ISN
ETH Zurich

INTERNATIONAL RELATIONS AND SECURITY NETWORK

THE RUSSIAN NUCLEAR ARSENAL

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

INTERNATIONAL RELATIONS AND SECURITY NETWORK

THE RUSSIAN NUCLEAR ARSENAL

Pavel Podvig
Center for International Security and Cooperation, Stanford University

TABLE OF CONTENTS

The history of the Russian nuclear forces begins at the time of the breakup of the Soviet Union, when Russia (as the legal successor of the USSR's nuclear power status) inherited all Soviet nuclear weapons and most of the military and industrial infrastructure that was involved in its development. The subsequent evolution of Russian nuclear forces was a difficult process of adjusting the size and role of its nuclear arsenal to the requirements of the post-Cold War security environment and to the realities of the new economic and political systems, which themselves were affected by the developments in the nuclear complex. As a result, the Russian nuclear arsenal that exists today is more of a product of this transition process than that of careful consideration and planning. To understand the current status of Russia's strategic nuclear forces we need to examine this transition and the internal and external factors that have shaped it.

The Soviet nuclear arsenal reached its peak in the mid-1980s, shortly before the United States and the Soviet Union began serious disarmament efforts. At the height of its development, the Soviet arsenal was estimated to include about 30,000 strategic and tactical nuclear weapons. These weapons were deployed with a variety of delivery systems – land-based ballistic missiles, submarines, and bombers. About 10,000 nuclear warheads were part of the strategic force; the rest was deployed with theater forces and tactical units.

The operations of its nuclear forces were supported by an extensive military infrastructure, which included early-warning radars, military satellites, nuclear weapons storage sites, as well as a command, control, and communications system designed to launch a nuclear strike.

Another important part of the nuclear forces infrastructure was the military-industrial complex responsible for the development and large-scale production of nuclear warheads and delivery systems. This complex consisted of several ministries that handled all aspects of nuclear weapons development – from uranium mining, the production of weapons-grade fissile materials and warheads, and scientific research to the mass production of missiles and aircraft. The core of the industrial complex included a number of research institutes and design bureaus, which played key roles in weapons development and production.

In the late 1980s, nuclear weapons were deployed across most of the territory of the Soviet Union, and some tactical nuclear warheads were deployed in Eastern Europe. However, by the time the Soviet Union had dissolved at the end of 1991, the military had successfully removed all nuclear weapons from the Eastern Europe and was in the process of transferring all tactical nuclear warheads from the Soviet republics to storage sites on Russian territory. This transfer was completed in the spring of 1992.

The situation with strategic nuclear warheads was somewhat different. At the end of 1991, four former Soviet republics had strategic nuclear weapons based on their territories. While most weapons were in Russia, about 450 intercontinental ballistic missiles (almost one-third of all land-based missiles of this kind) and their nuclear warheads were located in the Ukraine, Kazakhstan, and Belarus. (Ukraine and Kazakhstan also had about 80 strategic bombers deployed on their bases.) None of these three countries, however, had the infrastructure that would have allowed them to maintain and operate nuclear weapons independently. In May 1992, they all pledged to remove nuclear warheads from their territories and to join the Nuclear Non-Proliferation Treaty as non-nuclear states. Russia was declared the only successor of the nuclear status of the Soviet Union.
Kazakhstan and Belarus agreed to transfer all nuclear warheads (as well as the missiles and aircraft that carried them) to Russia. The transfer was completed in April 1994 and November 1996, respectively. Ukraine had returned all nuclear warheads to Russia by June 1996, but claimed ownership of the missiles and aircraft based on its territory; most have since been liquidated, but some were sold to Russia in the late 1990s and early 2000s.

One of the reasons the former Soviet republics managed to quickly resolve the issues related to nuclear warheads and delivery systems was the fact that these issues were covered by the US-Soviet Strategic Arms Reduction Treaty (START) of 1991. The treaty provided a legal framework for the transfer of nuclear warheads to Russia or for the elimination of launchers that remained outside of its territory.

Unlike warheads and missiles, non-nuclear military facilities that supported various aspects of the operation of strategic forces, were not covered by arms control arrangements, so Russia had to negotiate the status of each facility individually with its neighbors. Although most of the facilities were still in Russia, five of nine early-warning radar sites were located outside of its territory in Ukraine, Azerbaijan, Kazakhstan, Latvia, and Belarus.

A number of strategically important objects were located in Kazakhstan, including Baikonur (the primary Soviet space launch and missile testing site), the missile defense proving ground at Sary-Shagan, and the nuclear test site in Semipalatinsk.

Some of these bases or facilities were eventually shut down, but most continued to operate, even though it took Russia more than a decade to negotiate the terms of use with the host countries. Today, Russia continues to use the Baikonur space launch site, most of the early-warning radars that were operational in 1991, and the missile-defense testing ground in Kazakhstan. The Semipalatinsk nuclear test site has since been closed.

The disintegration of the Soviet Union also resulted in significant changes in the military industry, affecting Russia's ability to maintain and modernize its strategic forces. The missile production industry was affected the most, since many key research and production facilities were located in Ukraine. Other industries suffered major disruptions of their subcontractor chains. One notable exception was the nuclear weapons production complex that historically had maintained all its vital research and production facilities in Russia.

