obering, Director of the U.S. Missile Defense Agency, "RLS i protivorakety SShA stanut na dezhurstvo do 2013," interview in *Nezavisimaya gazeta*, April 20, 2007.

[10] See A. Arbatov and V. Dvorkin, eds., Carnegie Moscow Center, *Nuclear Weapons after the Cold War* (Moscow: ROSSPEN, 2006), P. 528.

[11] See T. A. Postol and G. N. Lewes, *The Proposed US Missile Defense in Europe: Technological Issues Relevant to Policy* (Washington, DC, 2007).

[12] V. Myasnikov, "Polny nazad," *Nezavisimoye voyennoye obozreniye*, November 23, 2007.

[13] Y. Kotenok, "Rossiya ustroit iz PRO resheto."

Chapter 9. The Militarization of Space and Space Weapons

Boris Molchanov

The space activities of countries can have an impact on the proliferation of nuclear weapons and their delivery systems in a wide variety of ways. Space intelligence gathering systems can serve the IAEA's interests by monitoring declared and undeclared nuclear infrastructure in the NPT member states, keeping watch on such sites in countries that have not joined the NPT, monitoring compliance with the MTCR and performing a number of other missions in the interests of maintaining the nuclear nonproliferation regime. As one of the principal elements in national technical monitoring systems, satellites have made nuclear arms control and reduction agreements possible, thus enabling countries to fulfill one of the NPT's most important provisions.

At the same time, however, the overwhelming superiority in general armed forces of countries such as the U.S. is largely supported by military space systems and can encourage threshold states to step up their efforts to obtain nuclear weapons as a means of self-preservation. Simultaneously, these countries will go to great lengths to hide their development of nuclear weapons and delivery systems from foreign space intelligence systems.

The most negative consequences for the nuclear nonproliferation regime would arise if space became a combat zone, that is to say, if countries deployed systems designed to destroy objects in space or strike targets elsewhere using weapons launched from space. This would trigger a new spiral of fierce competition among the great powers with unpredictable consequences. It would also very likely set off a new round of vertical and horizontal nuclear proliferation, where the nuclear powers would increase their nuclear arsenals, and new countries would acquire nuclear weapons. In such a situation, cooperation among nations to strengthen the nuclear nonproliferation regime would be neglected and disregarded.

The analysis presented below of the current state and prospective developments of space activity makes it possible to assess the consequences of the expansion of its military component in greater detail.

The Main Types of Military Space Activity

More than 125 countries are currently active in space with the U.S. and Russia leading in the field. However, France, China, Japan, Germany, Britain, Canada, the Netherlands, Belgium and Spain, along with a number of developing countries – such as India, Pakistan, Argentina, Egypt and others, are active in space, as well. At least 40 countries are to some extent involved in programs to develop and use space-based information support systems for weapons. More than 20 countries have the scientific and production potential to independently develop and build space technology and launch satellites using their own or rented space launchers.

The U.S., Russia, China, France and Japan all have space information support systems (in particular, imaging reconnaissance systems), while Britain and Germany are currently working on such systems. India has second-generation remote Earth-sensing space systems that are also capable of carrying out image reconnaissance, but at a lower resolution. Meanwhile, the United Arab Emirates are known to have engaged a number of firms to create their own military satellites. The list does not end here.

There are currently around 780 actively functioning satellites in orbit around the Earth, of which 425 belong to the U.S., 96 to Russia, and 22 to China.[1] The estimated number of satellites in orbit will increase by more than 400 over 2010-2015. It should be noted that there is a trend for developing multiple-satellite constellations of up to 100 small-sized satellites capable of performing dual purpose functions.

Space systems have become an integral part of the leading powers' military capability. It would be practically impossible or quite ineffective for the advanced countries to carry out military operations today without the use of space systems. Information support space systems make the biggest contribution to the effective conduct of military operations.

The satellite constellations currently in orbit comprise over 150 information support satellites in operational use or in orbital reserve. Overall, military satellites account for around 40% of the total number of satellites in orbit. They can be deployed at any orbital altitude: 25% are deployed in low orbits, 20% in middle orbits, and 55% in high-elliptical and geostationary orbits. Russia, the U.S. and other NATO countries all have military satellites, with the overwhelming majority belonging to the U. S., which spends a lot more on its military space programs than all the other space powers combined (more than 20 times what Russia spends).[2]

In terms of their functions and numbers, the United States' and main NATO countries' military satellites can be classified as follows:

- Reconnaissance and targeting systems (photographic, optical-electronic, radar, radio- and radio-technical reconnaissance); total number — around 50 satellites;
- The space-based component of nuclear missile attack early warning systems — eight satellites;
- The Navstar space global positioning system (GPS) — 29 satellites (of which 24 are in constant operational use);
- Space communications and military command systems — 30-32 satellites;
- The environment monitoring system — 16 satellites;
- The topogeodesic system — two satellites;
- The oceanographic system using the Orbview-2 satellite (Seastar), which also has two weather satellites working for it;
- The Earth natural resources reconnaissance system, comprised of three Landsat satellites.

After 2011 (following the development and deployment of the SBIRS-High multipurpose information and reconnaissance system [consisting of six satellites] and a space surveillance and tracking system [made up of 24-30 satellites] to carry out missile defense tasks, etc.) the U.S. and other NATO countries could have 160-176 military satellites in orbit.

Military space systems have been used actively and very effectively to support military operations by conventional armed forces in regional conflicts. The first Gulf War in 1991 gave a clear demonstration of the role space systems play as a major part of the U.S. military power. The U.S. made use of more than 100 reconnaissance, communications and navigation satellites during that war.[3] Space systems were used in practically every phase of the military operations (from planning the initial deployment to the final ceasefire) and had a direct impact on the conflict's conduct and outcome.

Numerous sources estimate that an orbital constellation of 119 satellites designed for various purposes was used to provide the information, intelligence and telecommunications support for the NATO operations in the Balkans at the end of the 1990s. This enabled NATO to achieve a new quality level in performing its reconnaissance, communications, navigation and meteorological support tasks. More than 80% of the radio exchanges, especially in rugged terrain, were carried out via satellite, and the use of precision-guided air- and sea-based missiles was also facilitated by GPS.

For maintaining tactical/battlefield command links, about 90% of the information the U.S. needed during the 2003 war in Iraq to conduct the operations of troops equipped, among other things, with precision-guided weapons was supplied primarily through space reconnaissance, communications and navigation systems.[4] The outcome of the Iraq war heightened interest in small artificial satellites that could be used to rapidly build up military and dual purpose orbital groups, especially rapid reaction reconnaissance, target detection and communications systems.

New thinking about how the wars of the future will be fought has given space systems particular significance, and this is reflected in the new approach the U.S. and NATO military command is taking to weapon systems development. This approach consists of integrating various forces and reconnaissance systems, radio-electronic warfare, communications and battle management into unified automated combat complexes, in which space systems are transformed from a supporting role into one of the main components in combat. Objectively, other countries with the necessary capability could also follow this trend. As the role and importance of space weapons systems grow, outer space will become increasingly filled with information support systems and their passive and active defenses. There is also the possibility that space weapons based on various platforms could eventually be used as part of active defenses.

In this respect, the creation and development of space weapons is focusing particularly on developing qualitatively new means of warfare. They will be based on missile defense and anti-space defense systems, as well as electronic warfare systems interfacing with weapons in space or on Earth.

Military and Political Aspects of Space Weapons

An analysis of the main focal points and results of space activity shows that the military aspect has dominated U.S. space policy and continues to do so. This is reflected in the general trend that the development of armed conflict has taken. The U.S. Space Command Vision for 2020 defines the key areas for development as follows:[5]

- The development of means and methods for the comprehensive control of space;
- The search for new forms and means of carrying out global military operations (including the potential capability of using force from space in any part of the world); the attainment of full functional unity in military operations between space forces and land, sea and air forces;
- The widespread implementation of information technology and promising weapon systems for all levels of military operations.

In order to make the use of precision-guided munitions more effective, a common information space is being created with a telecommunications and computer network to better combine information from navigation, communication and reconnaissance satellites with data from air-, ground- and sea-based systems, as well as from civilian sources.

The use of a unified high-bandwidth telecommunications system will make it possible to receive, right down to tactical command level, the broadest range of data in real time on the nature and coordinates of targets, including video imagery transmitted from the central command center and reconnaissance systems.

Carrying out this vision of making space activity one of the main national security priorities would most likely lead to a new spiral in the militarization of space. In January 2001 a report published by the Commission to Assess United States National Security Space Management and Organization (the Rumsfeld Commission) set forth concrete steps in this direction.[6] The report's main provisions outlined an extensive program for the U.S. to ensure its domination in space.

In order to achieve this goal, the report proposes raising the activities to a new quality level within the framework of targeted programs, including, in particular, the development of various types of space weapons (above all for missile and space-attack defense tasks). Work is also underway on developing a new generation of space information support systems for precision-guided munitions.

The basic premises in the opinion of the U.S. leadership to undertake new efforts to militarize space and develop missile defense systems can be summarized as follows:

- The prospects for proliferation of nuclear weapons, especially nuclear-armed missiles;
- The steady trend toward blurring the distinctions between the military and civilian use of space;
- The technical similarities in developing and producing anti-missile and anti-satellite systems;
- The reduction in the level of Russia's space activity, along with the increase in space activities by countries hostile or potentially hostile to the U.S.

Effective organization and stable funding guarantee that the work undertaken within these programs is able to continue, and as a result the U.S. could considerably increase its space capabilities, including its military component.

The coming years could see the emergence of a system based primarily on missile and space-attack defense systems incorporated into the national missile defense strike and information networks and linked to the common national defense system. U.S. military specialists believe that in the future the first stage of the system's deployment would cover most U.S. territory and U.S. and NATO forces in forward theaters of military operations, while the final deployment would protect U.S. territory in its entirety from ballistic missile attacks.[7]

Official U.S. military space policy documents outline the main objectives of the U.S. space programs:[8]

- Ensuring that the U.S. has free access to space and its use;
- Maintaining America's leading position in space as the power with the largest economic, political, military and technological capabilities;
- Preventing the emergence of threats to American interests in space, and, should deterrence fail, ensuring the adversary's destruction;
- Preventing countries in a state of conflict with the U.S. from gaining access to space;
- Developing economic, political and military cooperation with other countries involved in space exploration.

The following tasks need to be carried out in order to achieve these objectives:

- Enhancing the combat capability of ground, sea and air forces through space information support;
- To the extent that it is technically possible, developing systems for launching strikes from space against the adversary's land, sea, air and missile forces;
- Implementing information coverage and, if necessary, armed control of space (including military operations against the adversary's space forces and their land-based infrastructure).

It is particularly noteworthy that the U.S. gives a broad interpretation to the task of controlling space in the foreseeable future. Alongside the traditional functions of tracking objects in space, this control may also be ensured by destroying the adversary's space hardware using anti-satellite weapons with various basing modes.[9]

In January 2001, the Commission on Space, authorized by Congress, strongly recommended that the United States retain the possibility of deploying weapons in space and defined three potential tasks that space weapons could perform:

- Protecting existing U.S. space systems;
- Obstructing the adversary's use of space and space systems;
- Carrying out strikes from space against any targets on land, at sea, or in the air.[10]

On August 31, 2006, the U.S. President approved the new National Space Policy. This document replaces Presidential Decision Directive NSC-49/NSTC-8 (U.S. National Space Policy) of September 14, 1996, and sets the main principles and objectives of U.S. space activity.[11]

In particular, it defines the responsibilities and duties of the Department of Defense:

- Supporting and enabling defense and intelligence requirements and operations during peacetime, crises, and all levels of conflict;
- Developing and deploying space systems that sustain the U.S. advantage in this field and facilitate improvements in defense and intelligence;
- Maintaining the capability to support space potential, enhance the forces, control space and use space systems;
- Providing space capabilities to support continuous global strategic and tactical warning systems, as well as multi-layered and integrated missile defenses;
- Developing plans and options to ensure freedom of action in space, and, if directed, to deny such freedom of action to adversaries.

The last two points indicate the existence of plans to deploy various types of space weapons.

The State of Progress on the Development of Space Weapons

Space weapons fall into three main general categories: kinetic energy weapons, directed energy weapons and conventional munitions delivered to or from space. These weapons can be based in space, on land, at sea or in the air. They can be anti-missile, anti-satellite or anti-aircraft weapons, or weapons used against targets on Earth.

The Strategic Defense Initiative (SDI) program announced by U.S. President Ronald Reagan in 1983 established the main outlines for the research on and development of space weapons.[12] Over the ten years of the implementation of this program (1983-1993), a flexible management organization system was established and perfected (including the areas of missile and air defenses). This organization coordinated the work of 400 industrial companies, scientific laboratories and universities, and 28,000 scientists and researchers in the U.S. and 10 other countries.

Although the U.S. administration issued an official statement that it was halting its ten years of work on the program in 1993, work on all of the projects included in it did not actually stop and continues to this day. The only change was that, depending on the results achieved, work on the projects was divided into two parts — design work and research work. The Ballistic Missile Defense Organization, a body within the Department of Defense that grew out of the agency responsible for SDI, was given responsibility for design work. Research was transferred to the Defense Advanced Research Projects Agency (DARPA), also part of the Department of Defense. These are long-term projects, but they have varying degrees of priority and are in varying stages of progress.

This program examined concepts and technology for developing military space systems based on the use of several types of space weapons.[13]

Kinetic energy weapons primarily use small, high-speed, self-guided interceptors to strike targets through direct impact at high relative approach speeds (up to 5-10 km/s). They could also use explosive (fragmentation) charges in the strike zone. This type of weapon would be used primarily in missile and air defense systems with various basing modes (land, air, sea, and space). A variety of missile systems could be used to deliver the kinetic energy weapons.

Directed energy weapons are a completely new kind of weapon that destroys targets using advanced technology and is best suited for use in space. These weapons create powerful directed beams of light, electromagnetic energy, or high-energy particles that travel at or close to the speed of light. Work has focused principally on laser and beam weapons.

Laser weapons emit a powerful beam of light energy. They can destroy various targets (spacecraft, missiles, warheads, targets in the air) by subjecting vital components, for example, solar panels, to thermal or functional attack, by burning their optical-electronic instruments, or using other effects to irreparably damage or disrupt the functioning of vital systems and their components. In principle, such weapons could be used in anti-satellite systems and missile defenses with various basing systems (primarily space-based).

Beam weapons emit a stream of high energy particles that move at a speed close to the speed of light. Research has looked into using beams of neutral hydrogen atoms, which are unaffected by the Earth's magnetic field. The particular feature of these weapons is the high penetrating power of the high energy particles that can destroy spacecraft, missiles and warheads with heat and radiation. In principle, space-based weapons systems could use beam weapons.

The so-called EMR (Electromagnetic Radiation) weapons that emit a powerful and extremely short burst of electromagnetic radiation to disable electronic devices, power and command networks and antenna feeder tracts have also been considered for destroying spacecraft and ICBMs. This kind of weapon can be created in both space- and land-based modes.

These types of weapons are all key components of space weapons systems, which, according to the U.S., include anti-satellite and missile defense systems, space-to-Earth attack systems, and information counter systems. All of these systems are currently at various stages of design and development.

The U.S. Military Space Program

The U.S. leadership has defined the following key tasks to be carried out using anti-satellite systems:

- Deprive the adversary's army and navy forces of the capability of receiving information support from space, thus considerably reducing their combat capability;
- Deny the enemy the ability to carry out effective space reconnaissance of U.S. territory and military operations theaters and the use of space communications and retransmission systems;
- Provide active protection for American orbital satellite constellations that support the combat control, intelligence, communications, navigation and weather tracking systems.

The U.S. has made the most progress in developing anti-satellite systems. Work in this area began in 1957. In 1962, the U.S. developed anti-satellite land-based interceptors using the nuclear-armed Nike-Zeus and Thor missiles, and deployed them on Johnston Island (in the Pacific). Two such anti-satellite systems were deployed from 1972 to 1974. In 1974, they were withdrawn from service and mothballed.

