LONG-RANGE PRECISION-GUIDED CONVENTIONAL WEAPONS: IMPLICATIONS FOR STRATEGIC BALANCE, ARMS CONTROL AND NON-PROLIFERATION

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Executive Summary

In a numerical sense Russian strategic nuclear forces during the next ten years will be reduced in accordance with the implementation of their modernization program. This will easily allow Russia to meet its SORT obligations. However, the smaller number of strategic forces creates an impression of Russia's increased vulnerability and a possible loss of the necessary nuclear deterrence potential. This in turn explains Russian sensitivity to US plans of deployment ballistic missile defenses in Eastern Europe.

The situation has been also complicated by new factors that potentially further decrease the viability of Russian strategic forces. Foremost is the growing counterstrike potential of precision-guided weapons which some Russian experts think are intended for use in a sudden disarming strike on Russia. These concerns are exacerbated by the key role assigned to such weapons in recent US defense documents. These weapons come in a wide variety of types, but they can be a threat to all components of the strategic nuclear triad. This paper attention will focus on precision-guided weapons that represent a potential threat to strategic silo-based missiles.

The US is the trend setter for this type of weapon. Current versions have significant improvements in terms of attack features and wider range of use. There has been a major increase in their use, from 2% of all munitions used in the Vietnam War to over 60% in the 2003 Iraq War. Existing US weapons already have high penetration ability, and will certainly in the future represent a real threat to stationary Russian ICBM launchers.

While new US doctrine appears to be directed at broadening the range of missions for nuclear weapons, tasks which have previously been assigned to nuclear weapons are gradually being transferred to non-nuclear precision-guided weapons. This is illustrated by appearance of the operational and strategic US concept of Global Strike. Apart from strategic bomber aircraft and submarines, the US Air Force and Navy are undertaking research aimed at creating effective conventional warheads for strategic ballistic missiles—though this is currently being hampered by the US Congress. Development of new types of 'bunker buster' bombs is also favoured by the US Defense establishment. A current limitation on aerial guided bombs is their short range, so that their carriers need to operate in an area protected by air defenses. Details are given of the range of US precision guided weapons currently deployed or in development, many of which might threaten Russian strategic force facilities. B–1B strategic bombers alone will be capable of delivering over 1,600 precision-guided weapons to targets.

None of this is to say that precision guided weapons will necessarily threaten the nuclear deterrence capability of another nation. Significantly longer preparation times are required than those for nuclear counterstrike, which means they will be hard to hide. This will allow the other side time to move to a higher state of preparedness. The time taken for an actual attack with these weapons will also be long, during which the adversary would be able to use

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its surviving nuclear arsenal in retaliation—though this could invite a nuclear response. Moreover an attack on ICBM sites would require that the attacked nation's air and sea defenses would be significantly reduced or eliminated in advance.

Above all, the colossal risk of nuclear escalation as a result of an attack with precision-guided weapons against a nuclear-armed country is totally incommensurate with the realistically imaginable advantages of carrying out such an operation, especially after the end of the Cold War.

The growing counterstrike potential of the U.S. precision-guided weapons, and potentially that of other countries, are not likely to be stopped or significantly limited. As such, they are likely to be taken into account by the Russian leadership when estimating the effectiveness of their nuclear deterrence forces. Thus, as long as such a threat remains even on a purely hypothetical level, there will be serious obstacles in the path of further reduction of nuclear arms and the related strengthening of the nuclear non-proliferation regime. In this sense, they are comparable to anti-missile and space systems, despite all the technical differences, since they too have started to undermine the nuclear nonproliferation regime and the future outlook for cooperation among states in their fight against other common threats to their security.

However, provided there is a sufficient political will, the problems caused by precision-guided weapons systems may be removed or reduced through various legal treaties. Similar counting rules as used in START could be implemented, regardless of whether they are dealing with nuclear or non-nuclear strategic weapons. This would also facilitate the verification regime. One could also conceivably ban the deployment of strategic nuclear weapons and their delivery platforms outside national territory, and later extend it to tactical nuclear weapons. Limiting areas patrolled by submarines armed with cruise missiles is another possible measure—something which might resolve a number of other issues raised by Russia on various occasions.