ARMS CONTROL PROCESS

Arms control agreements between the United States and the Soviet Union played a very important role in determining the shape of strategic forces in both countries. Limits that arms control treaties placed on the development and deployment of new systems ensured some predictability in the nuclear arms race. In addition, arms control negotiations provided a framework for domestic and international debate on security issues. After the breakup of the Soviet Union, the arms control process became even more important. It provided the institutional arrangements that helped Russia and the United States to develop their relationship and discuss bilateral issues on a regular basis.

The two major arms control issues that shaped the US-Russia relationship in the 1990s were reductions of strategic offensive forces and limits on missile defense development. The first issue was the subject of two strategic arms reduction treaties – START and START II. Missile defense development was limited by the Anti-Ballistic Missile (ABM) Treaty. There were other arms control and disarmament agreements, which dealt with eliminating intermediate-range missiles, conventional force reductions, chemical and biological weapons, and a ban on nuclear tests, but, their role was less politically prominent.

The START Treaty was signed by the USSR and the United States in July 1991, a few months before the breakup of the Soviet Union. Afterwards, the four former Soviet republics that had strategic nuclear weapons on their territories – Russia, Ukraine, Kazakhstan, and Belarus – signed the Lisbon Protocol in May 1992, accepting the disarmament obligations of the Soviet Union. All countries, except Russia, pledged to eliminate nuclear weapons on their territories.

The treaty called for an almost two-fold reduction in strategic forces from the levels achieved in the late 1980s. At the time the treaty was signed, the US and Soviet Union had more than 2,300 strategic delivery systems and more than 10,000 strategic nuclear warheads. The treaty established the limits of 1,600 delivery systems and 6,000 associated warheads using complicated accounting rules so the actual number of nuclear warheads that both sides were allowed to keep was somewhat higher. There were a number of other limits, which reflected the ideas about strategic stability and nuclear security that were prevalent at that time. The treaty also provided very elaborate procedures for the elimination of delivery systems, verification, and information exchange.

The START reductions were to be completed in seven years once the treaty entered into force. The treaty was then to remain in place for an addition eight years after the specified requirements were met. The breakup of the Soviet Union caused a significant delay in the ratification of the treaty, as it had to be approved by all successor countries. It eventually entered into force in December 1994; the treaty term will expire in 2009.

Even before the START ratification process was completed, Russia and the United States began negotiations on the next stage of nuclear arms reductions. The result of this effort was the START II Treaty, which was signed in January 1993. Unlike START I, it was a bilateral agreement between Russia and the United States that did not include any other former Soviet states.

The new treaty used the elimination and verification procedures specified in the START I Treaty, but called for deeper reductions in offensive weapons: 3,000–3,500 nuclear warheads on each side. Among the few specific provisions of the START II Treaty was the complete elimination of land-based ballistic missiles with multiple warheads (*multiple independently-targeted reentry vehicles* or *MIRVs*), a requirement that would later prove the most controversial. Another controversial provision of the treaty was the timeline for the reductions: all weapons had to be eliminated by January 2003.

There were several factors that exacerbated tensions surrounding the START II Treaty. First, its provisions were structured in a way that allowed the United States to keep most of its missiles intact (although with fewer warheads), which theoretically would allow for the quick reconstitution its strategic forces. Russia did not have this capability, for it had to liquidate most of its missiles in order to comply with the treaty provisions. The ban on land-based MIRVed missiles presented another serious challenge, for if Russia were to keep its forces at the level of 3,000–3,500 warheads specified in the treaty, it would have to produce several hundred new single-warhead missiles to compensate for the elimination of its multiple-warhead missiles. Even though the treaty allowed 10 years to complete

all changes to its strategic forces, a program of this kind was clearly beyond Russia's economic capabilities. Russia found it difficult to dismante its existing weapons given the economic pressures it faced and as a consequence, the 2003 deadline looked increasingly unrealistic.

While criticisms of the specific provisions of the START II Treaty were valid, the reason the provisions caused so much discontent in Russia stemmed from the growing sense of frustration about the loss of Russia's strategic balance with the United States and with Russia's apparent inability to keep its strategic forces at the level that would preserve its status as one of two equal nuclear superpowers.

Concerns about the loss of strategic parity were exacerbated by the US missile defense development efforts and discussions that questioned the viability of one of the key US-Soviet arms control agreements – the 1972 ABM Treaty, which prohibited the development and deployment of strategic missile defense systems that would have capability to protect entire territory of a country. The logic of the ban was to prevent the United States and the Soviet Union from attempting to gain strategic superiority by building a missile defense system. During the Cold War, legal provisions of the treaty were backed up by the capability of each party to prevent attempts of this kind by threatening an offensive weapons buildup. But after Russia all but lost this capability following the collapse of the Soviet Union, from its point of view the legal protection offered by the ABM Treaty was the only obligation that prevented the US from disrupting the strategic balance by building a strategic missile defense system.

The perceived disparity of the START II Treaty and the direction of the US missile defense program only made these problems worse. Even though in the early 1990s the United States had not expressed an interest in developing strategic missile defense systems to protect its entire territory, its program was clearly moving in that direction. In 1994, Russia and the United States undertook an effort to reach an agreement that would preserve the ban on strategic missile defense systems while allowing the development of non-strategic systems that presumably could not disrupt the strategic balance– but the negotiations were progressing very slowly.