In 1977, work began as part of the ASAT Program on the new generation MALS anti-satellite system, which involved launching a SRAM/Altair missile with a miniature MHV interceptor on a vertical trajectory from an F-15 fighter airplane to destroy its target by direct impact. In 1984-85, this system, which had an attitude limit of 1,000 km, was put through flight tests that involved destroying a real target in space. Using this system, the U.S. expected to be able to destroy 3-5 satellites operating at low orbits of up to 1,000 km over a period of 1-1.5 days.

Work on the MALS Program came to a halt in 1988 for a number of technical and political reasons, and the system was mothballed. It is estimated that it would take several months to get the system into combat-ready condition. The decision to halt the MALS Program, however, did not mean that the U.S. had abandoned plans to develop the ASAT anti-satellite system, including ground-, air- and sea-based components.

A new stage of work on the anti-satellite system got underway in 1989. This time the main focus was on developing land-based anti-satellite weapons. A new project was presented in the U.S. in 1991 — dubbed the 'environmentally friendly' KEAsat (Kinetic Energy Anti-Satellite) interceptor, that weighs several dozen kilograms, supposedly does not create debris, and can be used against targets in orbit and sub-orbit.[14] The purpose of an anti-satellite system using this interceptor would be to destroy all low-orbit military satellites within a week.

According to the design concept, the interceptor is fitted with a rolled up panel (a Teflon sheet 113 square meters in area), which is unrolled just before the interceptor impacts the target, 'enveloping' the disabled satellite in the sheet and preventing the fragments and debris from the satellite and the interceptor itself from scattering. The idea is that using this anti-satellite weapon would not create additional space debris, thus ensuring the safety of other spacecraft. In reality, however, the impact of the interceptor with its target at such a high speed would create so much kinetic energy that no such sheet would likely be able to stop the scattering of an enormous quantity of fragments.

The U.S. Armed Forces planned to carry out seven flight tests, two of which were to use two non-functioning American satellites as targets, while the other five involved having the interceptors pass close to satellites in orbit. Deployment of the first 10 KEAsat systems was slated to begin by June 1998, but this did not happen. However, the work that was done and the technological results achieved up until then were preserved.

A number of U.S. projects to develop anti-satellite weapons have reached the stage of experimental work on prototypes, and flight tests were carried out for some of them. The KEAsat space interceptor, which is a modernized version of the small-sized Brilliant Pebbles interceptor developed during work on the SDI program, has undergone flight tests.[15] Deployment of land-based anti-satellite systems using these interceptors is entirely realistic. It was said that if President Bush had decided to deploy the KEAsat system, it could have been put in place very quickly, given its similarity and relation to the EKV-PLV missile defense system that was tested.[16]

In 1990, Rockwell International won a contract to build a demonstration land-based anti-satellite system. This was to be a mobile tractor-trailer system firing a three-stage launch vehicle. The interceptor itself was to have been of the same design as the Brilliant Pebbles interceptor. For the first stage of deployment, it was anticipated that 60-79 anti-satellite missiles could be acquired in order to outfit one battery, which would subsequently be increased to two batteries having 48 launch vehicles each.

If the political decision is made, the deployment of these anti-satellite missiles with high success in destroying their targets is entirely feasible. Another possible component of the ASAT system would be the use of one or two land-based systems using laser weapons (based on the currently operational anti-satellite laser MIRACL – Mid-infrared Advanced Chemical Laser) to functionally disable the most important reconnaissance satellites. This weapon uses a deuterium fluoride chemical laser, part of a test bed located at the U.S. Armed Forces' White Sands Missile Range in New Mexico.

The first series of successful real-life experiments was carried out in October 1997, using the direct effect of two pulses fired by this laser to destroy an MSTI-3 satellite orbiting at an altitude of 420 km and a 90° inclination. Evaluation showed that a direct beam from this laser has the energy to disable a satellite's solar panels and optical-electronic instruments at altitudes of 400-700 km and destroy the sensitivity of photo-receptors in the space-based early warning and surface surveillance systems orbiting at any altitude, including geostationary satellites.

The Space-Based Laser (SBL), built on an orbiting anti-missile/anti-satellite platform with a striking range of 1,000-3,000 km, has achieved a certain degree of technical readiness. American specialists see this kind of system as potentially effective in defending against ballistic missiles of any range during the boost phase of their flight (altitudes of 10 km and up). Aside from use in missile defense systems, the space-based laser weapon is also seen as promising for destroying low- and mid-altitude orbit satellites and targets in the air at ranges from several hundred to several thousand kilometers.

The SBL's components include:

- A high energy hydrogen fluoride Alpha chemical laser;
- An optical system for focusing the beam, designed under the framework of the LODE program;
- A main adaptive segmented mirror developed through the LAMP program.

In 1990, two space experiments were carried out, RME and LACE, which demonstrated excellent beam accuracy and stability in aiming a laser beam at a target. The adaptive optical system has been used to develop the technology of compensating for distortion in the laser beam as it passes through the atmosphere. These experiments demonstrated the theoretical feasibility of building the SLB's detection, tracking, guidance and beam control systems.[17]

In February 1999, the U.S. Air Force signed a contract with a group of companies (Boeing, Lockheed Martin, Space, and TRW) to prepare and conduct a complex space experiment called IFX (Integrated Flight Experiment), in which an experimental laser weapon would be put into near-Earth orbit. The program called for a series of ground and space tests. According to the plans, the experimental laser would be put into orbit in 2012 at an altitude of 425 km and a 28-degree inclination. The model would have sufficient chemical reagents for three disabling or ten low-power shots.[18] In 2013, an experiment was to have been conducted using a laser to destroy a target missile imitating a ballistic missile in the boost phase. An experiment had also been planned to refuel an artificial satellite in orbit as part of support operations for the space-based laser platform. This experiment had been scheduled to take place in 2004 as part of the Orbital Express Program for the purpose of testing the possibility of reloading a simulator of a chemical laser in orbit in order to extend its service life.[19]

But despite the progress made on the SBL, a number of key problems, such as placing a full-scale laser station in orbit, refilling its laser components in orbit, etc., were not resolved. The technical difficulties with work on the SBL seemed to have convinced the Ballistic Missile Defense Organization to stop preparation work on the IFX experiment in October 2002. More work was needed on a number of areas of the SBL program, and as a result of some problems the program went back to the technology development stage. The SBL program management was disbanded, and all the work in this area was transferred to a new program called Laser Technology. It is now part of the program to build an airborne laser. Thus, for the foreseeable future, research and experimental work in the area of space-based lasers is unlikely to go beyond the 'technical' stage.

The main activity at the moment is concentrated on developing an anti-missile and anti-satellite airborne laser (ABL). The U.S. successfully completed a series of initial flight tests of a low-power laser and ground tests of a final-version megawatt-class military laser in August 2007. The ABL system is designed to destroy ballistic missiles during the boost phase as part of a theater missile defense system, as well as satellites in low orbits.[20]

Thus, by 2010 or later, the U.S. could theoretically create and use mobile or stationary, land-based, anti-satellite weapons using KEAsat small-sized direct impact interceptors; space-based anti-missile and anti-satellite weapons with kinetic interceptors; land-based lasers to functionally disable satellites; and airborne lasers to destroy low-orbit satellites and theater ballistic missiles.

To all appearances, the U.S. has now completed development of practically all basic components of modern anti-satellite systems, making it possible to actually build the systems relatively quickly, depending on military and political developments.

The following are the main trends that can be identified in the development of anti-satellite systems in the U.S.:

1. If necessary, U.S. anti-satellite capabilities could be used to threaten the access to space by countries wanting to use space in their own national interests.

2. Integration and direct continuity of key design elements and basic systems are used in anti-aircraft and anti-space defense. Among these key elements and systems are the interceptors, their on-board systems and self-guided warheads, on-board weapons, command and communication centers and combat information support systems.

3. The search continues for alternative solutions in the development and comprehensive use not only of the various types of anti-satellite weapons (kinetic, laser, beam, etc.), but also of the various basing modes (stationary and mobile land-based, air-, sea- and space-based).

4. There is a trend towards creating such small-sized kinetic anti-satellite weapons as KEAsat.

5. The fruits of full-scale scientific, production and technological anti-satellite weapons development programs are preserved and accumulated by mothballing them, while retaining the ability to reactivate them rapidly should the need arise.

6. Broad-scale research continues in the area of informational and intelligence support for the military use of anti-satellite weapons, including development of algorithms to identify satellites by their spectral signatures captured from reflected or stray solar radiation.

Soviet Space Weapons

Practical work on developing space weapons began in the Soviet Union with the IS (Satellite Destroyer) anti-satellite weapon, similar to the U.S. SAINT (Satellite Inspection Technique) project. The weapon's main components had all been developed by 1967, and tests began in October of that year. The first successful interception was achieved on November 1, 1968. The IS system entered experimental service in February 1973. It could destroy satellites at altitudes from 250 km to 1,000 km. In 1978, a modernized version of the system, the IS-M, entered service. The Soviet Union resumed tests of this anti-satellite weapon in April 1980, and the last test was conducted on June 18, 1982.[21] In August 1983, the USSR made the commitment that it would not be the first country to deploy such weapons in space as long as other countries, including the U.S., refrain from deploying anti-satellite weapons of any kind in space.[22] The IS-M remained in service until 1993, when President Yeltsin issued a decree withdrawing it from service.[23]

In the mid-1980's the USSR began a development program as a response to the American SDI. Soviet efforts were asymmetrical in nature and focused on three main areas: missile defense penetration systems for ballistic missiles, individual protection systems for satellites, and space defense systems, including weapons for destroying space objects. Work on these projects was still in the research and development phase when the Soviet Union ceased to exist and the program came to a halt. However, were a space arms race to get underway, these projects could be revived.

Chinese Anti-Satellite Weapons

In 2007, the news broke about a successful test of an anti-satellite weapon in China (after three failures). Media reports said that on January 11-12, 2007, the destruction of a Chinese satellite, FengYun-1-3, was confirmed, and fragments of the satellite were detected. The satellite was launched on May 10, 1999, from the Taiyuan Test Range (Wuzhai) and was part of China's weather observation system. It was a serially-produced satellite weighing 954 kg, with a body in the form of a six-sided prism, 1.42 x 1.42 x 1.2 meters in size, with two solar power panels, each with an area of 9.58 m^2.[24]

The satellite was destroyed over central China at an altitude of 864 km and an inclination of 28 degrees. A correlation was revealed between the time of the satellite's destruction and the launch of an intermediate-range ballistic missile from the Xichang launch center. There was no notification of an upcoming ballistic missile launch from Xichang or of tests of anti-satellite weapons in open information sources. However, China had reserved airspace and closed it off to aviation in advance. The reserved airspace zones were confirmed to be related to the ballistic missile's launch. This suggests that the satellite's destruction was related to the launch of the ballistic missile, during which an anti-satellite weapon was tested.

Space-Earth Attack Systems

Plans for building these kinds of weapons first emerged in the U.S. along with the first satellites (the FOBS project to deploy nuclear bombs in space). However, real efforts to build such weapons began in 1987. The SBGV (Space-Based Ground Vehicle) project involved developing a space-based glider intended to destroy strategic targets, primarily mobile missile launchers and surface ships located deep within the enemy's defense perimeter, rapidly and with high precision. The vehicle was to be guided to its target over the first part of its trajectory by an inertial-guidance or Navstar system. During the second phase, when targeting mobile objects, it would receive its target information from an orbital surveillance satellite, and during the final phase in the atmosphere it would use its self-guided homing warhead.

According to information initially published on the project, the SBGV had a weight of 432 kg, a maximum flight distance from start to target of 22,000 km, and a minimum re-entry time of 3-5 minutes. Flight tests of this system were to be carried out before 2002, but no information on such tests has since appeared in open sources.

It was planned at first to equip this system with two types of warheads:

- For destroying soft ground, sea or air targets;
- For destroying hardened targets, primarily underground sites.

In the latter case, the warhead is equipped with a penetrator that can destroy targets 20 m deep with concrete walls up to 2-3 m thick. The program to develop the SMV (Space Maneuvering Vehicle) has been the logical continuation of this work. Boeing, under contract from the U.S. Air Force, has been working on this vehicle for several years now. It is designed to carry out a number of military tasks (in orbits from reference orbit to geostationary): expeditiously placing lightweight satellites into orbit, inspecting or destroying space objects, performing the functions of space command and surveillance, transporting general purpose vehicles or small guided missiles, or carrying a hypersonic gliding kill vehicle with an armor-piercing warhead for destroying hard targets on the ground.[25]

The SMV has been conceived to cover practically the whole range of tasks related to armed conflict in space or from space. However, it is substantially limited at present by its relatively small payload of around 500 kg.

The X-40A, an 0.85 scale model of the SMV, was created in 1998 to test the technology for developing and using the SMV. The first successful tests of the X-40A were conducted at Holloman Air Force Base (New Mexico) in August 1998, and the series of flight tests was completed in July 2001.[26]

For the initial stage of operations with the standard SMV, Boeing proposes placing it in orbit using the AirLaunch three-stage solid-fuel rocket, which is under development. This method of transport, which would be launched from a Boeing 747, offers great flexibility in placing the SMV into various orbits at various inclinations, as well as rapid application. Specialists say that if the project gets the go-ahead, the first launch of the SMV-AirLaunch system could take place in the next few years.[27] In light of the system's current shortcomings and limitations (especially with respect to payload), the Air Force has decided to initiate a new phase of design work on the SMV project.

Notwithstanding existing R&D publications on the construction of spacecraft for attacking targets deep within enemy territory, there continue to be great doubts on the operational and strategic need for such systems. The laws of space dynamics (with the exception of geostationary orbit) prevent a space-based weapon from being permanently above or within strike range of a target. There are also the weight restrictions on the kill vehicle and the overall high cost of the system. Most important is the lack of any operational or strategic missions that a space-based or fractionally-orbiting weapon could carry out more effectively than land-, sea- or air-based weapons, especially those stationed on bases or on patrol close to a likely adversary's borders.

The Potential Capabilities of Counter-Information Weapons

The U.S. accords an important role to counter-information weapons in carrying out radio-electronic warfare in space, as indirectly confirmed by its own measures to protect space systems from electronic warfare. In particular, in January 2000, the U.S. telecommunications system's National Coordinating Center was transformed into the National Telecommunications and Information Administration and given responsibility for evaluating the vulnerability and survivability of the system and analyzing threats and anomalies that could affect the U.S. telecommunications infrastructure.

The importance of this area probably also explains the publication of information on work to develop electronic warfare weapons. Reports of Senate hearings have revealed that in 2004,[28] the U.S. Air Force established the 76th Space Control Squadron to destroy or disable foreign satellites using land-based active interference stations.

The U.S. is currently working hard on space inspection technology, in particular through the ANGELS (Autonomous Nanosatellite Guardian Evaluation Local Space) program. In 2005, the Department of Defense started funding the ANGELS program to build autonomous micro-spacecraft that can protect and diagnose malfunctions in U.S. satellites, but that can also be used to inspect and take action against the satellites of a likely foe. In 2005, Lockheed Martin received a contract from the U.S. Air Force's research laboratory to develop an autonomous inspection micro-spacecraft for the ANGELS program.

This is a dual purpose program that could be used in electronic warfare and space defense. According to evaluations by experts from the U.S.

Center for Defense Information, the autonomous micro-spacecraft built using ANGELS technology could be fitted with radio transmitters for creating radio interference or devices for spraying paint that would block the functioning of satellites' optical instruments. The launch of an ANGELS experimental inspection micro-spacecraft into geostationary orbit is planned in 2009. Work on the means of conducting electronic warfare is focusing in particular on the development of orbital high power radio frequency transmitters that could destroy or disable space-based electronic military command and communications systems and also disable enemy missile attack early warning satellites.