Finally, further development and use of this type of weaponry may serve as an encouragement to the "threshold" states to speed up their acquisition of nuclear weapons as a means of asymmetric defence. This risk may only possibly be reduced by bans on development, deployment or use of precision-guided weapons on a unilateral or alliance basis.

Introduction

Two things came to define military and political relations between the USA and the USSR 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 Russian-American 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. missile defense system deployment plans – are all arguments for assuming that nuclear deterrence will continue to play a defining or at least significant part in relations between the two great powers even in a multipolar and increasingly globalized world.

Over the coming decades, Russia will scale back its 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 even a bit of 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 in 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.

But the cutbacks to the strategic forces have helped create the view among Russian strategists that Russia is becoming more vulnerable as a result and risks losing its needed nuclear deterrent capability. This in large part explains Moscow's strong objections to U.S. plans for the deployment of strategic missile defense system installations in two areas in Europe. As President Putin put it, these plans aim "to neutralize our nuclear missile capability".[2]

Some Russian experts have also voiced fears that the country's nuclear forces might find their viability under threat.[3] They forecast that the increased vulnerability of Russian deterrence (counterstrike forces) in the face of a combined strategic ABM system and a counterstrike nuclear potential by the USA creates an outlook for growing strategic instability, political tension, and a new blind alley in strategic arms control negotiations.

The situation becomes even more complicated due to the presence of new additional factors that potentially decrease the viability of Russian strategic forces. Among them is the growing counterstrike potential of precision-guided weapons.[4] Some Russian experts think that American PGMs are means designed to launch a sudden disarming strike against Russia.[5]

1. Precision-guided weapons, their generic features and doctrinal role

In military literature the term "precision-guided weapon" usually means a guided weapon that is able to destroy its target, as a rule, with one munition.[6] This definition can cover a fairly wide class of munitions from weapons weighing only a few grams to guided aerial bombs that may weigh many tons, or from miniature pilotless aircraft that are hand-launched, to intercontinental ballistic missiles.

Precision-guided weapons can be a threat to all components of the strategic nuclear triad: stationary and mobile strategic missile launchers, missile-carrying submarines at bases (and also, as means of anti-submarine defence, a threat to submarines patrolling the sea), and strategic bombers on airfields and in mid-air. For each of these components the types of precision-guided weapons, the vulnerability of the target and the means of attack are quite specific and must be analysed separately. In this paper attention will be paid mostly to those kinds of precision-guided weapons and their means of delivery that represent a potential threat to strategic silo-based missiles.

The most significant breakthrough in the development of precision-guided weapons was made at the end of the 20th century by, most prominently, the USA. There are a number of objective trends that permit one to speak about a qualitative change in the role of precision-guided conventional weapons in future conflicts. Among them:

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[2] Statement by Russian President Vladimir Putin to the press and replies to journalists' questions on the results of the negotiations with the Ukrainian President V. Yushchenko, 12th of February 2008 г.

[3] In this regard the reaction by Russian experts to an article by Keir A. Lieber and Daryl G. Press in *Foreign Affairs* was quite symptomatic (Keir A. Lieber & Daryl G. Press, The Rise of U.S. Nuclear Primacy, *Foreign Affairs*, Vol. 85, N 2, March—April, 2006, pp. 42-54). This article concludes that the USA have become capable of depriving Russia of a retaliation capability. One can argue whether the authors are correct or whether they are being overdramatic, but this article inspired a discussion in Russia about the viability of Russian forces.

[4] Eugene Miasnikov, Vysokotochnoye Oruzhiye i Strategichesky Balans (Precision-Guided Weapons and Strategic Balance), *Center for Arms Control, Energy and Environmental Studies at Moscow Institute of Physics and Technology*, Dolgoprudny, November 2000, 43 p.