In 1997, Russia and the US made an attempt to resolve the issues of strategic arms reductions and missile defense. At the Helsinki Summit that year, they agreed to extend the timeline for the implementation of START II by five years until the end of 2007. The extension was to allow Russia enough time to carry out the reductions and necessary modernization of its strategic forces. Both sides also agreed on the terms of a so-called demarcation agreement that was supposed to resolve the missile defense issue. The agreement, signed in September 1997, allowed for the development of most non-strategic missile defense systems that were under development in the United States.

The compromise that was reached in 1997 proved unsatisfactory. Russia believed that the 1997 demarcation agreement protected of the ABM Treaty and demanded that this agreement be ratified before START II could enter into force. The Russian parliament ratified the START II Treaty with this condition in April 2000. But by that time, the United States had all but abandoned attempts to preserve the ABM Treaty in its initial form. Ratification of the demarcation agreement had never been considered as an option in the United States, which effectively precluded the START II treaty's entry into force.

In 2001, when the newly-elected Bush administration made missile defense one of the priorities of its defense policy, the issue almost became a source of a serious disagreement between Russia and the United States. However, by that time it was clear that even if Russia were to respond to the US missile defense development, none of the steps it could realistically take – such as, keeping its heavy missiles in service or deploying other missiles with multiple warheads – would seriously change the US-Russian strategic balance. Nor was this balance in danger of being undermined by the missile defense systems that were under development – flight tests have convincingly demonstrated that the capabilities of these systems are quite limited. On the Russian side, practical considerations also played a significant role – the military saw an opportunity to reject the START II treaty, which imposed serious restrictions on the Russian strategic forces.

The political situation after the September 2001 terrorist attacks on the United States made withdrawal from the ABM Treaty possible. In December 2001, the United States notified Russia about its intention to withdraw from the treaty and the reaction from Russia was very restrained. The only practical response was Russia's withdrawal from the START II treaty in June 2002, when the US withdrawal from the ABM Treaty was complete. This step, however, was expected and the START II Treaty could not have entered into force anyway.

The START II Treaty was replaced by the Strategic Offensive Reduction Treaty (or the Moscow Treaty), signed by Russia and the United States in 2002. The agreement calls for the reduction of operational nuclear warheads levels to 1,700-2,200 by the end of 2012. Unlike its START predecessors, the Moscow Treaty does not set any limits on delivery systems and requires no transparency or verification. Since the treaty does not require the elimination of launchers or warheads, the United States and Russia can easily reconstitute their forces to the level that existed before the reductions. In practice, however, this possibility is unlikely becase the evolution of strategic nuclear forces in both countries will almost certainly bring the number of nuclear warheads to much lower levels than those specified in the treaty.

The Moscow Treaty is likely to be the last US-Russian arms control agreement related to strategic forces. It demonstrates that both countries feel confident that their strategic forces provide adequate deterrence to the extent required by the current state of US-Russia relations.

STRUCTURE OF THE RUSSIAN NUCLEAR FORCES

The Soviet Union and the United States were the only two countries that built a complete nuclear triad – a strategic force that consisted of land-based intercontinental ballistic missiles, strategic submarines with ballistic missiles, and strategic bombers equipped with gravity bombs or air-launched cruise missiles. The original logic behind this composition was that the three legs of the triad would complement one another, taking advantage of relative strengths and guarding against potential vulnerabilities. For example, the combination of accuracy and high-yield warheads made land-based missiles suitable for attacking hardened targets, such as missile silos or command posts. Submarines were valued for their survivability, which made them suitable for a retaliatory strike.

In reality, the makeup of US and Soviet triads was determined by a number of factors, only a few of which were related to military capabilities of the weapon systems. For example, the Soviet Union traditionally considered land-based ballistic missiles to be the most important part of its strategic force – largely because the Soviet industry developed significant expertise in missile development and production at the very early stages. In addition, ballistic missiles had a strong advocate in the Strategic Rocket Forces (the service that was created in 1959 to operate them). In contrast, strategic aviation in the Soviet Union was relegated to secondary roles, since it had never had strong institutional support in the military or a successful development record similar to that of the missile industry.

Russia preserved the overall structure of the Soviet strategic forces and tried to maintain all components of the nuclear triad. However, in the new (post-Soviet) economic and political environment, the services had to compete for the limited resources that Russia was able to spend on its military. For most of the 1990s, the military received only minimal funding, which did not allow for serious restructuring or modernization of the strategic forces. The development funds allocated to strategic systems went primarily toward the development of a new single-warhead, land-based missile, known as Topol-M, which was supposed to replace the existing MIRV missiles under the terms of the START II Treaty. In 1996, an attempt was made to launch the construction of a new strategic submarine, but the lack of funds brought the construction to a virtual halt. The situation was worsened by the inability of the military and the industry to define clear priorities in the midst of economic and political uncertainty of the 1990s.

In 1998, the Russian government undertook the first attempt to draw a detailed development program for the strategic forces that would take into account the capability of the industry, as well as Russia's arms control obligations. The program incorporated the START II requirements and called for a modest modernization of all three components of the nuclear triad, the early-warning network, and the command and control system that supports operations of the strategic forces.