Realistic technical conditions are in place for eventually developing space-based electronic warfare weapons using existing radio technology. The key to increasing the energy potential of on-board space-based electronic warfare systems is to develop large-dimension antennas. In the early 1970s, the U.S. deployed a 9-m diameter parabolic mirror antenna in space designed for a maximum working frequency of 8.25 gigahertz. A 15-m diameter antenna with a maximum working frequency of 9 gigahertz was designed for the Rhyolite satellite. Work is underway on developing a 55-m diameter mirror antenna (weighing 320 kg). Designs have also been developed for parabolic mirror antennas 15, 30, and 100 meters in diameter with frequencies of up to 12-18 gigahertz. The technology for building large-dimension antennas with apertures of several hundred meters could be ready within the next few years. Work is also underway on developing adaptive phased-array space-based antenna shields. Analysis of existing data shows that single-component mirror antennas with an amplifying coefficient of up to 50 dB and multi-component antennas with a diameter of up to 200 meters and an amplifying coefficient of up to 100 dB could be built by 2010.

Electronic warfare systems to disrupt space-to-Earth, space-to-space, and Earth-to-space radio communications could probably be service-ready in the near future. A space-based anti-communications satellite electronic warfare system could include 2-4 electronic warfare satellites in stationary orbit, fitted with 4-8 interference transmitters. Deployed in stand-by mode, they could have a service life of several years.

An analysis of the current status of the development of anti-satellite weapons shows the following:

1. The U.S. already has a diverse arsenal of advanced space technology and research and development work for building and perhaps bringing into service some models of ground- (stationary and mobile) and sea-based anti-satellite weapons after 2010.

2. The U.S. 76th Space Control Squadron, which can destroy or disable foreign satellites using active interference ground stations, was formed and began functioning in 2004.

3. In terms of amounts of research and development work and ground and flight testing, the following anti-satellite weapons are the closest to completion:

- The modified Aegis Mk7 sea-based anti-missile (anti-satellite) system using STANDARD-3 (SM-3) missiles and a self-guided kinetic warhead designed by Boeing;
- Army mobile land-based systems designed as part of the KEAsat program;
- The ABL airborne laser anti-satellite and anti-missile system;
- The MIRACL land-based anti-satellite laser to functionally disable vital information satellites.

4. Scientific work and research has been completed and technology development work has begun on a space-based laser deployed on an orbiting anti-missile/anti-satellite platform. This project will probably not go beyond the technology development stage for the foreseeable future.

5. Research and experimental work is underway on the following projects:

- Space-to-Earth weapons;
- The reusable SMV (Space Maneuvering Vehicle) for performing a broad range of tasks, including anti-satellite missions and destroying ground targets from space;
- Space-based electronic warfare weapons;
- Space inspection technology using autonomous micro-satellites for the protection and diagnosis of malfunctions in U.S. satellites, and also for destroying the satellites of a likely adversary; this work is being carried out as part of the ANGELS (Autonomous Nanosatellite Guardian Evaluation Local Space) program.

The International Legal Basis for Military Activities in Space

The international laws currently regulating military activity in space do not cover all aspects of such activity and do not guarantee against the militarization of space, especially where the development of space weapons is concerned. Repeated attempts to extend the system of restrictions on using space for military purposes and bolster the regime governing the peaceful use of space have encountered resistance, chiefly from the U.S.

American official documents clearly state the goal of consolidating the existing U.S. strategic military advantage. Therefore, Washington considers it disadvantageous to toughen the current international laws governing the use of space for military purposes.

At the same time, however, there are real limitations that already affect the normal operation of space systems. For example, there are restrictions related to space debris, the growing difficulties of arranging orbits rationally, the orbital configurations of some satellite systems, etc.

The pollution of near-Earth space that has naturally resulted from the accumulation of man-made space debris is a problem that is becoming extremely urgent and requires separate examination. Many countries have expressed serious concerns over this issue, because important Earth orbits could soon be so filled with waste that it may become unfit for use.

Another limiting factor already having a real impact is that geostationary orbit has now become quite crowded. Efforts are therefore taken or need to be taken at the international level to distribute and allocate orbital locations to the various countries where they can station their satellites, as well as to provide access to other operational orbits and satellite communications radio-frequency bands (to avoid interference). Furthermore, the issue of the use of nuclear energy in space also needs to be addressed, along with other matters.

Space activity is regulated by a series of international treaties and agreements.[29] The following kinds of military space activity are allowed under international law:

- The use of reconnaissance satellites and space-based remote sensors for verification of arms control treaties (and indirectly for reconnaissance);
- The use of communications, navigation and weather-monitoring systems;
- The use of military personnel for scientific research and other peaceful purposes.

Among the types of military space activities that are incompatible with international law are the following:

- Placing nuclear weapons and other types of weapons of mass destruction in orbit around the Earth, on celestial bodies, or in orbit around them;
- Testing nuclear weapons in outer space;
- Deploying military bases and carrying out military tests or maneuvers on celestial bodies or in orbit around them;

- Carrying out hostile acts or using force on celestial bodies or in orbit around them;
- Deliberately obstructing orbits in order to hinder the normal operation of spacecraft (provision of the Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques of 1977).

Types of military space activity not prohibited by international law include:

- Development, testing and deployment in space of anti-satellite weapons and (following the U.S.'s withdrawal from the 1972 ABM Treaty) space-based missile defense systems without WMD;
- Space-based anti-missile defense suppression systems and active and passive satellite defenses;
- Development and deployment in space of optical-electronic and radio-electronic suppression systems;
- Conduct of applied military space experimental work, with the exception of hostile environmental modification techniques.

One of the main areas for improving the current international legal framework regulating the use of space for military purposes is the expansion of restrictions prohibiting the testing, deployment and use of systems and means of obstructing the operation of space systems that support countries' socio-economic, military, commercial and scientific activities. Space systems in this context should be taken to mean the totality of approved functioning and interlinked orbital and ground systems used for carrying out one or several tasks in space or from space. A system includes satellites, their launch vehicles, command facilities, and information collection and processing systems.[30]

Improving the laws on the use of space has long been the subject of negotiations, in particular between the USSR and the U.S. on nuclear and space weapons, and at the UN disarmament conferences in 1985-1990.

During this period, the Soviet Union, in particular, presented a draft treaty on prohibiting the use of force in space or from space directed toward the Earth, but the U.S. did not support it then. This draft treaty envisaged a ban on resorting to or threatening to resort to the use of force in space, in the atmosphere and on Earth using space objects in orbit around the Earth, on celestial bodies or deployed in outer space in any other fashion as means of destruction. The parties to this treaty were expected to agree to the following obligations:

- Not to test or deploy in orbit around the Earth, on celestial bodies or in any other way any space-based weapons for attacking targets on Earth, in the air or in space;

- Not to use space objects in orbit around the Earth, on celestial bodies or deployed in space in any other way as means for attacking any targets on Earth, in the air or in space;
- Not to destroy, damage or disrupt the normal operation and not to change the flight path of other countries' space objects;
- Not to test or develop new anti-satellite weapons, and to eliminate existing weapons of this kind;
- Not to test or use manned spacecraft for military purposes, including anti-satellite missions.

It would be worthwhile returning to the discussion of these proposals today. These kinds of prohibitive measures would be effective in times of peace and would reduce the potential for destabilization in the event of armed conflict. Some of the provisions could also be observed during times of war. The fact remains, however, that no positive solution has yet been found to the problem of preventing the weaponization of space.

On September 26, 1997, the U.S. and Russia signed a package of bilateral agreements that included additional restrictions on the production of space-based high-energy lasers and interceptors, as well as substitute systems that could serve tactical or strategic purposes.[31] However, these agreements do not solve the problem as a whole, because there is no international law prohibiting the development and testing of all types of space weapons and the means for acting against other elements of the space infrastructure.

In 2007, a group of experts from the U.S., Russia, Canada, France and Japan completed work on a Model Code of Conduct for Responsible Space-Faring Nations. The Code's main goal was to preserve and develop the space activities of all countries that are aimed exclusively at exploration and the peaceful use of space, including military support purposes.[32] The draft Code established countries' right of access to space for carrying out exploration work and social and economic activities, and for providing support for their armed forces without creating obstacles for other countries. It also stipulated countries' rights to receive necessary information in the process of implementation of the Code. Countries had the obligation to take responsibility for safe activity in space, provide all necessary information concerning the safety of space objects, minimize the creation of space junk, and not interfere with other countries' activities.

The Model Code of Conduct for Responsible Space-Faring Nations sets out only the most general provisions. It does not give a definition of space weapons or the ways they are used, and it does not contain other restrictive measures. This was a conscious choice made to encourage the maximum number of countries, above all the U.S., to sign the code on a voluntary basis.

Work will need to be done in the future to draft a legally binding agreement that sets out restrictive measures in detail, gives definitions of the different types of weapons based in various modes that could disrupt the effective operation of space systems, and also stipulates the transparency measures needed to confirm compliance with the agreement's provisions.

On February 12, 2008, Russia and China officially submitted a draft treaty on preventing the militarization of space to the UN Disarmament Conference. In the words of Russian Foreign Minister Sergei Lavrov, who presented the draft treaty in Geneva, it aims to eliminate the existing loopholes in international space law, reinforce security and arms control, and prevent the militarization of the space environment around the Earth.

But the U.S. refused to give its backing to a new international treaty on preventing an arms race in space. Commenting on the draft treaty circulated at the UN Disarmament Conference, White House Press Secretary Dana Perino said that the United States does not support the drafting of new legal provisions or other measures that close or restrict access to space and to its use. As for plans to deploy weapons in space, the U.S. government adopted the view that the only way to bring such plans to light would be to discuss each country's space policy and strategy separately.[33]

On February 21, 2008, an event took place that merited particular attention. A Standard-3 (SM-3) anti-missile interceptor, part of the sea-based Aegis Mk-7 system, was launched from the U.S. Navy cruiser Lake Erie in the Pacific Ocean and destroyed a defunct spy satellite, USA 193/NROL-21, at a height of 247 km.[34] The U.S. Department of Defense explained the action by saying that the satellite carried a tank with 543 liters of frozen highly-toxic hydrazine, but many experts found this explanation wanting. As the satellite re-entered the atmosphere, the temperature, rising to the point where plasma forms, would have inevitably caused the tank to disintegrate, and the hydrazine would have evaporated with no danger to the environment.

The satellite in question had no solar panels, and this suggests that it may have been powered by a radio-isotope generator using plutonium-238, which has a half life of around 90 years.[35] The usual course of action in such emergencies is to separate the power source and put it into a 'disposal' orbit of around 1,000 km, where it can remain for hundreds of years. Such operations have been carried out on many occasions in order to protect the Earth and its atmosphere from radioactive pollution. It could be that in this particular case such an operation was not possible for technical reasons. The U.S. has issued no official information to date. Whatever the case, the U.S. Department of Defense took advantage of the situation to demonstrate the SM-3 missile's capability to destroy a satellite.

It is also worth noting that the decision to destroy the USA 193 satellite came just a few days after the U.S. rejected the draft Russian-Chinese treaty on prohibiting the deployment of weapons in space. The U.S. decision was perhaps also motivated by the precedent China set in destroying its own weather satellite in 2007. Washington strongly criticized the Chinese experiment, calling it 'space hooliganism,' and then repeated such an act itself, using more advanced technology. Thus another step was taken towards the militarization of space. It is likely that the near future could turn a completely new page in the militarization of space with the deployment in space of weapons to destroy or disrupt the operation of satellites, as well as targets on the ground, in the air or at sea. This could potentially bring about global destabilization in the military and political situation.

The reality of this danger stems not only from the considerable experience the U.S. and the Soviet Union built up over the years in their work on designing and developing space weapons and space weapon defenses. Even more troublesome is the emergence of new technology, making it possible to build and deploy large numbers of relatively cheap small military satellites, to use weapons based on new physical principles in space, and to create various means to disrupt satellite constellations and ground control and communications centers.

The U.S.'s current strategic goal of monopolizing or dominating the military and armed use of space, which motivates American rejection of initiatives for new international treaties and agreements, is quite short-sighted in the long term and counterproductive even for America's own security. Washington took a similar approach to the development of nuclear weapons in the late 1940s and missile technology in the 1950s-60s. In both cases it lost its monopoly and U.S. territory became vulnerable to a devastating enemy strike for the first time in history. Now, following the end of the cold war, the U.S. admits that the further proliferation of nuclear weapons and missiles in the world has become the biggest threat to its security.

It is entirely possible that the development of space weapons could follow the same scenario. For now, the U.S. has obvious and indisputable economic and technological domination in space. However, if a space arms race were to begin, other countries would inevitably get involved – above all China, Russia, India, Iran and others – and American superiority would be lost or undermined with time. This is all the more likely because although the U.S. has the greatest potential for developing space weapons, it is also the country most dependent on space support systems for its military and civilian activities. Furthermore, satellites are inherently vulnerable, due to their technical characteristics and the laws of space dynamics (predictability of orbits, detectability, limited capacity for maneuvering, and so on). Finally, if space, which has no national borders or natural shelters, is filled with weapons, there will be a great danger of accidents, incidents, false alarms, command system malfunctions, etc. In this sense, the collision of American and Russian satellites on February 10, 2009, was a serious warning to all nations of the world.

Countering the proliferation of nuclear weapons and missiles is the main argument for developing space weapons today. This argument is used to justify the development of missile defense systems, as well as active defenses for one's own satellites and the means to destroy an adversary's satellites in the event of an armed conflict with countries involved in proliferation. There is a hypothetical basis to this strategic logic in some cases, but in the broader long-term context the growing threat of a space arms race and, to an even greater extent, conflicts in space would inevitably trigger vertical and horizontal missile and nuclear proliferation and create an irreversible crisis for the entire nuclear nonproliferation regime.

The only way to prevent such global military-political developments is to begin urgent work on drafting and concluding international agreements for preventing the weaponization of space. The first step should be to have a special UN committee approve the draft Code of Conduct for outer space activities.

This should be followed by the drafting and conclusion of legally binding agreements guaranteeing the peaceful use of space (including use by military support satellites).

Aside from the strategic difficulties (above all the U.S.'s desire to ensure its military superiority in space), there are big problems with defining the subject matter of the treaty, i. e., space weapons, as well as verification measures. This is due to a number of reasons, including the wide range of space activities and space systems, their close links with land-based infrastructure and systems (including weapons), and the strict secrecy surrounding countries' defense and commercial space activities in all cases, except international and purely scientific projects.

The most promising approach, it seems, would be to define space weapons as weapons deployed in space and weapons for destroying space objects (as opposed to 'objects in space') regardless of their basing mode.[36] This definition would cover all space-based missile defense and anti-satellite systems, potential weapons for striking targets on Earth from space, and also anti-satellite systems based on land, at sea or in the air.

At the same time, it would leave outside its scope restrictions and prohibitions concerning offensive ballistic missiles, sub-orbital offensive weapons, and missile defenses based in any medium except space.

As for verification, inspecting the nature of satellites before launch and all the more so once in orbit would be extremely complicated, and the space powers would be unlikely to accept it. Furthermore, such inspections carried out in space could be seen as constituting anti-satellite systems and actions in their own right. The principal method of ensuring compliance with the agreements could therefore be to prohibit or regulate tests of weapons of various kinds launched from spacecraft or launched from any basing system against satellites. This would be much easier to verify, especially if a system of notification and confidence-building measures regarding space launches and tests in space or via space were agreed on.

Notes

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[15] *Novosti kosmonavtiki*, # 1 (216) (2001).

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[19] *Novosti kosmonavtiki,* 13, # 4 (243) (April 2003): 57.

[20] *Space News* 18, # 5 (2007): 16; # 35: 8.

[21] M. V. Tarasenko, *Voyenniye aspekty sovetskoy kosmonavtiki* (Moscow: TOO Nikol, Agentstvo ros. pechati, 1992).

[22] S. V. Cherkas, *Sovremenniye politiko-pravoviye problemy voyenno-kosmicheskoy deyatelnosti i osnovy metodologii ikh issledovaniya* (Moscow: MO RF, 1995).

[23] *Entsiklopediya XXI vek: Oruzhiye i tekhnologii Rossii* (Moscow: Izd. dom "Oruzhiye i tekhnologii," 2002), s.v. "Kosmicheskiye sredstva vooruzheniya."

[24] Based on materials from sites: http://www.spacedaily.com; http://www.spacelauncher.com.