[5] See, for example: Michail Volzhensky, PRO: Zamaskirovana pod Zashchitu, Sozdana dlya Napadeniya (BMD: "Camouflaged as a Defence, Created for Attack"), *Izvestiya*, 28th of May 2007

[6] The problem of defining precision-guided weapons is described in detail in a paper: Vitaly Tsymbal, Vozrastaniye Strategicheskoi Roli Vysokointellektualnogo Oruzhiya I Problemy Kontrolya za Ego Razvitiyem (The Growth of the Strategic Role of Highly Intelligent Weapons and the Problems of Controlling their Development), ***Nuclear Control,*** June-July 1997, pp. 39-43.

- Enhancement in strike characteristics of precision-guided weapons – their power, and circular error probable (CEP) - at cost levels making series production and mass-scale use economically acceptable.
- A greater range of conditions under which these weapons may be effectively used as a result of deployment and the modernization of supporting infrastructure (reconnaissance, targeting and damage assessment).

The increasing role of precision-guided weapons in military conflicts is supported by statistics. During the war in Vietnam the number of guided aerial bombs in 1972 represented only 2% of the overall number of munitions dropped by the U.S. Air Force; during the war in Iraq (in 1991) the number reached 8%; during the "Allied Force" operations in Yugoslavia (in 1991) they represented around 30%; in the operation "Enduring Freedom" in Afghanistan (in 2001-2002) the figure was over 50%; and finally, during the operation "Iraqi Freedom" (in 2003) in Iraq it was over 60%[7].

Precision-guided weapons that are already a part of the U.S. Armed Forces armaments may be used for striking a wide variety of targets, including stationary and well-fortified objects (such as underground bunkers, reinforced structures and bridges), and armoured mobile targets (such as tanks, armoured vehicles and artillery). With sufficiently precise target pointing, the existing classes of cluster ammunition may effectively strike land based mobile ICBM launchers. Even modern ICBM silos may be vulnerable to precision-guided weapons.

Some assessments show, that future kinetic or tandem shaped charge munitions weighing 0.5–1.0 tons are capable of penetrating a layer of homogeneous steel 2.3 m thick.[8] Furthermore, in all likelihood, the U.S. Armed Forces already have PGM with such capability, for example the BLU-122 bomb, which is a modernized version of the GBU-122 penetrating bomb.[9] If their CEP can be brought to within 1-2 meters – the developers' goal – these types of weapons will represent a real threat to Russian stationary ICBM launchers.[10]

It is possible that the development of non-nuclear attack weapons will lead to a situation where stationary ICBMs are vulnerable to munitions that create a powerful electromagnetic impulse as well. In the case of such weapons, the available delivery accuracy for precision-guided weapons (of less than 10 m) may already be quite sufficient.

The utilisation of precision-guided weapons as a means of counterstrike seems likely only in a situation where the attacking party is very confident that such a massive unexpected strike would be sufficiently effective, such as in the case of a strike that would incapacitate the majority of the enemy's strategic forces. If the aggressor can be sure that its strike will neutralize the overwhelming majority of the enemy's strategic forces, and can count on its own nuclear capacity and missile defense systems to restrain and reliably protect against any response attack the enemy launches using its few surviving missiles, that kind of strategy might look very attractive from the aggressor's point of view.

Decisions taken by the USA vis-à-vis their strategic programs only strengthen such fears in Russia. In the US Defense Department's program documents, the development of precision-guided missiles, with the appropriate information technologies and infrastructure, are given a key role. New doctrinal tenets appear to be objectively directed, on the one hand, towards broadening the range of tasks to which nuclear weapons can be applied. On the other hand,

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[7] Barry D. Watts, Six Decades of Guided Munitions and Battle Networks: Progress and Prospects, Center for Strategic and Budgetary Assessments, March 2007, p. 20.