Although these decisions called for a uniform development of all components of the strategic forces, the Strategic Rocket Forces quickly emerged as a dominant service. In 1999, it proposed a plan that would combine all strategic forces under its operational command. In addition, the Strategic Rocket Forces sought to have control over most of the development and acquisition budget. These proposals led to a serious conflict within the Russian military, placing the Strategic Rocket Forces in confrontation with other services and advocates calling for a greater role for conventional forces. The conflict was resolved in 2000 following a decision that formally preserved the equal status of all components of the nuclear forces and established development plans that gave no clear priority to any service.

After the US withdrawal from the ABM Treaty and the subsequent demise of START II, the structure of Russian strategic forces was no longer determined by arms control constrains (START I ceilings were too high to be of any practical importance, while the Moscow Treaty does not really set any limits). As a result, the pace of the strategic modernization is now determined primarily by internal institutional interests of the services and by the ability of the military and industry to manage development projects and the production of weapons systems. Military requirements, as they were understood during the Cold War, still play some role in determining the direction of the modernization, but this role appears to be secondary at best.

The Strategic Rocket Forces

At the peak of its development in the early 1990s, the Strategic Rocket Forces included almost 1,400 intercontinental ballistic missiles, which could carry about 6,600 nuclear warheads. At the time of the breakup of the Soviet Union, only 735 of these were still operational and under Russia's control, as shown in Table 1. About 400 of missiles of older types (SS-11, SS-13, and SS-17) had been deactivated, while others were outside of the Russian territory: 104 SS-18 missiles were based in Kazakhstan; 130 SS-19 and 46 SS-24 missiles were based in Ukraine. In addition, 81 road-mobile SS-25 missiles, while formally under Russian control, were based in Belarus.

One of the problems that Russia faced in the 1990s was that the development and production of its most modern ICBMs was based in Ukraine. The Ukrainian Yuzhmash produced the SS-18 and SS-24 missiles and was involved in development of the earlier version of the SS-27 missile. Of the remaining Russian-produced missiles, the SS-19 had not been in production since mid-1980s, while production of the SS-25 was increasingly difficult because of disrupted links with subcontractors. Russia had to concentrate its efforts on moving development and production of the SS-27 Topol-M to Russia and on extending the service lives of the Ukrainian-produced SS-18 missiles. Another missile produced in Ukraine, the SS-24, also went through a service life extension program, but the extension was limited and all these missiles had been completely withdrawn from service by 2005.

The development and production of the SS-27 missile was transferred to the Moscow Institute of Thermal Technology and to the Votkinsk plant in Russia. The first flight test of this missile was conducted in 1994. In December 1997, the Strategic Rocket Forces first accepted two missiles of this type for service. In the last several years, these missiles have been deployed at a rate of four to six a year. A road-mobile version of the SS-27 missile has been undergoing tests and is expected to be deployed in 2006.

The SS-27 Topol-M missile will eventually replace the SS-25 Topol road-mobile missile, although in smaller numbers. The SS-25 missiles, which were deployed in 1988-1992, are now reaching the end of their operational lives. They have been withdrawn from service in the last few years in a process that will be completed in 2010-2012.

One of the reasons the SS-24 and SS-25 are being decommissioned is that these are solid-propellant missiles, which require a complex and costly replacement of the propellant to extend their service lives. A life-extension procedure for liquid-fuel missiles is much simpler and usually requires only periodic testing of the aging missiles. Russia has been conducting flight tests of this kind and now considers it safe to keep the liquid-fueled SS-18 and SS-19 missiles in service for about 25 years or even longer.

Even with these life extension programs, Russia will have to remove most of its SS-19 and SS-18 missiles from service in the near future. The SS-19/UR-100NUTTH missiles that are currently in service were deployed in 1979-1984 and will have to be decommissioned by the end of the decade. However, some missiles of this type may stay – Russia has about 30 SS-19 missiles that it purchased from Ukraine in the early 2000s. If deployed, these missiles could probably stay in service for 20-25 years.

Designations	Basing	Warheadsper missile	1991	2005	2012 (estimate)
SS-18, R-36M, RS-20	silo	10	204	85	50
SS-19, UR-100NUTTH, RS-18	silo	6	170	129	30
SS-24, RT-23UTTH, RS-22	silo	10	10	–	–
SS-24, RT-23UTTH, RS-22	rail-mobile	10	36	–	–
SS-25, RT-2PM Topol, RS-12M	road-mobile	1	315	294	20
SS-27, RT-2PM2 Topol-M, RS-12M2	silo	1	–	40	50
SS-27, RT-2PM2 Topol-M, RS-12M2	road-mobile	1	–	0	50
Total			735	548	200

Table 1. Russia's land-based intercontinental ballistic missiles

Submarines	Missiles per submarine	Warheads per missile	1991	2005	2012 (estimate)
Delta I, Project 667B	12 SS-N-8, R-29, RSM-40	1	18	–	–
Delta II, Project 667BD	16 SS-N-8, R-29, RSM-40	1	4	–	–
Delta III, Project 667BDR	16 SS-N-18, R-29R, RSM-50	3	14	6	–
Delta IV, Project 667BDRM	16 SS-N-23, R-29RM, RSM-54	4	7	6	6
Typhoon, Project 941	20 SS-N-20, R-39, RSM-52	10	6	–	–
Borey, Project 955	12 SS-NX-30, Bulava, RSM-56	(?)	–	–	2
Total		49	12	8	