[25] *Aviation Week & Space Technology* (June 11, 2001).

[26] Ibid.

[27] Ibid.

[28] *Zarubezhniye kosmicheskiye kompleksy i sistemy*, # 3, 1992.

[29] Cherkas, *Sovremenniye politiko-pravoviye problemy.*

[30] *Slovar voyennykh terminov* (Moscow: Voyennaya academiya Genshtaba VS RF, 1998).

[31] C. W. Mayens, *Global Focus: U.S. Foreign Policy at the Turn of the Millennium*, ed. M. Honey and T. Barry, PP. 97-98 (New York: 2000).

[32] *Model Code of Conduct for Responsible Space-Faring Nations* (Stimson Center, Space Security Program [S. l.], October, 2007).

[33] See *Krasnaya zvezda: Yezhenedelny vypusk*, March 5-11, 2008; *Nezavisimoye voyennoye obozreniye*, February 29-March 6, 2008.

[34] *Nezavisimoye voyennoye obozreniye,* February 29-March 6, 2008; *Krasnaya zvezda: Yezhenedelny vypusk*, March 5-11, 2008; *Argumenty nedeli*, March 6, 2008.

[35] *Argumenty nedeli*, March 6, 2008.

[36] Unlike space objects, including spacecraft in orbit, which complete at least one full revolution in orbit around the Earth, 'objects in space' is a broader term which includes the former and also any objects taken outside the atmosphere, including the stages and warheads of ballistic missiles.

Conclusion

Alexei Arbatov

The analysis presented in this book concerns the very complex and contradictory set of problems and prospects vis-à-vis global nuclear energy and the development and proliferation of nuclear technology, as well as missiles and missile technology, and the issues of tactical nuclear weapons, scientific and technical progress in precision-guided conventional weapons, missile defense and the military use of outer space.

All of these issues are shaping a new environment for the nuclear weapons nonproliferation regime compared to that which existed when the Nuclear Non-Proliferation Treaty was drafted back in the 1960s. Military-technical developments and increasing political frictions between the great powers over this last decade have left the system of nuclear arms control treaties, built over the second half of the twentieth century, in a state of almost complete collapse. The NPT and the nonproliferation regimes are in the midst of a deep crisis that could allow irresponsible states and extremist organizations to gain access to weapons of mass destruction and their delivery systems.

A number of significant observations, conclusions and recommendations can be made on the basis of these studies.

One. It is commonly believed that because of the economic and environmental problems associated with fossil fuels, the world will not be able to meet its growing energy requirements for at least the next 30-50 years without developing nuclear energy. However, successful efforts to solve this problem by sharply increasing the share of nuclear energy depend on guaranteeing acceptable prices for nuclear energy, improving its safety and raising its environmental impact standards, and preventing the proliferation of nuclear weapons that could arise as a result of the greater accessibility of dual purpose technology and materials.

The predicted 'renaissance' of nuclear energy could end up having the opposite effect to that intended and create dangers to international security through the spread of nuclear weapons, which would be even more serious than the political consequences of insufficient energy to fuel world economic growth. Furthermore, if safety standards in the ever-growing number of countries developing nuclear energy do not meet the most stringent demands, the possible resulting environmental disasters and the social and economic costs could have an even greater impact than the effects of greenhouse gas emissions.

The current nuclear weapons nonproliferation regime and safety levels for nuclear energy are insufficient to guarantee against these risks. Radical measures are needed to strengthen the regime, mechanisms and institutions of the Nuclear Non-Proliferation Treaty in regard to all of its provisions (including Article VI on disarmament), as well as major additional legal, financial and economic, administrative, scientific and technical steps.

Two. The nuclear fuel cycle issue plays a key role in ensuring that the development of nuclear energy in the world does not create the danger of nuclear weapons proliferation. The nuclear fuel cycle issue has come under scrutiny of late because of the ongoing crises over the Iranian and North Korean nuclear programs. However, if the Iranian and North Korean problems were successfully resolved at multilateral negotiations and the fuel cycle issue were then forgotten, in the future more problems and dangers in this area would still be inevitable.

It is possible to prevent the proliferation of critical nuclear technology through the fuel cycle if the parties to the NPT accept the need to renounce building their own fuel cycle enterprises, and if countries that already possess this technology make a long-term transition towards internationalizing fuel cycle services in suitable forms, preferably under the aegis of the IAEA. This would be another 'historic compromise' in the nonproliferation regime, similar to the compromises embodied in Articles IV and VI of the NPT. Along with price incentives, a series of technological incentives for countries renouncing their own fuel cycle activities should be put in place. The transition to international fuel cycle centers under the aegis of the IAEA should go hand-in-hand with the extension of the 1997 Additional Protocol to the entire civilian nuclear infrastructure, not just in the non-nuclear weapons states, but also in the nuclear weapons states. Moreover, if the FMCT is concluded, the Additional Protocol should also be extended to nuclear weapons states' uranium enrichment and spent fuel processing facilities.

Three. The Global Nuclear Energy Partnership is an even broader and more long-term program that includes international fuel cycle centers as one of its integral components and aims at ensuring the military, political and environmental security of expanding nuclear power production, based on new technology and materials. In addition, this program would enable the United States to resolve its nuclear energy problems and make up for the ground it has lost since restrictions were imposed in the U.S. on the nuclear energy industry after the accident at Three Mile Island.

However, the GNEP has been the subject of serious criticism in the U.S., above all for the plan to build a commercial-scale reprocessing facility. Another focal point is the need for more intensive study of new nuclear energy technology, in particular fast neutron reactors, new types of fuel, and plutonium separation techniques. The U.S. Congress has blocked cooperation with Russia (under a 123 Agreement), citing Russia's alleged bolstering of Iran's nuclear program and delivery of conventional weapons to Iran.

A well-planned joint American-Russian research and development program in the nuclear energy field could help both countries make faster progress, especially on fast neutron reactors and the fuel for them, and also on processing spent nuclear fuel. The U.S. could show willingness to work closely with Russia in providing international nuclear fuel cycle and spent fuel processing services (at the center in Angarsk), and this would be a real answer to the countries that are concerned about guarantees for fuel enrichment services. Russia, for its part, could make more detailed information available to the U.S. on its center in Angarsk and nuclear facilities in other parts of the country that could work with the United States.

Four. The proliferation of missiles and missile technology provides the simplest and most effective means for delivering nuclear and non-nuclear weapons, thus contributing to the proliferation of weapons of mass destruction. But missiles themselves, even their conventionally-armed versions, coupled with modern navigation systems, are creating an increasing threat as a potential means of attacking nuclear power plants and other hazardous sites. Missile and nuclear proliferation is discouraging the great powers from taking further steps in nuclear disarmament and encouraging them to withdraw from existing agreements, in spite of their obligations under Article VI of the NPT. This is exacerbating the crisis throughout the nonproliferation regime and destabilizing the strategic balance between the leading powers.

The existing system of restrictions on missile and missile technology proliferation does not create effective barriers to the spread of such weapons, above all in countries with unpredictable regimes, which can acquire them through foreign transactions or build them themselves, using their own technical capabilities.

Urgent steps are needed in this situation to make the missile nonproliferation regime more effective, but it would be better to start by raising the status of the MTCR and the International Code of Conduct separately. In any case, given the difficulties involved in defining the subject of the agreements and the control system to be put in place, it would be necessary to readjust the correlation in the existing agreements between verification systems and confidence-building measures, with the emphasis shifting to the latter. At the same time, it would make sense to begin advance work on the longer-term project of drafting a treaty that would integrate the provisions of the MTCR, the ICOC and the Global Control System as the foundations for a new global and legally binding missile nonproliferation regime, cemented in an international agreement on the nonproliferation of missiles and missile technology along the lines of the NPT. The treaty could have a regularly updated approved list of restricted missile systems and their characteristics as an annex. It should include all of the technical definitions for the subject matter of the treaty, the verification and confidence-building measures, the mechanisms for verifying compliance, detecting violations and imposing sanctions for violations, and the means for dispute resolution.

Five. The increasing counterforce potential of U.S. precision-guided weapons (and probably those of other countries in the future) is a natural consequence of the development of attack and information systems and technology, which cannot realistically be stopped or significantly restricted, particularly given the wide variety of their possible uses. These weapons were originally developed to make operations against the enemy at the regional and local level more effective and to fight the proliferation of WMD and international terrorism, but they have started to have a destabilizing effect on military and political relations between Russia, the U.S., and the other great powers. They are beginning to undermine prospects for cooperation between countries in combating common security threats. This was inevitable in a situation where relations between the great powers remain locked in mutual nuclear deterrence mode and where new arms systems are developed (and used locally) on a unilateral or bloc basis.

At the same time, with the necessary political will, the problems arising from precision-guided weapons can be reduced through various possible agreements. In particular, in the new U.S.-Russia strategic reductions treaty that is to replace START-1 after 2009 and SORT after 2012, it would be worthwhile preserving the principle of counting warheads on strategic delivery systems regardless of whether they are nuclear or conventional, which would facilitate the verification process. Other measures are also possible, such as restricting submarine patrol zones and not deploying aircraft carrying precision-guided weapons in the new NATO member countries.

The large-scale deployment of precision-guided weapons creates a powerful incentive for threshold states to speed up their efforts to acquire nuclear weapons as an asymmetrical means of defense. Reducing this incentive is possible only by restricting the deployment and use of precision-guided weapons on a unilateral or bloc basis in order to avoid destabilizing military and political relations between the great powers and to bolster their cooperation on the whole range of nonproliferation issues.

Six. Cutbacks to strategic nuclear forces, along with NATO's eastward expansion and U.S. plans to build a missile defense system in Europe despite Russia's objections, have all contributed to the increasing role of tactical nuclear weapons in the military balance. At the same time, tactical nuclear weapons are also becoming more important for the great powers as a means of responding to the proliferation of missiles and nuclear weapons in the world.

Russia and the U.S. now tie further strategic reductions to making nuclear disarmament multilateral. This puts the issue of limiting tactical nuclear weapons on the agenda, as they form the bulk, if not the entirety, of the other nuclear powers' nuclear arsenals (with the exception of Great Britain). Meanwhile, Russia and the U.S. have no formal agreements on these weapons, except for the INF Treaty and parallel unilateral commitments dating from the early 1990s, which have given rise to a good number of reciprocal questions and complaints.

One possible way to start untangling the knot of problems in this area would be for Russia and NATO to make the mutual pledge not to deploy tactical nuclear weapons in Central and Eastern Europe. This zone would include the territory of the countries that have joined NATO since 1997, as well as Belarus, the other former Soviet republics in Europe, and Russia's Kaliningrad Region. It would be easier to verify the complete absence of tactical nuclear weapons in this zone than quantitative restrictions.

The direct reduction or limitation of tactical nuclear weapons implies measures for verifying the elimination of nuclear munitions. Because almost all delivery systems for these weapons are dual purpose in nature, the approach used in U.S.-Soviet strategic nuclear arms control agreements, which restricted an agreed list of delivery systems rather than the actual warheads, would not be suitable. In the history of arms control there has been no experience of verifying the elimination of nuclear warheads.

However, if political relations between Russia and NATO improve and progress is made in reducing and restricting conventional forces and conventional arms in Europe, it could be possible to reach an agreement under which Russia and the U.S. would withdraw all tactical nuclear weapons to their national territory and store them exclusively at centralized storage depots outside areas where their armed forces are stationed. This would greatly reduce tactical nuclear weapons' operational readiness level and reinforce their protection (although it would not necessarily lead to their elimination). This kind of reduction could be verified in the same way as the aforementioned prohibition on deploying tactical nuclear weapons in Central and Eastern Europe.

Physical reductions of tactical nuclear weapons through elimination would be pointless and unverifiable without the FMCT and establishment of control measures for existing stocks of weapons-grade nuclear materials and nuclear munitions in storage. In this respect, the elimination of tactical nuclear weapons would be no different technically than eliminating the warheads of strategic nuclear forces being reduced through cutbacks. The elimination of strategic and tactical nuclear warheads would be part of a more radical stage of nuclear disarmament farther in the future.

Seven. After the end of the cold war, the relation between strategic and non-strategic missile defense systems and the proliferation of nuclear weapons and their delivery systems underwent a considerable transformation. Unilateral or bloc-based missile defense programs will encourage countries to enhance or increase their offensive forces, possibly motivate Russia to withdraw from the INF Treaty, and encourage China, India and Pakistan to increase their nuclear and missile capabilities. This would lead to an even deeper crisis in the nuclear nonproliferation regime or even its complete collapse, and it would increase incentives for threshold states to acquire nuclear weapons.

At the same time, if the U.S., Russia, NATO and other nuclear and non-nuclear countries were to work together on developing and deploying strategic and non-strategic missile defense systems, this would mark a completely new stage in the global strategic partnership. The road to this partnership requires first overcoming the serious differences between Moscow and Washington in this area, starting with a compromise on missile defense in Europe. This would entail a joint evaluation of threats, mutual use of a number of missile defense components, and reliable and legally binding guarantees for Russia that the missile defense system would not be used against it.

Paradoxically the last missile defense crisis and its resolution have brought about a unique opportunity for developing strategic cooperation that would radically transform the mutual nuclear deterrence relationship that still exists between the U.S. and Russia and would reverse vertical nuclear proliferation. Only under these conditions would it be possible to reach a consolidated position among the great powers on effective action against the policies of threshold states, guaranteeing strict compliance with all of the nuclear nonproliferation regime's provisions, ensuring compliance with UN Security Council resolutions restricting nuclear and missile programs, and convincing countries to renounce the development of the full nuclear fuel cycle.

Eight. The argument used in support of Russia's withdrawal from the INF Treaty is that it needs to develop intermediate-range and battlefield and tactical missiles (including conventionally-armed missiles) as a counterweight to the U.S. missile defense system in Europe and to other countries' missile forces. However, these arguments are extremely dubious, and in any case Russia has other means for achieving these objectives. Russia's withdrawal from the INF Treaty would be fraught with a number of negative consequences for its own security and for international stability.

In particular, if Russia does deploy new intermediate-range missiles, NATO would most likely take measures in return, including adding new missile defense bases and deploying the U.S. Pershing-2 system and ground-based cruise missiles or enhanced intermediate-range systems on the territory of new NATO member countries much closer to Russia's heartland, with all the strategic, political and economic consequences this would entail for Russia.

Furthermore, if Russia were to withdraw from the INF Treaty, fingers would inevitably stop pointing at the U.S. as the one to blame for the collapse of the nuclear disarmament system and would point at Russia instead. This would undermine the NPT even further, as it would be seen as a direct violation of the nuclear-weapons states' obligation to engage in nuclear disarmament in compliance with Article VI of the treaty.

Nine. The near future could well usher in a completely new stage in the militarization of outer space through the deployment of weapons in space to destroy satellites and intercept ballistic missiles (and eventually, perhaps, also launch strikes against targets on Earth), and this threatens to destabilize the military and political situation on a global scale. Of greatest concern is the emergence of new technology, making it possible to create and put into orbit a large number of small, relatively cheap military satellites equipped with precision-guided impact systems, along with others.

The U.S. has indisputable economic and technical superiority in space at the moment, but if a space arms race were to begin, other countries would inevitably get involved, above all China, Russia, India, Iran, Brazil, Japan, Pakistan and others. In this situation, the U.S., despite its superiority in space, is also the country most dependent on the security of satellite support systems for its military and civilian activities and would therefore have the most to lose. Furthermore, since there are no national borders or natural shelters in space, if it were to become filled with weapons there would be a significant danger of accidents, incidents, false alarms, command system malfunctions, etc.

In the long run, the growing threat of a space arms race and particularly the prospect of a conflict in space would inevitably lead to vertical and horizontal nuclear and missile proliferation and create an irreversible crisis for the entire nuclear nonproliferation regime.

Urgent work needs to begin on drafting international agreements to prevent the weaponization of space. The first step could be for a special UN committee to approve the Model Code of Conduct for Responsible Space-Faring Nations. Subsequently, legally binding agreements guaranteeing the exclusively peaceful use of space (including military support) would be required. Given the difficulties of applying control measures to satellites before launch and in orbit, the focus should be on prohibiting or regulating tests of weapons used from space objects and against space objects.