[8] Eugene Miasnikov, 2000; *Ibid*.;

[9] Amy Butler and Douglas Barrie, *Dig for Victory*, *Aviation Week and Space Technology*, 11th of September, 2006

[10] Eugene Miasnikov, 2000; *Ibid*.;

tasks which have previously been assigned to nuclear weapons are gradually being transferred to non-nuclear precision-guided weapons.[11]

The U.S. DoD Global Strike military strategy option provides an example of these changes. Global Strike concept aims to make it possible for the USA to carry out high-precision strikes from a great distance against targets in any corner of the globe.[12] In the framework of this new concept, a portion of U.S. strategic delivery systems is being reoriented towards solving non-nuclear tasks.

The USA 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 ballistic missile submarines, fitting them out to carry long-range sea-launched cruise missiles (SLCMs). 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, and the only obstacle still in the way of deployment of these weapons are the restrictions imposed by Congress.[13]

2. Development of Precision-guided Weapons in the USA

Currently, the U.S. Defense Department is purchasing and developing a few dozen types of precision-guided weapons that can potentially threaten silo-based ICBMs. First of all, these are weapons that are primarily intended for equipping strategic bombers and submarines: guided aerial bombs (including those of modular design), guided missiles of the "air-to-surface" type, as well as air and sea-based long-range cruise missiles. In the future, long range ballistic missiles could also be used as non-nuclear delivery systems for PGMs.

The development of future types of non-nuclear munitions for striking highly protected and deeply buried targets is being conducted in the US within the framework of HDBTD (Hard and/or Deeply Buried Target Defeat Capability Program). The US Defense Department allocates the highest priority to this line of development because it is directly linked to the fight against the growing terrorist threat, and the proliferation threat of weapons of mass destruction. It is worthwhile noting that in the public domain there is only a sketchy information about developments in the area of precision-guided penetrating munitions aimed at the destruction of well-protected underground structures. As a result, only an approximate picture of the situation can be seen. Nonetheless, an analysis of the information available makes it possible to conclude that PGM do constitute a real threat to silo-based ICBMs.

Guided Aerial Bombs

Guided aerial bombs are those equipped with a guided system, permitting minimal deviation from the target point[14]. When compared to other types of precision-guided weapons, guided aerial bombs have the highest impact and penetrating capacity and are thus the main weapons intended for striking hard, and deeply buried point targets. However, because the range of aerial bombs usually does not exceed 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 and this 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 non-nuclear

[11] Nuclear Posture Review, 2001

[12] 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, 4th of April, 2005.

[13] Anatoli Diakov and Eugene Miasnikov, "Bystryi Globalnyi Udar" v Planah Razvitiya Strategicheskih Sil SShA ("Prompt Global Strike" in U.S. Strategic Forces Development Plans), *Center for Arms Control, Energy and Environmental Studies at Moscow Institute of Physics and Technology*, Dolgoprudny, 14th of September, 2007, 9 p.

[14] S. Semyonov, Sovremennye Upravlyayemye Aviatsionnyye Bomby (Modern Guided Aerial Bombs), *Zarubezhnoye Voyennoye Obozreniye*, N 4, 2005, pp. 45-51.

weapon in the present U.S. Air Force arsenal is GBU–28, which can be carried by B–2 strategic bombers and F–15E fighter-bombers. The GBU–28 was first used during the Gulf War in 1991, after which it was modernised a number of times (to GATS/GAM, GBU–37, GBU–28B, GBU–28C).

The GBU–28 carries a BLU–113 penetrating warhead with a mass of around 2 tons that is capable of penetrating a concrete wall thicker than 6 m[15]. This is probably a lower estimate because even when only the bomb's kinetic energy and blast effect rather than its cumulative impact is taken into account, it achieves a penetration depth of around 5.4 meters in concrete.[16] Assessments of the GBU–28 aerial bomb show that due to its kinetic energy the bomb can penetrate a plate of rolled armour plating with a thickness of more than 0.3 m.[17] But there is evidence to suggest that later modifications could have been equipped with shaped charged penetration warheads that would considerably increase the bomb's lethality against armor. Currently a modified version of the GBU–28C aerial bomb is in production, armed with a BLU–122 penetrating warhead that is comparable in mass and size to BLU–113, but with a penetrating capability 20% higher, and a striking capability 70% higher.[18] The GBU-28 uses a laser and inertial navigation system (INS) with data adjustment made using the satellite navigation (GPS) system or through combined means.