Table 2. Russian strategic submarines and sea-launched ballistic missiles

With the new production of the Topol-M and various life-extension programs under way, Russia could maintain its land-based ICBM force at the level of 150-200 missiles, which would have about 800 warheads by 2012, as summarized in Table 1. It could keep about 50 newer SS-18 heavy missiles, and up to 30 SS-19 missiles. These silo-based multiple-warhead missiles would account for most of the warheads and could stay in service until 2015-2020. In addition to these, Russia is planning to have about 100 single-warhead SS-27 Topol-M missiles, which will be deployed in silos and road-mobile launchers. Most of the SS-25 Topol missiles will have been decommissioned by 2010-2012.

Theoretically, in addition to the missiles described here, Russia could deploy one more missile as part of its land-based force. This missile, the Bulava, is being developed as a sea-launched, multiple-warhead missile. It shares some components with the SS-27 Topol-M and can be deployed in silos. It is unlikely, however, that Russia will ever need a new silo-based, multiple-warhead missile.

These plans reflect the consensus about the role and structure of the land-based missile force that emerged from discussions over the last decade. They also allow Russia to reconcile its development and modernization plans with the existing production capability of the industry. Another important consideration for Russia is that this strategic force structure, which preserves multiple-warhead missiles and heavy missiles in particular, provides it with a certain degree of protection should the United States decide to pursue a large-scale missile defense program. However, a massive buildup in response to such a program is highly unlikely, partly because it would require significant additional resources, but mostly because the projected missile force would preserve its retaliatory potential even in the presence of a missile defense. We also should not expect dramatic reductions in the number of missiles or warheads. Most missiles will probably not be removed from silos until the end of their service lives, although it is possible that some will be deactivated earlier.

Strategic fleet

Strategic nuclear-powered submarines constituted an important part of the Soviet Union's strategic forces. As shown in Table 2, at the time of its breakup, the Soviet Union had 49 modern ballistic-missile submarines, which carried more than 700 missiles and about 2,600 warheads. Strategic submarines were assigned to the Northern Fleet, which was based at the Kola Peninsula, and to the Pacific Fleet, based in the Far East region and at the Kamchatka Peninsula. The breakup of the Soviet Union did not affect the strategic fleet directly, for all ballistic missile submarines were located in Russia.

The task of maintaining nuclear submarines and the infrastructure that supported their operations presented Russia with a serious challenge. By the early 1990s, Russia had a large number of ballistic missiles and attack nuclear submarines that had reached end of their operational lives and were awaiting dismantlement. However, the infrastructure that existed at that time was not sufficient to support the massive dismantlement effort that was required for the elimination of all submarines. In addition, the dismantlement procedures included extensive operation with radioactive materials, which presented the risk of the radioactive contamination of the areas surrounding its submarine bases. Most of these problems have been solved with the help of the international community, but as of 2005, the elimination of old nuclear submarines has not yet been completed – some 120 submarines have been eliminated, while approximately 80 are awaiting dismantlement.

The difficulties posed by decommissioning, as well as general lack of funds in the military, had a serious negative impact on the fleet modernization program bringing most submarine overhaul programs to a halt. The main missile development program – the modernization of the SS-N-20/R-39 missile, also known as Bark – encountered serious difficulties (all three flight tests of the missile ended in failure). This missile was being developed to replace old missiles on Typhoon-class submarines and for deployment on strategic submarines of a new type known as Borey-class. In 1996, Russia launched the construction of the first submarine of this type, but this proceeded extremely slowly. The future of the Delta IV submarines was also in doubt, since their SS-N-23/R-29RM missiles were approaching the end of their operational lives and there were no new missiles to replace them.

In 1998, the government drastically revised its strategic fleet modernization plans. It cancelled the modernization of the SS-N-20, replacing it with a new missile development program. The contract for the new Bulva missile was given to the Moscow Institute of Thermal Technology, which was the primary contractor for the Topol-M land-based missile. The Bulava was presented as a universal missile that could be deployed on land as well as on submarines. Another change in the fleet development plans involved the resumed production of the SS-N-23/R-29RM missiles (or, rather, of its slightly modified version, known as the Sineva). These missiles were to be deployed on Delta IV submarines during their overhaul.

These decisions resulted in several changes in the composition of the strategic fleet and the cancellation of the SS-N-20 program forced the early retirement of Typhoon submarines. As of 2005, the only submarine of this class that is still operational is the lead ship *Dmitry Donskoy*, which was converted to a test bed for Bulava missiles.

The Bulava missile performed a successful flight test in September 2005 and may be ready for deployment some time in 2008. Missiles of this type will be deployed on two Borey-class submarines that are currently under construction – one launched in 1996 and another launched in March 2004.

In 2005, the Russian strategic fleet consisted of six Delta III and six Delta IV-class submarines, not all of which are operational. The missiles deployed on Delta III submarines are probably well beyond their original service lives. Only one submarine of this type seems to have operational missiles on-board. Out of six Delta IV submarines, only one has been equipped with the new R-29RM Sineva missiles. Other submarines of this type are either in overhaul or have old missiles on board.