Ten. In order to implement the proposed measures, which are important both for strengthening the nonproliferation regime in the world, and also in their own right, as steps to bolster strategic military stability, two main conditions need to be fulfilled.

First, the political leaders of the great powers need to make nuclear nonproliferation and related issues part of their national security strategy priorities, not just in word, but in deed. Cooperation in these areas should supersede other interests and ideas (such as the expansion of NATO and the EU, spreading democracy and defending the rights of national minorities, military consolidation, rivalry in nuclear technology and conventional arms markets, competition for the supply and transit of energy resources, etc.) The experience of the last 20 years shows that the end of the cold war did not guarantee that a new kind of partnership would emerge in its place, or that the political and military-technical issues in relations between the powers would fade away by themselves. The only way to achieve this is through an interlinked series of bilateral and multilateral agreements among countries, which will serve as a foundation for their consolidated position in the international organizations that have an influence on security (the UN Security Council, the IAEA, the Nuclear Suppliers' Group, the Organization for Security and Cooperation in Europe, NATO, the Russia-NATO Council, the Collective Security Treaty Organization, the Shanghai Cooperation Organization and others).

Second, untangling the complex knot of problems examined above will be possible only on the basis of objective and professional analysis by expert communities of major countries, giving the authorities intellectual encouragement and weakening the pressure of bureaucratic and defense industry interests. Given the complicated links between the various issues, taking measures in the right order is just as important as the actual substance of the measures.

In the most general terms, this order would be as follows. Signing a new bilateral U.S.-Russian strategic reductions treaty based on the solutions proposed above is of primary importance. At the same time, if the CTBT came into force and the deadlock in negotiations on the FMCT was broken, this would give a big boost to vertical and horizontal multilateral nuclear disarmament. In addition, official international recognition should be given to the Code of Conduct in space.

The next stage should focus on further measures regarding offensive and defensive strategic arms (lowering the launch readiness levels of American and Russian ICBMs and SLBMs and developing joint MAWS and missile defense systems), and agreements on tactical nuclear weapons, along with the preservation of the INF Treaty. Restrictions should also be extended to cover precision-guided weapons able to perform strategic tasks. These agreements require a positive military and political climate in the form of a moratorium on the further eastward expansion of NATO, a new treaty on major cutbacks to conventional forces and weapons in Europe, and the establishment, with the NATO-Russia Council's help, of a joint rapid reaction force for peacekeeping tasks.

Multilateral efforts should focus on extending transparency measures and restrictions to the nuclear forces and also to the missiles and missile programs of other countries. Efforts are also needed to make the MTCR and International Code of Conduct legally binding, to take major steps to internationalize the nuclear fuel cycle and develop the GNEP, to finalize the FMCT, to make the 1997 Additional Protocol and IAEA integrated safeguards universal and extend them to the nuclear powers, and to toughen export control measures and conditions.

Steps that should be taken at later stages include an agreement on preventing an arms race in space, the enhancement of joint MAWS and missile defense systems (including space-based systems), and the creation of a collective force to counter proliferation and international terrorism (based on the Proliferation Security Initiative) under the aegis of the UN Security Council and regional security organizations within the framework of relevant new international legal provisions.

Appendix*. The Missile Defense Plan in Central Europe[1]

Vladimir Pyryev

The multi-layered space-, land-, air- and sea-based missile defense system consists of means to detect enemy missile launches, track, target, and finally kinetically destroy the missiles and their re-entry vehicles. Command and coordination is carried out using the information and intelligence communications channels (C2BMC) set up within the U.S. Armed Forces' Strategic, Pacific Ocean and Northern Commands. The U.S. missile defense is an open system; new components can be added to it, it can be modernized and expanded, and its capabilities can be developed as far as technological and financial limits allow.

In early 2008, the system consisted of the following installations:

- 24 OBV-class land-based GBI interceptor missiles (21 at Fort Greely in Alaska and 3 at Vandenberg Air Force Base in California);
- 3 stationary early warning radars at Shemya Air Force Base (Alaska), Beale Air Force Base (California) and Fylingdales Air Base (Britain);
- A sea-based SBX mobile radar in the Pacific Ocean near Adak Island (Alaska);
- A GBR-P radar on Kwajalein Atoll (Marshall Islands);
- 2 advance-based AN/TPY-2 (earlier designated FBX-T) mobile radars at Shariki Air Base (Honshu Island, Japan) and the Juneau Test Range (Alaska);
- 17 cruisers and destroyers with Aegis missile defense systems able to detect and track short and intermediate-range missiles (10 of them are equipped with an overall total of 21 SM-3 anti-missile missiles);
- Patriot missile defense systems with 546 PAC-3 missiles.[2]

By 2013, plans call for the missile defense system to include:

- 54 land-based interceptor missiles (44 in the U.S. and 10 in Europe);

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* This appendix was completed before the cancellation of the BMD Europe plans in 2009.

- 5 early warning radars, together covering the entire northern hemisphere (located in Alaska, California, Greenland, Britain and Central Europe);
- 4 THAAD systems, equipped with a total of 96 interceptors;
- Up to 100 SM-2 sea-based interceptors;
- 132 SM-3 interceptors;
- 1 SBX sea-based radar in the Pacific Ocean;
- 4 AN/TPY-2 advance-based radars;
- 18 ships equipped with the Aegis system;
- Patriot systems.[3]

Development work and tests are currently underway for the ABL, the THAAD system, the KEI universal interceptors, the multiple kill vehicle (MKV) with independently targeted kinetic warheads, the STSS satellite system,[4] and the SM-3 Bloc II interceptor (a joint project with Japan).

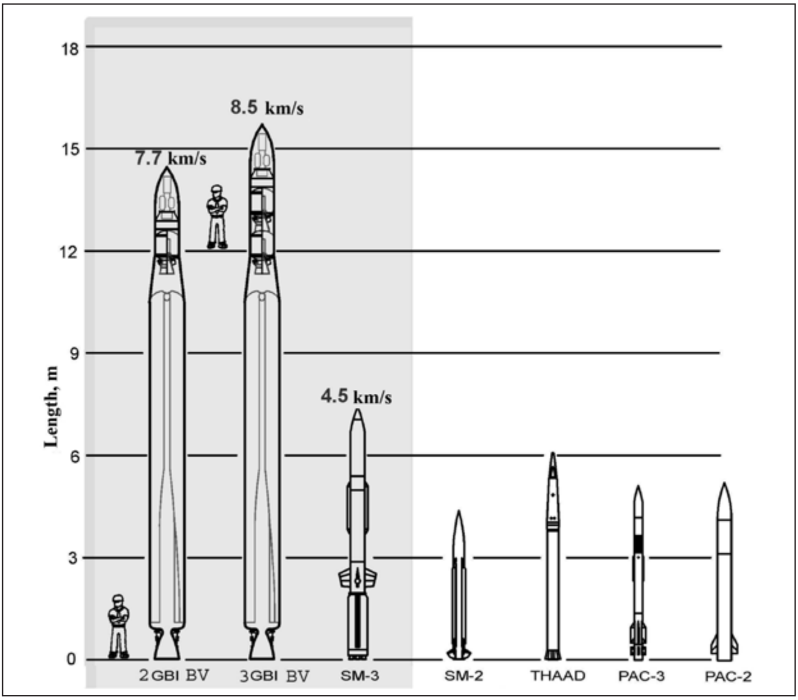

Figure A1. The U.S. missile defense system interceptors

Table A1

Characteristics of OBV interceptor stages one-three

Name	Weight, kg	Weight w/o fuel, kg	Weight fuel, kg	Fuel	Vacuum thrust, kN	Specific impulse, NS/kg	Total thrust, MNs	Burn time, s	Diameter, m	Length, m
Orion-38	878	108	770	HTPB	34,31	2811	2,182	67,8	0,97	1,34
Orion-50XL	4 339	416	3923	HTPB	160,10	2840	11,176	69,8	1,27	3,11
Orion-50SXLG	16 418	1 386	15032	HTPB	721,00	2871	43,325	68,3	1,27	10,27

Sources: "Pegasus user's guide," http://www.orbital.com/NewsInfo/Publications/peg-user-guide.pdf.

The OBV-class GBI missile interceptors deployed on U.S. territory are three-stage solid-fuel missiles able to reach a speed of more than 8 km/s, with a weight of 22.7 tons and a length of 17.2 m.

The EKV kill vehicle (weighing 50-60 kg) has its own directional control engines and guidance system. Its current version features an infrared independently-targeted warhead. Targets are acquired at distances of 600-800 km, i.e., 40-60 seconds before direct impact. There are plans to incorporate three types of detectors to monitor the infrared, visible light, and ultraviolet frequencies, thus considerably increasing the unit's targeting ability, in spite of the presence of decoys.

The effective striking distance of 4,000-5,000 km can be achieved only with maximum information support, ensured through deployment of a space information echelon with satellites in low orbits to identify and track targets and provide target guidance information. If the space information echelon is absent and only ground-based information systems are used, the GBI can be used at a range of 2,000-2,500 km.

The maximum efficiency of strategic missile defenses with GBI interceptors and other systems is ensured by an information system that encompasses current space-, land- and sea-based missile defense information installations. However, in the future they will also rely upon a space-based missile launch detection system using six satellites placed into stationary and high-elliptical orbits. A key component of this system will be the space-based STSS system made up of 24-30 satellites in low orbits.

The European component of the U.S. missile defense system already includes UHF-band radar stations in Britain and Greenland. Future plans include the deployment of ground-based strike forces and stationary and mobile X-band radars. The mission of the interceptors located in Europe would be to destroy the warheads of missiles launched from the Middle East at the mid-course phase of their trajectory.

Currently there are plans to deploy 10 2-stage silo-based GBI interceptors in Poland near the Baltic coast. The explanation for this is that if Iran launches a strike against Southern Europe, three-stage interceptors (like those deployed in the U.S.) would not have time, if launched from Poland, to intercept intermediate-range missiles. Instead of a third stage, the plan is to equip the missiles with multiple reentry vehicles. The two-stage interceptor with an operational range of 1,000-5,000 km needs to be able to intercept ICBMs and intermediate-range missiles.[5] Three possible locations are under consideration: Zegrze, near the town of Koszalin; Debrzno, near Czluchow; and a site not far from Slupsk. The site, with an area of around 243 hectares, will be staffed by up to 200 people, not including security guards.

The second new site is the EMR radar, planned for deployment in the Czech Republic. Its mission will be to detect and track multiple targets (over 100), guide interceptors and evaluate firing results. These objectives will be achieved by a modular GBR-P pulse radar operating in the 3-centimeter band (X-band 8-12 GHz) with a rotating complex polygonal active phased transmit/receive antenna array 12 m in diameter. The signal from this radar is resolved into a very narrow 0.14° wide beam electronically spread over a sector of 50 x 50°. Thus, in operating mode, the radar would probably be angled approximately 2° above the horizon. Up to 90% of its components will remain the same as those used in the active phased array of the mobile AN/TPY-2 radar and the THAAD missile defense system. The radar has a high resolution of 15 cm and can distinguish fine detail at a great distance. Its maximum detection distance is 6,700 km. The radar will be removed from its current site in the Marshall Islands and modernized.

The location chosen for the radar is the Brdy Test Range in the western part of the Czech Republic, around 70 km southwest of Prague (2 km from the settlement of Mishov). The station will have up to 200 personnel running it, including 120 American servicemen. Construction will be completed in 2011-2012.

The EMR radar's mission includes accurately directing the interceptors to their self-targeting zone and identifying decoys. However, the radar has low search capacity and needs to rely on target information received from early warning radars in Britain and Greenland. Information will also come from the space-based echelon: first from the high-orbit missile attack warning satellites (on the launch time and type of missile), and then from the low orbit missile defense satellites (on the number of warheads on the missiles).

The third component is the mobile AN/TPY-2 radar with a forward-based phased antenna array in Southern Europe intended to detect, target and track missiles launched from Iran.

The stated purpose of establishing a third land-based missile defense site in Europe (the first two are in California and Alaska) is to protect the territory of the U.S. and European Union from an Iranian missile threat. Efforts have been made to stress that this site is not directed against Russia's nuclear forces, and that the interceptors would not be able to destroy Russian ICBMs.[6]

However, Theodore Postol from the Massachusetts Institute of Technology, a former adviser to the Commander-in-Chief of Naval Operations, and George Lewis from Cornell University studied the combat characteristics of the interceptors planned for deployment in Poland and concluded that they do constitute a threat to Russia. At a speed of more than 5 km/s, an interceptor would be able to destroy the warhead of a missile launched from European Russia to the northwest,[7] which contradicts the official statements made by Henry Obering, Director of the U.S. Missile Defense Agency.[8]

Their conclusions have been supported by other scientists who previously held senior posts in the American administration, Richard Garwin and Philip Coyle, and also by David Wright from the NGO The Union of Concerned Scientists. In Garwin's opinion, the effectiveness of at least one of the missile engines is higher than the estimate given by Postol.

In the models that the Missile Defense Agency has presented to demonstrate that its proposed system is not directed against Russia, the horizontal component of the American interceptor missiles' speed has been lowered by 30% (5.4 instead of 7.7-8.3 km/s), while the same figure for the Russian missile has been raised by 15% (5.8 instead of 5.1 km/s).

This is not realistic, because the ICBM and the interceptor belong to approximately the same class, but there is a 15-fold difference in the weight of their payloads: the ICBM's payload is 1,100 kg, while the interceptor's is 70 kg. Therefore, the interceptor's speed should be 40% higher.[9]

There is also a contradiction in the Agency's statement that the missile defense site in Europe could also protect Hokkaido Island from missiles launched from Iran. Calculations show that this would be possible only if the interceptor had a speed of 9-9.5 km/s. Therefore, the interceptors based in Poland could not have the speed cited by the Agency (5-6 km/s).

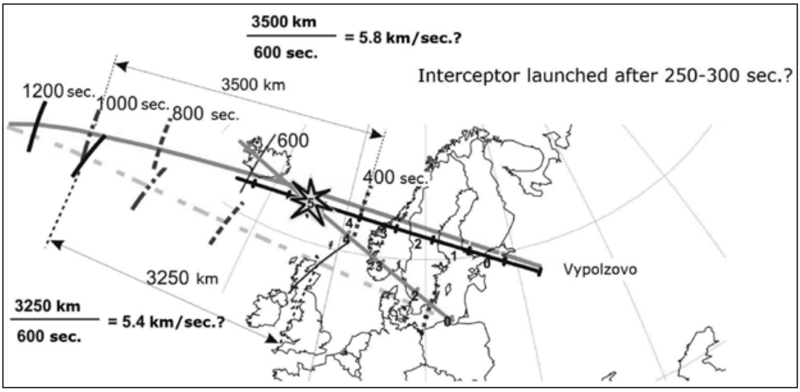

Figure A2. Diagram showing the mistakes in the Missile Defense Agency's slide allegedly demonstrating the inability of interceptors based in Poland to destroy missiles launched from Vypolzovo.

Postol's calculations were based on the launch of an SS-25 missile from Vypolzovo (Yaroslavl Oblast), detected by satellites 50 seconds later. In this time, the missile would have traveled 30 km from its launch site and would have reached an altitude of 25-30 km. The missile would be picked up by the radar station in the Czech Republic 200 seconds into its flight at a distance of 560 km and a height of 315 km. The interceptor would be launched 200 seconds after the threat arose (250-300 seconds according to the Agency's data). In Postol's calculations, the interceptor would overtake the missile warhead in pursuit near Iceland during the 500th second of the missile's flight at a 25° angle and a distance of 2,400 km. For the interceptor, the impact would take place 300 seconds into its flight at a distance of 1,800 km and altitude of 660 km.