Development of another bomb more powerful than the GBU–28, the Massive Ordnance Penetrator (MOP), is near completion. Its mass is 13.6 tons, while the penetrating warhead's weight is around 9 tons and the weight of explosives is 3.5 tons.[19] Experts estimate that the bomb can penetrate reinforced concrete at least 30-35 meters thick, and that the explosive charge would have sufficient blast impact to destroy protected targets through their external components (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.[20]

Aerial bombs of the "Paveway" type (GBU–10, GBU–24, GBU–27), with a semi-active laser guidance system manufactured by Raytheon, have been in use for more than 30 years. Almost all types of strategic and tactical Air Force aircraft in the USA carry the "Paveway" guided aerial bombs. The payload of GBU–10, GBU–24, GBU–27 aerial bombs is high explosive ordnance, free-fall bombs of the Mk–82 type, as well as penetrating bombs of the BLU–109 type. Existing estimates indicate that such a warhead can penetrate up to 1.5 m of concrete from a height of 10 km[21]. Currently, the BLU–109 warheads are being replaced by the BLU–116, which are not very different in weight and size, but have twice the penetration depth of the BLU-109.[22]

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[15] A. Grigoriev, Novaya Amerikanskaya Upravlyayemaya Bomba (New American Guided Bomb), *Zarubezhnoye Voyennoye Obozreniye*, N 2, 1992, p. 46

[16] Eugene Miasnikov, 2000; *Ibid.*;

[17] Eugene Miasnikov, 2000; *Ibid.*;

[18] Maj. Mike Lauden, BLU-122 Warhead Program, Precision Strike Technology Symposium, 19th of October, 2005

[19] K. Kirillov, Osnovnyye Programmy Razrabotki v SShA Novukh UAB (Main Development Programs of New Areal Bombs in USA), *Zarubezhnoye Voyennoye Obozreniye*, N 4, 2007, pp. 50-52

[20] John M. Donnelly, Item in War Request Stokes Fears of Iran Strike, *Congressional Quarterly*, 23d of October, 2007

[21] Eugene Miasnikov, 2000; *Ibid.*;

[22] BLU-116 Advanced Unitary Penetrator (AUP); Amy Butler and Douglas Barrie, 2006, *Ibid.;*

Guided aerial bombs with laser guidance are used by illuminating a target detected by the operator with a laser beam from a supporting aircraft. A receiver on the guided aerial bomb registers a reflection from the target and sends signals to the bomb's guiding system. The precision of laser-guided bombs is around 3 m. In order to increase the range of conditions under which guided aerial bombs of the "Paveway" type can be used, the third generation (known as the "Enhanced Paveway") is equipped with modules that allow the correction of the trajectory, based on a space-based radio navigation GPS system.

A GBU–15 gliding aerial bomb, developed by Boeing and made operational in 1974, is also capable of carrying a BLU–109 penetrating warhead.[23]

At the beginning of the 1990s a Joint Direct Attack Munition program (JDAM) received a powerful incentive for the creation of universal modules for correcting gravitational bombs of the usual kind by 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 conditions and have a CEP of up to 5 meters when using the GPS flight path adjustment system.[24] As penetrating warheads, alongside the BLU–109 (GBU–31), the less massive BLU–110 and BLU–111 (with weights of 450 kg and 225 kg) are being also used.