The difficulties experienced by the fleet led to a dramatic fall in the number of patrols performed by strategic submarines. While the Soviet fleet performed up to one hundred patrols in the mid-1980s, the Russian fleet has been able to perform no more than one or two in recent years (and sometimes none at all, as in 2002). This, of course, reflects the changes in US-Russia relations since the end of the Cold War, but at the same time indicates that Russia is experiencing problems keeping its strategic fleet operational.

According to current development plans, the Delta IV submarines will be refitted with R-29RM Sineva missiles. In addition, in 2007-2010 the fleet will receive at least two Borey-class submarines currently under construction that will carry Bulava missiles. It is possible that the fleet will receive one or two more submarines of this type or will refit one or two Typhoon submarines with Bulava missiles, but this is unlikely to happen before the end of the decade. Taking into account that the Delta IIIs will be decommissioned by that time, Russia will have no more than eight ballistic missile submarines. Given that the Borey submarines will carry 12 Bulava ballistic missiles (there is no data on how many warheads this missile will have), we can estimate that the eight strategic submarines will have about 120 sea-launched ballistic missiles and about 500 nuclear warheads.

Strategic aviation

Strategic aviation was traditionally the least developed leg of the Soviet nuclear triad. Strategic bombers did not figure prominently in Soviet nuclear war plans and were relegated to supporting roles. Nevertheless, the strategic aviation did receive its share of resources and by the time of the breakup the Soviet Union, it had a moderate strategic bomber force that included 23 modern supersonic Tu-160 Blackjack bombers and 88 Tu-95MS Bear turboprop bombers carrying nuclear air-launched cruise missiles. (The force also included about 60 older Tu-95 bombers that were decommissioned in the early 1990s.) The composition of the Soviet strategic air force is presented in Table 3. It should be noted that some of the aircraft listed in the table were deployed on bases outside of Russia – 19 Tu-160 and 25 Tu-95MS bombers in Ukraine and some

Bombers	Cruise missiles	1991	2005	2012 (estimate)
Tu-95MS Bear H	6 or 16	88	64	64
Tu-160 Blackjack	12	23	14	15
Total		111	78	79

Table 3. Russian strategic bombers with air-launched cruise missiles

Tu-95MS bombers in Kazakhstan. Most of them were returned to Russia, and in the case of Ukraine in exchange for payment.

In 1992, Russia suspended the production of strategic bombers until 1999, when it resumed their production. Since then the strategic aviation has added two new Tu-160 aircraft to its force and expects to add one more in 2005-2006. In 2001, Russia also initiated a modernization program that will equip the Tu-160 bombers with new avionics that would allow them to use gravity bombs and conventional high precision weapons.

The Tu-95MS aircraft will probably get some avionics upgrades as well, but this modernization is likely to preserve their current role of nuclear cruise missile carrier. No significant reduction of the Tu-95MS bomber force is expected.

With air-launched cruise missiles remaining the primary weapon of strategic aviation, Russia is working on a modernization of its Kh-55/AS-15 Kent missiles, which are currently deployed with bombers. A modification of this missile, Kh-555, will be replacing the Kh-55 in the coming years.

While it is unlikely that strategic aviation will change its status relative to other components of the Russian strategic forces, its role may undergo some serious transformation. In contrast to ballistic missiles, bombers offer a certain degree of flexibility in carrying out an attack and could in some circumstances be used to demonstrate force. In addition to this, bombers could carry out conventional missions, which makes them the only leg of the strategic triad that can be potentially "usable" in various conflicts. It is possible that in time an increasingly larger number of strategic bombers will be diverted to conventional roles.

Early warning and missile defense

Along with the strategic launchers and nuclear warheads, Russia preserved the key elements of the command and control system that supported operations of the strategic forces. This includes the early-warning system, in conjunction with various command and communication systems and facilities, that together are supposed to support timely decision-making and disseminate launch orders. An early-warning system is a key element of a strategy based on a "launch-on-warning" posture. This posture relies on timely detection of a missile attack to ensure that a retaliatory strike can be initiated before the attacking missiles hit their targets. In theory, this option can enhance deterrence, since it effectively denies an attacker the advantage of a surprise. At the same time, this option is quite dangerous, for it leaves very little time for decision-making and therefore creates an opportunity for an error.

One way to reduce the probability of an error is to have at least two types of early-warning systems that would use different physical principles to detect missiles. The detectors that are used in missile early warning are infrared sensors deployed on satellites, which can identify a missile plume shortly after a launch, and radars that can detect warheads at the later stages of flight.

The Soviet Union choose to deploy both types of systems: a constellation of early-warning satellites and a network of radars. However, the deployment had not been completed by the time the Soviet Union collapsed, so these systems provided only limited early-warning capability. In the years after the breakup, the system has further deteriorated and its capability is now even more limited.