What is troublesome is that the position of the radar in the Czech Republic is symmetrical with that of another U.S. X-band radar, the Globe-2 in Norway (Vardo), with regard to the trajectories of missiles launched from Vypolzovo, Tatishchevo, Kozelsk and Teykovo in the direction of the U. S. East Coast. This radar, as well as the stations on the special U.S. Navy missile range instrumentation ship Invincible and the vessel Observation Island, is not officially part of the missile defense system and is used to monitor space, provide early warning of a nuclear missile launch, and monitor the activities of Russian missile launch sites and ballistic missile launches. The Globe-2 radar's X-band has greater power and a better target searching capability. If needed, it is capable of directing the radar in the Czech Republic to the required area and increasing its accuracy in determining the parameters of missiles' and complex ballistic targets' movement through the use of multi-positioning location algorithms. It has a resolution of up to 5 cm.

Geometric calculations taking into account the Earth's curve show that the radar in the Czech Republic can track a missile launched from Vypolzovo as soon as 120 seconds after the missile's launch at an altitude of 150-170 km, that is, when the third stage begins operation. True, this is possible only with target information from the space echelon or the radar in Norway. The UHF-band active phased array radar in Britain (Fylingdales) also starts tracking the ICBM at the end of the active portion of its trajectory (170 seconds into the flight, at a distance of 380 km and an altitude of 230 km).

The Fylingdales radar operates on a wavelength of 70 cm (UHF-band) and can detect targets at a distance of up to 5,500 km. Modernization under the UEWR program has made the radar more accurate in determining the parameters (coordinates, speed, direction) of warheads in flight. In addition to carrying out search functions, it can now also be used for tracking and guiding interceptors with a good degree of accuracy, but it cannot perform the task of distinguishing warheads from decoys. This is why the early warning radar operating in the meter-band (UHF and VHF-band) will be used mainly to detect targets, and the radar operating in the centimeter band (X-band) will be used for their identification.

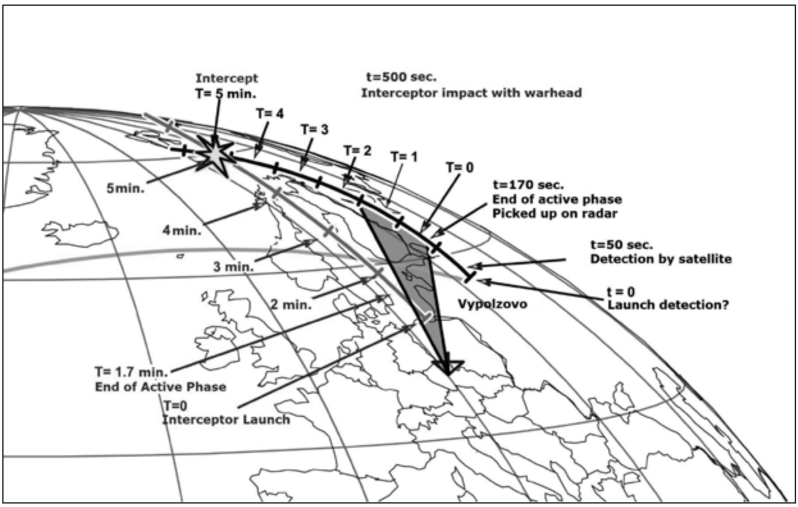

Figure A3. Diagram of the interception of a missile launched from Vypolzovo by interceptors launched from Poland

The diagrams show the active phases of the trajectories of two- and three-stage BV interceptor missiles and those of Russian SS-25 and SS 18/19 missiles.

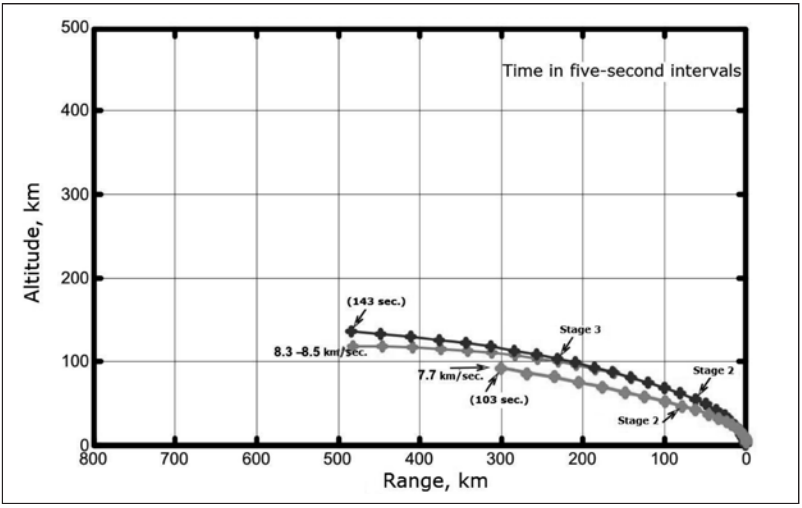

Figure A4. The active phase of BV-class GBI interceptors

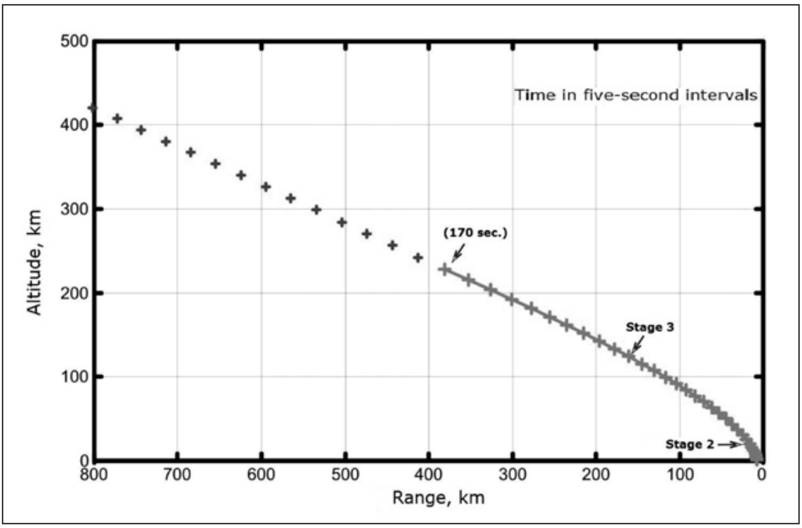

Figure A5. The active phase of the trajectory of an SS-25 missile

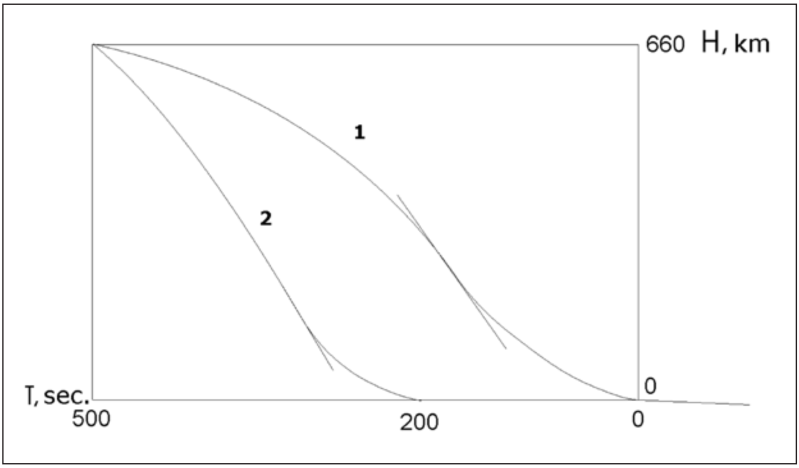

Figure A6. Correlation between elevation altitude of a missile (curve 1) and an interceptor (curve 2) against flight time of an SS-25 launched from Vypolzovo

Table A2

Trajectory control points (time in seconds/distance in km/altitude in km) for various portions of the intercept of an SS-25 missile launched from Vypolzovo

Control point	Agency	Theodore Postol	Geometric calculations
Launch registered		50/30/(25-30)	
Picked up by radars in the Czech Republic and Norway		170/380/230	120/(150-170)/120
Picked up by radar in Britain			170/380/230
Interceptor launched	250-300	200/560/350	
Missile intercepted	—	500/2400/660	

Postol made similar calculations for the interception of an SS-18/19 missile launched from Tatishchevo (Saratov Oblast) and Dombarovsky (Orenburg Oblast). This missile's first stage fires for 155 seconds, and its second stage operates for 185 seconds (including entry into orbit). During the 340 seconds of the active phase of the missile's trajectory, it covers a distance of 660 km and reaches an altitude of 390 km.

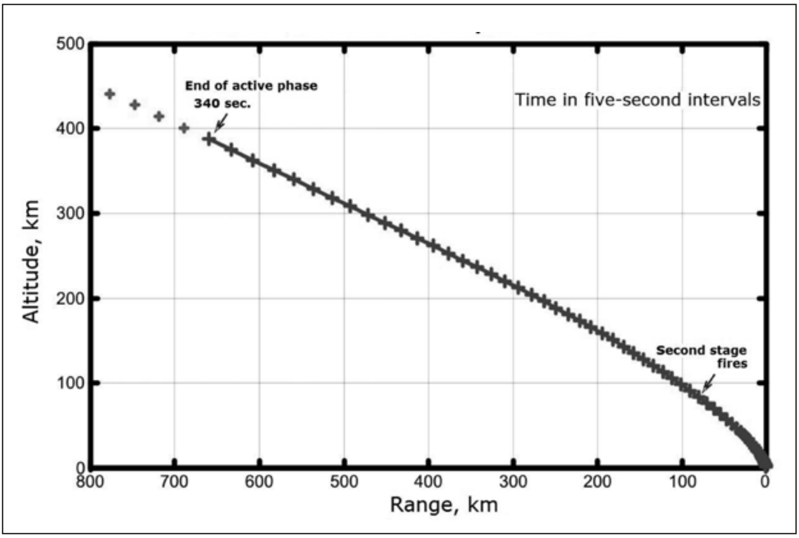

Figure A7. The active phase of the trajectory of an SS-18/19 missile

The missile is detected 50 seconds after its launch from Tatishchevo and is detected on radar 320 seconds into its flight at a distance of 560 km and an altitude of 340 km. According to one of the versions of the calculations, the interceptor is launched 350 seconds after the perception of the threat. It then intercepts and destroys the warhead in pursuit, south of the Aland Islands in the Baltic Sea, 540 seconds into the missile's flight at an inclination of 48° and a distance of 1,850 km. For the interceptor, the impact occurs after 290 seconds at a distance of 630 km and an altitude of 760 km.

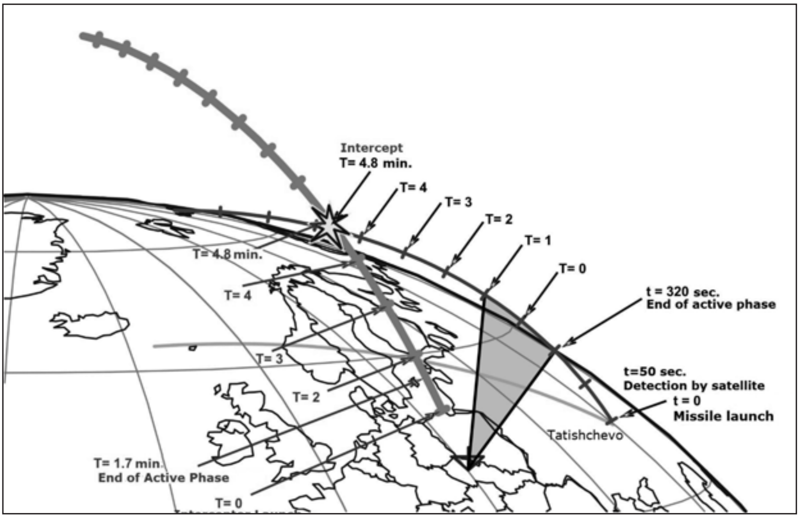

Figure A8. Diagram of the interception of a missile launched from Tatishchevo by interceptors launched from Poland

Another set of calculations has the interceptor being launched seven minutes after the launch of a missile from the Orenburg Oblast. The threat is eliminated 14 minutes after its onset.

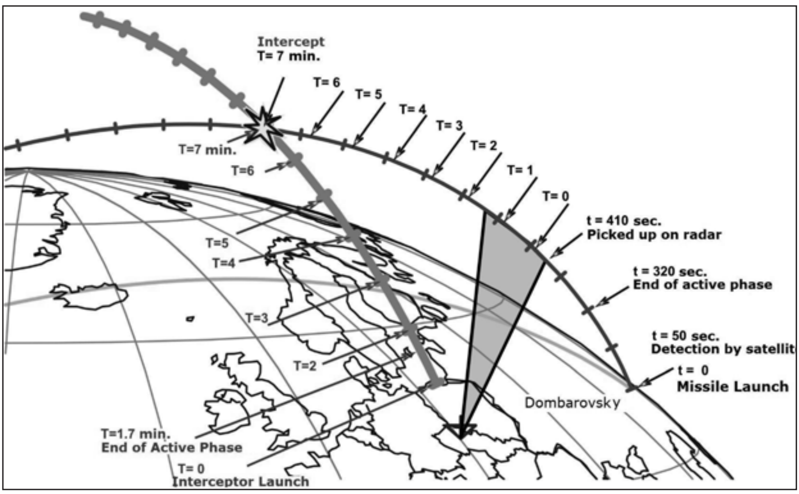

Figure A9. Diagram of the interception of a missile launched from the Orenburg Oblast by interceptors launched from Poland

There are several possibilities for destroying warheads in mid-course. For missiles launched from Dombarovsky, the intercept trajectory could be either a pursuit or a head-on trajectory. The same would apply to missiles launched from Iran.

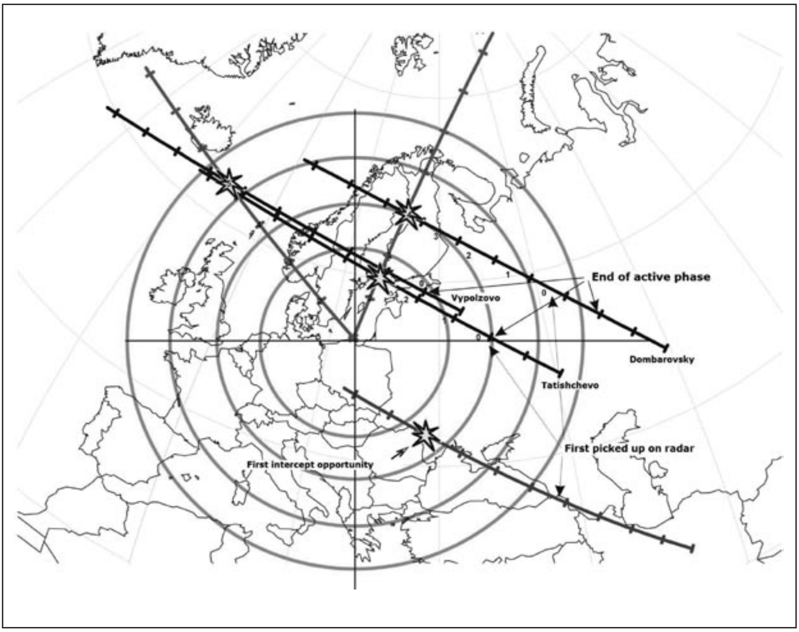

Figure A10. Diagram showing the interception of Russian ICBMs and missiles from Iran by interceptors launched from Poland

These calculations were based on information provided by the Missile Defense Agency, the technical specifications of the rocket engines and launch vehicles, and data on the active payloads they can deliver to various orbits.

Table A3

Characteristics of stages 1-3 of the BV interceptor

Name	Weight, kg	Weight w/o fuel, kg	Fuel	Thrust Vac (kN)	ISP (sec)	Tot. Imp. (MNs)	Burn time, s	Diameter, m	Length, m
Orbus-1S	476	53.2	HTPB	30.38	293.3	1.19	39	0.69	1.26
Orbus-1S	476	53.2	HTPB	30.38	293.3	1.19	39	0.69	1.26
GEM-40VN	13 064	1361.0	Solid	499.20	274.0	No data	63	1.00	13.00

Sources: "Rocket Engines USA," http://space.skyrocket.de/index_frame.htm; http://www.skyrocket.de/space/doc_eng/orbus-1.htm; "Boeing Ground-Based Interceptor (GBI)," http://www.designation-systems.net/dusrm/app4/gbi.html.