Of the eight early-warning radar sites that were operational in 1991, five were outside of Russian territory, as can be seen in Table 4. However, Russia has lost only the site in Latvia, where all radars have been demolished. Other sites remained operational and continued to provide Russia with early-warning information about missiles and space objects (the radars also work as part of the space surveillance network). At the same time, Russia could no longer upgrade the radar network – most of the newer more powerful and more accurate phased-array radars of the Pechora

Radar station	Country	Radars	Year operational
Olenegorsk	Russia	Hen House	1976
		Pechora prototype	1978
Mishelevka	Russia	2 Hen House	1972-1976
		Pechora	never operational
Pechora	Russia	Pechora	1984
Krasnoyarsk	Russia	Pechora	never operational, dismantled in 1990
Balkhash	Kazakhstan	2 Hen House	1972-1976
		Pechora	never operational
Sevastopol	Ukraine	Hen House	1979
Mukachevo	Ukraine	Hen House	1979
		Pechora	never operational
Gabala	Azerbaijan	Pechora	1985
Skrunda	Latvia	2 Hen House	dismantled in 1998
		Pechora	never operational, dismantled in 1994
Baranovichi	Belarus	Volga	2002

Table 4. Soviet and Russian early-warning radars

type never went operational. The early-warning network relies mostly on older Hen House radars, which were built in the 1970s.

The existing network does not provide full coverage of all possible directions of attack. Dismantlement of the radar in Krasnoyarsk in the late 1980s (completed under pressure from the United States), as well as the loss of the radar site in Latvia, have left gaps in radar coverage. However, the most important approaches are partially backed up by other radars (for example, by the new radar in Belarus), so the gaps do not significantly increase the vulnerability of the strategic forces.

The situation with the space-based early-warning system is very similar. The system operates at a fraction of its full capacity, but still provides Russia with adequate information about a possible missile attack. Russia maintains two space-based early-warning systems: a first-generation one, known as Oko or US-KS, that relies primarily on satellites on highly-elliptical Molniya-type orbits, and the second-generation US-KMO, which includes geostationary satellites.

The US-KS system can detect only those launches that originate from the US territory. The full constellation of first-generation satellites, which can provide reliable 24-hour coverage, would include up to nine satellites on highly-elliptical orbits and one geostationary satellite. But for the past several years the system has been operating with just three satellites in it. Still, the satellites continuously cover the US territory and would be able to give a warning about an attack, although not with the reliability that a full system would provide.

The second-generation early-warning system was built to detect launches of sea-based missiles as well as land-based ones. A full constellation of these satellites would include up to seven satellites on geosynchronous orbits, which would provide coverage of most of the Earth's surface. However, as of 2005, there were no satellites of this type in orbit and it is not clear if this system will ever be fully operational.

Another important part of the Russian strategic force is the missile defense system deployed around Moscow. The system consists of 100 nuclear-tipped interceptors and a battle-management center with a large phased-array radar in Pushkino. The

system in its current configuration was accepted for service in 1994, replacing the old missile defense system deployed in the 1970s. There is conflicting data on whether the interceptors of the system are deployed with their nuclear warheads on a regular basis, but the battle-management radar is operational. It provides a backup to the early-warning radar network and works as part of the space-surveillance system.

Tactical nuclear weapons

In addition to the strategic offensive arsenal, the Soviet Union built and maintained a large tactical nuclear force. Estimates put the number of tactical nuclear warheads at the end of the 1980s at about 15,000-20,000. These ranged from artillery shells and nuclear mines to short- and medium-range ballistic missiles, gravity bombs, and nuclear torpedoes.

Tactical nuclear weapons present a unique security challenge. Unlike their strategic counterparts, which are deployed as part of weapon systems that are under constant, highly-centralized control, tactical weapons can be quite compact, they are usually deployed in a decentralized manner, and often lack the safeguards that exist on strategic weapon systems. All of this makes tactical weapons more vulnerable to diversion or unauthorized use. In September-October 1991, the United States and the Soviet Union recognizing this threat exchanged unilateral initiatives that called for the elimination of most of the tactical nuclear weapons or for their withdrawal from active service. Russia later confirmed the Soviet obligations and extended them to cover additional systems.

Russia agreed to eliminate all weapons deployed with its ground forces – short-range missiles (medium-range missiles were being eliminated in accordance with the Intermediate-range Nuclear Forces Treaty), mines, and artillery shells. Russia also agreed to remove all naval nuclear weapons (cruise missiles and torpedoes) from its ships, eliminating one-third of them and placing the rest into storage. Another measure was to eliminate half of the air force and air-defense weapons and place the rest into centralized storage.

Most of these measures, including the elimination of warheads removed from service, had been implemented by the end of the 1990s (some ground-forces weapons were still awaiting elimination as of 2000). However, tactical nuclear weapons still constitute an important part of the Russian nuclear arsenal. Moreover, developments in recent years indicate that the Russian political and military leadership see the role of these weapons growing. According to the logic that is prevailing in Russia today, tactical nuclear weapons can compensate for the weakness of Russia's conventional forces. This argument, which first appeared in the early 1990s and mirrors the logic used by the United States and its allies in Europe during the Cold War, became more prominent with the expansion of NATO, the growth of China's economic and military power, and the deterioration of Russia's conventional capability.

Even though tactical nuclear weapons have not been withdrawn completely, Russia has done a lot to reduce them. It is estimated that Russia has about 3,400 operational weapons, with up to 10,000 to 12,000 weapons in reserve or at various stages of dismantlement.

The number of deployed tactical weapons is still large enough to justify concern about their theft or unauthorized use. Ensuring safety and security of these weapons is one of the major tasks facing Russia today. However, there are several factors that make the situation more stable than it was in the early 1990s. First, all weapons have been moved to centralized storage facilities. In normal circumstances they are no longer deployed with the units to which they are assigned (although they could probably be distributed to these units in a time of a crisis). Second, most of the storage facilities are receiving security upgrades (major funding for this program is provided by the United States). Although this program has not yet been completed, it has made significant improvements in warhead security.

It is unlikely that Russia will forgo its tactical nuclear weapons unilaterally or as part of an arms control agreement. Moreover, it is possible that it will reverse some of the steps taken after the 1991 declarations. For example, it is possible that a new short-range missile, known as the Iskander, can be deployed with nuclear warheads. Given that the capabilities of Russia's conventional forces are still in decline, the calls for an increased role for nuclear weapons (and tactical weapons, in particular) will continue. Under these conditions, it is important to keep the dangers associated with these weapons under control and continue work to reduce them by providing incentives for further reductions and assistance for safety and security improvements.

LITERATURE

There are several books that provide good reference information on the history and the current status of the Russian nuclear forces.

One of the most recent detailed studies is Pavel Podvig, ed., Russian Strategic Nuclear Forces (Cambridge, MA: MIT Press, 2001). This book by Russian authors provides a description of the development and the current structure of Russian strategic forces, of the military industry, including the nuclear industry, and of the Soviet nuclear testing program.

Another volume of this kind, Thomas B. Cochran et al, *Nuclear Weapons Databook, Volume IV: Soviet Nuclear Weapons* (New York: Ballinger, 1989), was based on the information that was publicly available in the United States in the late 1980s. Nevertheless, it provides very detailed and accurate information about the Soviet nuclear forces, which is still relevant today. The only exception is the chapter on the Soviet nuclear industry – it has been updated in Thomas Cochran, Robert S. Norris, Oleg Bukharin, *Making the Russian Bomb: From Stalin to Yeltsin* (Boulder: Westview Press, 1995), which contains a very detailed description of the Russia nuclear weapons production complex. The *Soviet Nuclear Weapons* book is especially valuable because it provides detailed information on tactical nuclear weapon systems that were deployed by the Soviet Union.

A very good narrative but still technical and detailed account of the development of the Soviet and Russian forces can be found in Steven J. Zaloga, *The Kremlins' Nuclear Sword: The Rise and Fall of Russia's Strategic Nuclear Forces, 1945-2000* (Washington, DC: Smithsonian Institute Press, 2002). A more scholarly publication, Nikolai Sokov, *Russian Strategic Modernization.* (Lanham, MD: Rowman & Littlefield Publishers, Inc., 2000), analyzes various aspects of the Russian modernization policy.

In the recent years the Russian military produced a number of official publications that contain descriptions of various weapon systems and components. An example of a publication of this kind is Sergeyev, I., ed., *Russia's Arms and Technologies: The XXI Century Encyclopedia, Volume 1: Strategic Nuclear Forces.* Moscow: Oruzhie i Teknologii (OrTekh), 2000.

In addition to the books, there are a number of reports published by non-governmental organizations and academic centers that provide information on various aspects of the Russian nuclear forces.

A report by the Bellona foundation, "The Russian Northern Fleet," *Bellona Report 2,* 1996, is probably the most comprehensive study of the Russian fleet and the problems associated with it available in the open literature. Another report, "The Russian Nuclear Industry – The Need for Reform," *Bellona Report 4,* November 2004, provides a good overview of the recent developments in the Russian nuclear industry.

The following report provides an up-to-date analysis of the issues related to safety and security of the Russian nuclear warheads and materials: Bunn, Matthew and Anthony Wier. *Securing the Bomb 2005: The New Global Imperatives.* Washington, D.C.: Project on Managing the Atom, Harvard University and Nuclear Threat Initiative, May 2005.
http://www.nti.org/e_research/cnwm/overview/cnwm_home.asp

The *Bulletin of the Atomic Scientists* published a regular column that provides an update of the status of the Russian nuclear forces. The most recent publication is Robert S. Norris, Hans Kristensen, "NRDC Nuclear Notebook, Russian Nuclear Forces, 2005," The *Bulletin of the Atomic Scientists,* March/April 2005, pp. 70-72. Earlier versions and updates are also available.
http://www.thebulletin.org/nuclear_weapons_data

Another source of information on the current status of the Russian nuclear forces is the web site Russian Strategic Nuclear Forces, which is updated regularly to reflect changes in Russian forces.
http://www.russianforces.org

ABOUT THE AUTHOR

Pavel Podvig is a research associate at the Center for International Security and Cooperation at Stanford University. Before joining CISAC in August 2004, he was a researcher at the Center for Arms Control, Energy and Environmental Studies at the Moscow Institute of Physics and Technology (MIPT). He also spent several years as a visiting researcher with the Security Studies Program at MIT and with the Program on Science and Global Security at Princeton University, and he taught physics in MIPT's General Physics Department for more than ten years.

At the Center for Arms Control Studies, he worked on various technical and political issues of missile defense, US-Russian arms control negotiations, and structure and history of the Russian strategic forces. During that time he was a principal investigator of a Russian Nuclear Forces research project, which produced a book, Russian Strategic Nuclear Forces.

Podvig graduated with honors from the Moscow Institute of Physics and Technology in 1988, with a degree in physics. In 2004, he received a PhD in political science from the Moscow Institute of World Economy and International Relations.