According to the Agency, these calculations are too optimistic and do not sufficiently account for the time needed to detect the target, track it and launch interceptors in pursuit. Furthermore, flight test data, the interceptors' fuel efficiency, the interceptors' mass, their inability to follow lower trajectories, and the characteristics of the Russian ICBMs are not considered.

Russia's view is that the potential threat from Iran does not justify deploying the planned missile defense components in Europe. Deployment of the EMR radar in the Czech Republic and the GBI interceptors in Poland would enable the American missile defense system to gather intelligence on Russia's strategic nuclear forces and in the future possibly intercept its ICBMs.

The Czech radar would be able to keep Russian airspace under surveillance starting at altitudes of 110-320 km from Russia's western borders as far as the Urals. The radar would make it possible to detect and track hundreds of missiles 60-75 seconds after launch from bases in European Russia to the northwest and to build mathematical models of their movements and trajectories. The Russian ICBMs would be picked up on radar during their warhead separation and decoys' dispersal, thus making it possible to determine their trajectory at the deployment stage and perhaps provide very valuable target information to in-depth U.S. missile defenses.

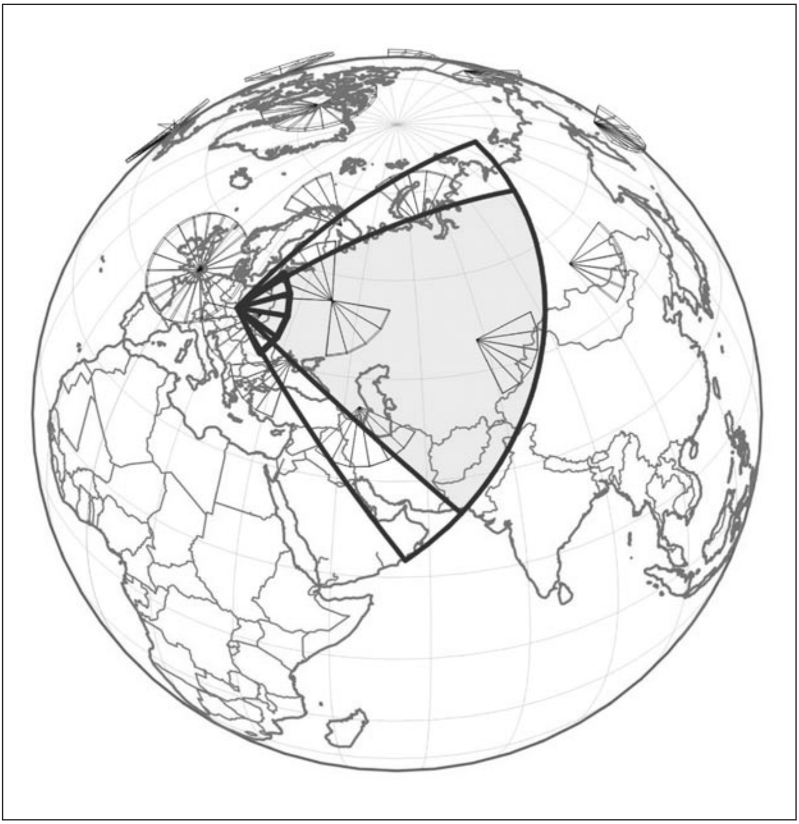

Figure A11. Zone covered by the identification and tracking EMR radar in the Czech Republic

There are other deployment options that would easily meet U.S. requirements for a system designed to protect against a potential threat from Iran. It would be more cost-efficient to have the initial target information for the X-band radar come from ground-based meter or decimeter (UHF) radars rather than from a space-based echelon. This function could be performed by the existing radar stations along Russia's southern borders that are part of its missile attack warning system (MAWS), tracking missile launches in southern Eurasia. These stations could provide the initial X-band identification, tracking and target information.

Figure A12. Zone covered by the Russian early warning radar in Gabala (Azerbaijan)

Moscow made a proposal to the U.S. regarding alternative missile defense deployment plans in Europe that would allay Russia's security concerns. In particular, it proposed providing information from the decimeter and meter-band MAWS radar stations in Armavir (the Voronezh-M radar station) and Gabala (Azerbaijan) for the mobile X-band AN/TRY-2 radars. According to media reports, the Voronezh-M radar could also be used for guidance in combat situations.[10]

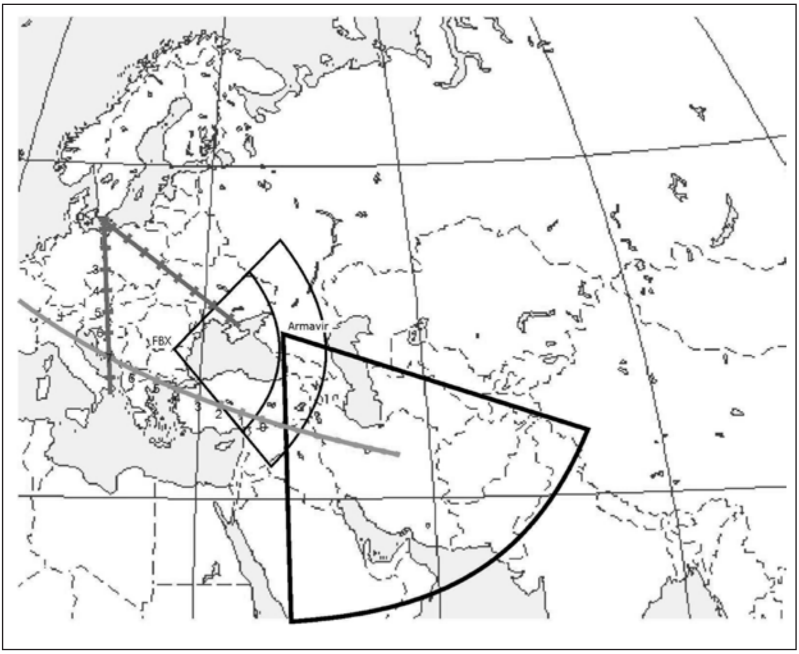

Figure A13. Diagram of the interception of missiles from Iran using information from the Russian early warning radar in Armavir, identification data from the AN/TPY-2 radar in Romania, and Aegis interceptors launched from the Baltic Sea

The sea-based Aegis system's interceptors are capable of kinetically intercepting the warheads of missiles launched from Iran and can provide the necessary protection for Europe. Figures 13-15 show the various options for intercepting missiles using the Aegis interceptors deployed in the Baltic and Mediterranean Seas.

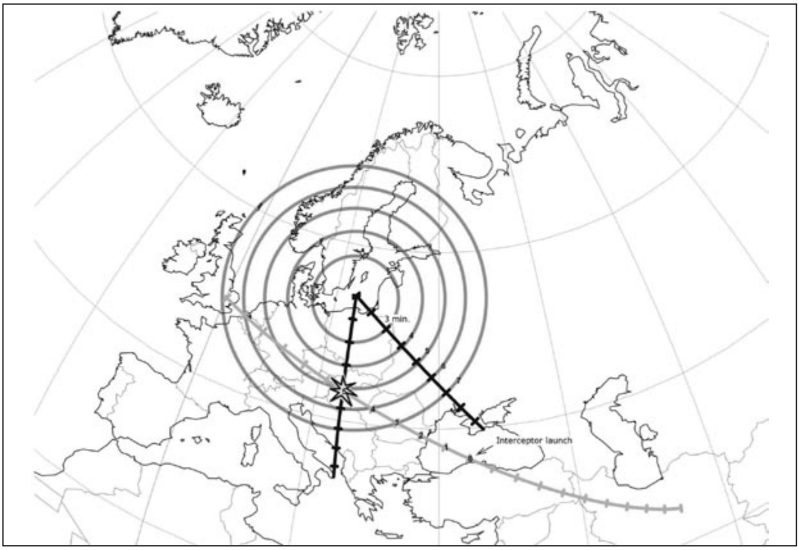

Figure A14. Diagram of the interception of a missile launched from Iran by an Aegis interceptor from the Baltic Sea

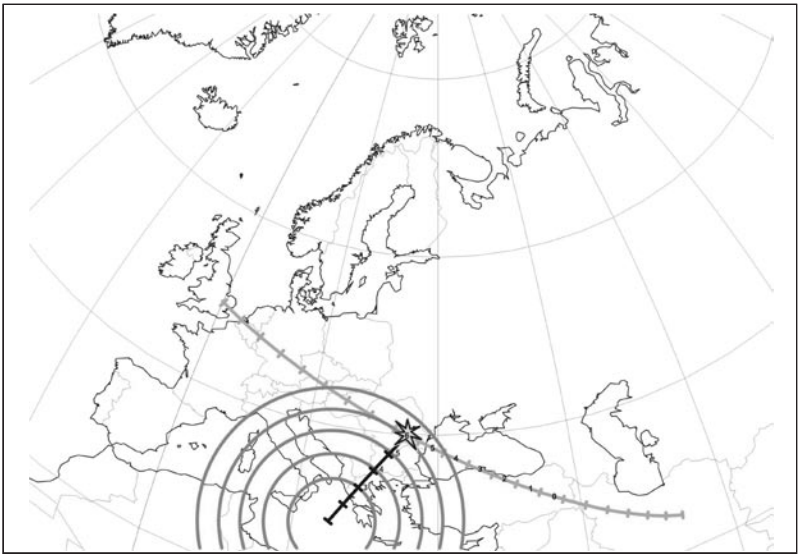

Figure A15. Diagram of the interception of a missile launched from Iran by an Aegis interceptor from the Mediterranean

Director of the Missile Defense Agency Obering's response to this was that the costs involved in protecting Europe from sea would be five times higher than the plan the Agency proposed. Additionally, only about half of Europe's territory would be protected against strikes from Iran. However, experts say that once the development of an enhanced SM-3 interceptor or the new KEI universal interceptor is complete, the costs would be comparable.[11]

At the same time, problems remain to be resolved with the Aegis kinetic kill vehicle's maneuverability and ability to target the warheads of intermediate-range missiles. The advantages of the two- or three-stage GBI interceptor and EKV kinetic kill vehicle are still unclear. In terms of effectiveness, the Aegis and GBI interceptors are practically equal. In Postol's opinion, it would therefore make more sense for the political leadership to leave the issue of whether to base the interceptors on land or at sea open for now. This view was reflected in the Congressional decision on conditions for financing the construction of a third missile defense zone in Europe in 2008. Congress concluded that an independent expert assessment of the economic feasibility of different types of missile defense configurations in Europe must be conducted.[12]

Target detection could also be performed by a few forward-based AN/TPY-2 radars placed between Iran and Europe. The AN/TPY-2 radar has an aperture area of 9.2 square meters and 25,344 X-band (8-12.5 GHz) transmit/receive modules installed. This radar's high carrier frequency (5.5 GHz) permits it to produce a narrow beam while keeping its antenna and components small. The AN/TPY-2 radar transmitter has high radiant power, and the phased array permits a high beam scanning speed and the ability to change signal type. As a result, this mobile solid-body radar has a ballistic missile detection and fire control range of up to 1,000 km. For distances of over 1,000 km, the modernized (UEWR) U.S. MAWS radar or the Russian Voronezh radar, which operate in the meter band, are more suitable for detecting and tracking ballistic missile warheads. As an alternative to the stationary radar in the Czech Republic, Russia's third-generation Voronezh missile attack warning radars operating in the VHF band could be used for U.S. missile defense. These radar installations can detect warheads at distances up to 1,000 km, but at the same time they can see the final stages of the missiles. This makes it possible for them to increase their detection range somewhat, and therefore, they could use this information to detect and track warheads.

A similar in-depth missile defense structure has already been implemented in Japan under the threat of ballistic missile attack from North Korea. In keeping with an agreement concluded between Washington and

Tokyo, an AN/TPY-2 radar station has been in position on the northern part of Honshu Island since September 2006. Together with the Japanese FPS-XX radar station (also operating in the three-centimeter band), it forms the backbone of the country's missile defense shield, covering Japan in the event of a North Korean missile attack. At the same time, these radar stations serve as part of the first echelon of U.S. defense. Targets would be intercepted by SM-3 missiles fired from four Japanese Navy destroyers equipped with the Aegis system and by ground-based Patriot PAC-3 systems. Two launch installations for these systems were installed at the Iruma Air Base near Tokyo in 2006, and Japan plans to deploy 30 Patriot systems by 2011. Japan's missile defenses will be integrated into the global American missile defense system, and a joint U.S.-Japanese command center is expected to be established by 2010. Furthermore, Japan and the U.S. are working together on modernizing the engine, fairing and kinetic kill vehicle of the SM-3 Standard missile. It is estimated that this will increase the interceptor's speed by 40-60% (up to 5 km/s), which will accordingly expand the area protected by the Aegis system.

By deploying AN/TPY-2 radars in Azerbaijan and/or Turkey and interceptor missiles in Albania, Bulgaria, Greece or Turkey, a system could be created that is just as effective as that proposed by the U.S., or even more so.

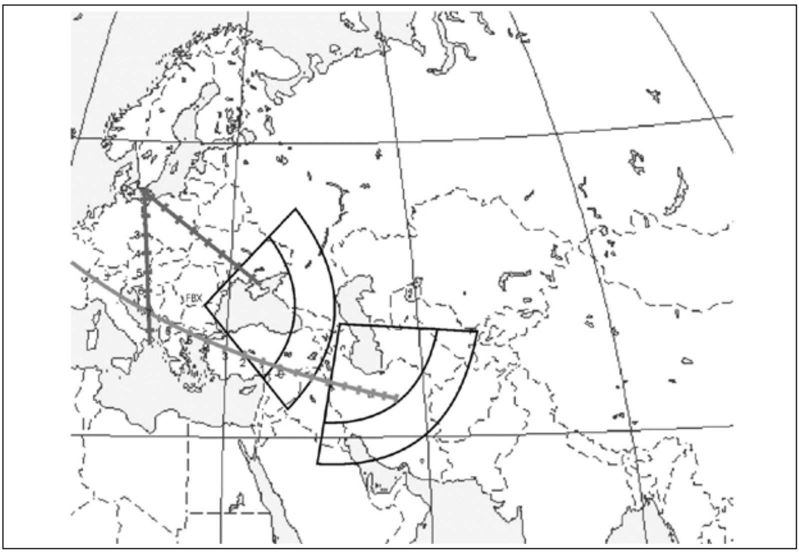

Figure A16. Diagram of the interception of a missile from Iran by an Aegis missile launched from the Baltic Sea, using information from the AN/TPY-2 detection radar in Azerbaijan and the AN/TPY-2 identification radar in Romania

Thus, there are no technical obstacles that would keep the U.S. from achieving its goals (protection from Iranian missiles) under a different missile defense system configuration. Making inaccurate and imprecise statements raises the suspicions among Russian military experts that the real motives of the U.S. differ from those publicly stated.

Russia is also worried by the prospect that the U.S. could modernize components of its missile defenses in Europe by enhancing the capabilities of the EMR radar, increasing the number of interceptors and integrating the system with the future European theater missile defense system.

As far as the EMR radar is concerned, it must be noted that phased array radars have an electronically controlled radar beam, which means that they can track many objects simultaneously and scan large areas of space in fractions of a second (whereas standard radars use mechanically mounted parabolic antennas and usually can track only one object at a time).

The GBR, SBX, and AN/TPY-2 active phased antenna array radars are constructed around receiver/transmitter modules based on UHF-band monolithic integrated microcircuits.[13]

The EMR radar can accommodate 291,000 modules, but in reality it has around 17,000. The scattered positioning of a limited number of modules makes it possible to narrow the beam and reduce the radar's energy consumption. Thus, the number of objects tracked simultaneously could be increased by fully utilizing the surface. An increase in the number of modules by 291 : 17 = 17-fold would increase the radar's capabilities 17^2 = 289-fold.[14] On the other hand, the AN/TPY-2 mobile radar with its relatively small antenna emitter area is already full of modules, leaving essentially no room for expansion. The factors currently preventing an increase in the number of modules are their high cost, short service life, and limited production capacity.

Table A4

Radars of different wavelengths used in missile defense

Type of radar	Band	Frequency, MHz	Wavelength, m	Frequency Bands, MHz	Resolution, m
Russian MAWS	VHF	150	2.00	~ 10	~ 10-15
U.S. MAWS	UHF	430	0.66	~ 30	~ 4-5
Cobra Dane, Shemya	L	1000	0.30	~ 200	~ 0.75
GBR	X	10 000	0.03	~ 1000	~ 0.15

Table A5

Characteristics of X-band missile defense and MAWS radar

Radar	Location	Range, km / ESS, m^2	Specific power Wt/ m2	Sensi-tivity *	Number of active phased antenna array modules	Effective aperture / aperture, m^2
GBR-P	Marshall Islands	2000/0.01	1.2×10^5	74	16 896	105/120
EMR	Czech Republic	4000/0.01?	5.4×10^5	380	22 000?	No data/120
THAAD/AN/ TPY-2	U.S., Japan	1000/0.01	7.0×10^5	37	25 344	No data/9.2
SBX	Adak (Alaska)	4800/1 600/0.1	1.5×10^5	2100	45 264	No data
Globus-2 AN/ FPS-129	Norway	No data	No data	45 000	Parabolic antenna diameter 27m	No data/572
AN/FPQ-16 PARCS	Colorado	3000/ No data	No data	No data	No data	No data
Cobra Judy AN/ FPQ-11	Ship-based	No data	No data	No data	Parabolic antenna	No data

* Measured as the signal to noise ratio at a distance of 1,000 km with a pulse duration of 1 microsecond from a target 1 square meter in area.

Note. ESS — Effective scattering surface.

Table A6

Characteristics of L-, S-, C-band, MAWS, missile defense and air defense system UHF radars

Radar	Location	Range, km / ESS, m^2	Frequency, MHz	Number of active phased antenna array modules	Number of targets	Angle of view	Effective aperture, m^2
AN/FPS-123, PAVE PAWS	Beale (California)	5500/ No data	420—450 (UHF)	2 mirrors, 1792 APA	No data	240	2 x 383
Cobra Dane AN/FPS-108	Shemya (Alaska)	5000/ No data	1215—1400 (L) (1175—1375)	29 APA	No data	No data	2 x 330
AN/FPS-120 SSPAR	Thule (Greenland)	5500/ No data	420-450 (UHF)	2 mirrors,	No data	240	2 x 346
AN/FPS-123 SSPAR PAVE PAWS	Clear (Alaska)	4800/ No data	420-450 (UHF)	2 mirrors,	No data	240	2 x 383?
AN/FPS-126	Britain	4800 / No data	420-450 (UHF)	3 mirrors,	2 x 330	360	625
Green Pine «Arrow»	Israel	500/2 50/0.02	1000-2000 (L)	No data	No data	No data	No data
Cobra Judy AN/FPQ-11	Ship-based	No data	2900-3100 (S)	12 288 PPA	No data	No data	38
Patriot PAC2/3 AN/MPQ-53/65	Mobile	175 (100) / No data	4000-6000 (C)	5161 PPA	100	90, slew 360	4,7

Note. APA — active phased array; PPA — passive phased array.

The target detection capabilities of a radar mostly depends on its average emitting power and antenna size, as well as the effective scattering surface (ESS) of the target. In the X-band, the effective scattering surface of a fighter plane and a warhead have on average a 10,000-fold difference: 10 and 0,01 m^2.

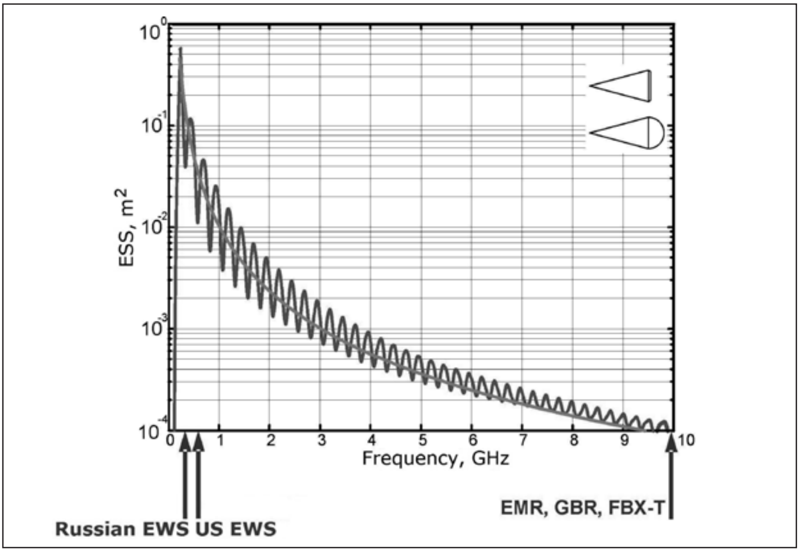

Figure A17. The correlation between the ESS of a conical object and the radar's frequency

This is due primarily to the correlation between the size of an object and the wavelength emitted by the radar. When an object's size is similar to the wavelength, the beam undergoes resonant scattering on the illuminated object. This is why the MAWS UHF-band radars are good at distinguishing warheads. In the X-band, the wavelength is much smaller than the size of the warhead, so optical scattering occurs, which is hundreds of times weaker than resonant scattering. In order to obtain a reflected signal which is comparable to that of resonant scattering, the attempt has been made to increase the emission power of the radar stations. However, since they have limited power capacities, the probe beam has to be narrowed, which correspondingly decreases the amount of space that can be scanned and lowers the search capability of X-band radars.

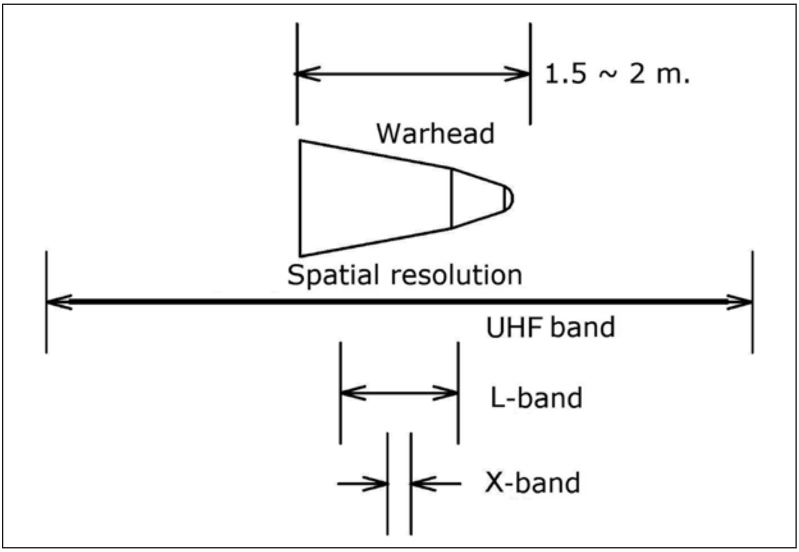

Figure A18. The correlation between warhead size and the wavelength of radars operating in different bands

It is exceedingly difficult to identify a nuclear warhead flying in a 'cloud' of false targets used to overcome missile defense systems. In Postol's opinion, this is a key issue for evaluating the effectiveness of missile defenses. Even a multi-faceted analysis using multi-parameter sensors (infrared and optical frequencies, reflected radar signals of differing wavelengths, etc.) does not guarantee a high probability of differentiating the real targets from the false ones. Postol has been trying for several years now to prove that the Pentagon does not have a good identification system — radars cannot distinguish a real warhead from a false target. He asserts that the entire missile defense test system has been designed to cover up these shortcomings. The resulting system will be fundamentally unreliable until it can demonstrate its capability to distinguish between warheads and simple means of overcoming missile defenses. According to Postol, existing radar and optical-electronic surveillance systems are unable to do this.

The anti-missile defense systems, including the many hundreds of decoys of various classes and electronic interference generators with which Russia has equipped its ICBMs, are powerful enough to get through any missile defenses, and so no missile defense system can threaten Russia's strategic nuclear forces. It cannot be ruled out, however, that in the distant future, the large-scale deployment of laser and kinetic weapons in space could reduce nuclear deterrent capability.

Notes

[1] Based on materials from presentations by Professor Theodore A. Postol at the Carnegie Moscow Center and in Washington, and also on other sources.

[2] Missile Defense Agency, *Fiscal Year 2009 (FY 09) Budget Estimates: Overview*, January 23, 2008, 08-MDA-3199; Missile Defense Agency, *Fiscal Year 2008 (FY 08) Budget Estimates: Overview*, January 31, 2007, 07-MDA-2175.

[3] D. Fried and H. A. Obering, "U.S. Missile Defense Plans for Europe" (briefing, Foreign Press Center, Washington, DC, February 22, 2007), http://fpc.state.gov/fpc/80958.htm; http://prague.usembassy.gov/md2_interview7.html.

[4] Missile Defense Agency, *Fiscal Year 2008 (FY 08) Budget Estimates: Overview*, January 31, 2007, 07-MDA-2175.

[5] S. M. Rogov, "Skatyvaniye k 'kholodnoy voine' priostanovleno," interview with the Director of the Institute for U.S. and Canada Studies, *Nezavisimoye voyennoye obozreniye*, July 13, 2007, http://nvo.ng.ru/concepts/2007-07-13/1_coldwar.html.

[6] D. Fried and H. A. Obering, "U.S. Missile Defense Plans."

[7] T. A. Postol, "The Proposed U.S. Missile Defense in Europe: Technological Issues Relevant to Policy," http://cstsp.aaas.org/content.html?contentid=1175; G. N. Lewis and T. A. Postol, "The Technological Basis of Russian Concerns," *Arms Control Today*, October 2007, http://www.armscontrol.org/act/2007_10/LewisPostol.asp.

[8] D. Fried and H. A. Obering, "U.S. Missile Defense Plans."

[9] T. A. Postol, "Proposed U.S. Missile Defense."

[10] S. M. Rogov, "Skatyvaniye k 'kholodnoy voine' priostanovleno."

[11] "How Many Aegis Ships to Defend NATO?" http://www.armscontrolwonk.com/1539/how-many-aegis-ships-to-defend-nato.

[12] *National Defense Authorization Act for Fiscal Year 2008,* HR 4986 (Enrolled as Agreed to or Passed by Both House and Senate), Subtitle C—"Ballistic Missile Defense," Sec. 221-229, http://www.govtrack.us/congress/billtext.xpd?bill=h110-4986.

[13] "Lokatsionniye radioelektronniye sistemy," http://www.sciteclibrary.ru/rus/catalog/pages/604.html; "U.S. and Military Space Systems, Policy, Doctrine, Law," in *Air University Space Primer*, http://www.globalsecurity.org/space/library/report/2003/primer.htm (accessed September 10, 2003).

[14] G. N. Lewis and T. A. Postol, "The Technological Basis of Russian Concerns," *Arms Control Today*, October, 2007, http://www.armscontrol.org/act/2007_10/LewisPostol.asp.

Summary

This collective monograph from the Carnegie Moscow Center's Nonproliferation program (and one outside author) differs from earlier works in the field in its emphasis on the 'external environment' surrounding nuclear nonproliferation. Previously, the central focus fell on strengthening the Nuclear Nonproliferation Treaty (NPT) and its regime and institutions; thus earlier volumes from the Center stressed reinforcing the IAEA safeguards system, bolstering export controls, toughening the rules for withdrawal from the NPT and ensuring that nuclear states respect their disarmament commitments. Other previous publications also examined the problems of denying terrorists access to nuclear materials and technology; stopping the production of materials used in nuclear weapons; and regional nonproliferation issues in the Middle East, the Far East and South Asia.[1] "Nuclear Proliferation: New Technologies, Weapons and Treaties" leaves these themes largely in the background, concentrating instead on issues that currently have a growing impact on ending the 'horizontal' escalation of the nuclear arms race.

In "Energy Resource Shortages, Global Warming and the Outlook for Nuclear Energy," Petr Topychkanov analyzes the coming global expansion of nuclear energy and its potential impact on the nonproliferation regime in light of an increased demand for ever-diminishing and environmentally damaging fossil fuels. In "Nuclear Fuel Cycle Security," Anatoly Dyakov examines the proliferation problems and dangers born of certain nations' plans to increase their use of nuclear energy by developing the nuclear fuel cycle. Dyakov looks at the pluses, minuses and difficulties of setting up international uranium enrichment and spent fuel processing centers, which have been proposed as a nonproliferation guarantee and an alternative to developing national nuclear fuel cycles.

Rose Gottemoeller reports on the advantages and drawbacks of international cooperation projects for a new generation of nuclear energy in "The Global Nuclear Energy Partnership as a Driver for U.S.-Russian Nuclear Energy Cooperation: Successes and Failures," analyzing the extent to which such projects can safeguard humanity from nuclear accidents and prevent nuclear energy's use in WMD proliferation. Sergei Oznobishchev's "Missiles and Missile Technology" looks at the proliferation of both, which gives nuclear weapons greater range and penetration capability in an increasingly multi-polar world. Oznobishchev also examines proposals and obstacles for toughening the controls on the use, supply and refinement of missiles and missile technology.

In "The Counterforce Potential of Precision-Guided Munitions," Yevgeny Miasnikov analyzes the role of high-precision non-nuclear weapons in global and regional military planning, assessing their potential for counteracting nuclear proliferation and enticing 'threshold' countries to develop nuclear weapons. In "Nonstrategic Nuclear Weapons," Alexander Pikayev offers a detailed study of tactical nuclear weapons and their role in great-power military and political relations and the proliferation of nuclear weapons among third countries. Pikayev also addresses the problem of restricting and eliminating tactical nuclear weapons through treaties.

Vladimir Dvorkin looks at the interaction between strategic offensive arms and anti-missile defense (ABM) systems in "Missile Defense at a New Stage of Development." The development of ABM systems is being spurred by the proliferation of missiles and nuclear weapons, Dvorkin maintains, and is in turn having an impact on offensive arms, great-power talks on their limitation and elimination, and cooperation in missile and nuclear weapons nonproliferation. In "Missile Defense and the Intermediate-Range Nuclear Forces Treaty," Alexei Arbatov examines the fate of the INF Treaty and the possibilities presented by intermediate-range missiles as a response to missile proliferation and the development of stability-threatening ABM systems. Boris Molchanov's "The Militarization of Space and Space Weapons" assesses these two ongoing processes and their influence on nuclear proliferation, as well as the prospects for an international legal regime to restrict the militarization of space.

Finally, Vladimir Pyryev's "The Missile Defense Plan in Central Europe" – an appendix compiled from materials provided by Theodore Postol – assesses the impact that deployment of a missile defense system in Central Europe would likely have on strategic stability.

To summarize, "Nuclear Proliferation: New Technologies, Weapons and Treaties" aims to expand the analysis of the military, technical, political and legal issues that affect the prospects for nonproliferation – and that will demand international attention if the world really intends to strengthen the nonproliferation regime.

Note

[1] A. Arbatov and V. Naumkin, eds., *Threats to the Nuclear Weapons Nonproliferation Regime in the Middle East* (Moscow: Carnegie Moscow Center, 2005); A. Arbatov and G. Chufrin, eds., *Nuclear Confrontation in South Asia* (Moscow: Carnegie Moscow Center, 2005); A. Arbatov and V. Mikheyev, eds., *Nuclear Proliferation in Northeast Asia* (Moscow: Carnegie Moscow Center, 2005); A. Arbatov and V. Dvorkin, eds., *Nuclear Weapons after the Cold War* (Moscow: Carnegie Moscow Center, 2006); A. Arbatov, ed., *On the Nuclear Threshold: Lessons for the Nonproliferation Regime from the North Korean and Iranian Nuclear Crises* (Moscow: Carnegie Moscow Center, 2007).

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The Carnegie Endowment for International Peace is a private, nonprofit, nonpartisan organization with headquarters in Washington D.C. The Endowment was created in 1910 by prominent entrepreneur and philanthropist Andrew Carnegie to provide independent analysis on a wide array of public policy issues.

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