Boeing Corp. has a program for the creation of a guided Small Diameter Bomb (SDB), with a mass of 120 kg, intended for striking stationary (GBU–39) and mobile (GBU–40) targets at a range of up to 100 km. The bomb has a capacity to penetrate a reinforced concrete wall up to 2 m thick and may be used from internal weapon bays and from an external node of load cell, with the speed of the carrier corresponding to M=1.7, and with a precision of not less than 3 m.[25]

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

Modifications of the AGM–154A and the AGM–154B are cluster type bombs and are designed to strike area targets and armoured vehicles. The AGM-154C modification has a unitary warhead of blast/fragmentation or penetrating type. Unlike the other glide bombs, it is also equipped with an infrared terminal seeker for guidance in the final phase of the flight path. Production of the AGM–154C guided aerial bomb started in December 2004. Overall, the USA Navy plans to purchase 7,000 guided aerial bombs of the AGM–154C type.[26] 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

In order to strike hard, deeply buried targets, guided air-to-surface missiles may be used. In contrast to guided bombs, guided missiles can be used outside enemy anti-aircraft defense range and at lower altitudes, thus substantially increasing the delivery system's viability. Cruise missiles are also more manoeuvrable than guided bombs and the guidance system is more resistant to errors in setting the target location during launching.

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[23] AGM-130 Missile, Air Force Link Factsheet;

[24] Joint Direct Attack Munition GBU-31/32/38, Air Force Link Factsheet;

[25] V. Kirillov, 2007; *Ibid.*;

[26] JSOW, Raytheon, 2006;

The U.S. Air Force's F-15E, F-16 and F-11 tactical aircraft can all carry AGM-130 guided missiles, which use a module 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 blast-penetrating munition at a range of more than 270 km to destroy targets at sea and on land.[27] The missile's flight path is controlled using an INS/GPS guidance system. An infrared camera with an automatic target seeker 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.[28] Serial production of SLAM–ER guided missiles began in 2000, and a greater part of the missiles in this arsenal were modernised versions of SLAM guided missiles. At present in the US Navy arsenal there are about 500 SLAM–ER missiles.[29]

The U.S. Air Force is developing JASSM (AGM–158 A) guided missiles, with a range comparable to SLAM–ER, but with a higher payload. This missile is equipped with a warhead weighing 450 kg of the high explosive or penetrating type. Strategic bombers of all types and F–16C/D fighter planes are armed with JASSM guided missiles.[30]

In parallel, Lockheed Martin, the company developing JASSM guided missiles, is continuing its research and development efforts with the aim of increasing the range of the JASSM–ER guided missile to up to 800 km and over, giving it also the ability to be retargeted in flight. Serial production of JASSM–ER guided missiles began in the 2008 fiscal year. Procurement orders for 2,400 JASSM and 2,500 JASSM-ER missiles are planned over the period to 2019.[31]

Long-Range Cruise Missiles

Tomahawk sea-launched cruise missiles (SLCM) underwent a number of modifications in their development (Block I–IV). The main differences in the latest Block IV modification (Tactical Tomahawk)[32] from the previous ones is its greater range (up to 1600 km) and the ability to be retargeted in flight.

As of 2006 Raytheon had manufactured about 4,200 Tomahawk missiles of Block I—III modifications, from which 1,900 were used in US military operations in 1991–2003.[33] In 2002 serial production of Block IV (Tactical Tomahawk) modifications began.[34] The current arsenal of missiles of this type is estimated to be about 1,000 units[35] and by 2015 the plan is

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[27] Standoff Land Attack Missile—Expanded Response (SLAM-ER) Backgrounder, The Boeing Company, September 2007; SLAM-ER Guided Missile, Boeing, January 27, 2005;

[28] Boeing Scores Direct Hit in SLAM-ER Land Moving Target Test, The Boeing Company, 5th of October, 2006;

[29] Standoff Land Attack Missile—Expanded Response (SLAM-ER) Backgrounder, The Boeing Company, September 2007;

[30] Tony Capaccio, Raytheon Tomahawk Might Replace Errant Lockheed Missile, *Arizona Daily Star*, 12th of June, 2007

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

[32] Modification of Block IV was made operational in 2004 г.

[33] Barry D. Watts, Six Decades of Guided Munitions and Battle Networks: Progress and Prospects, Center for Strategic and Budgetary Assessments, March 2007, pp.238, 246.

[34] The modification was also called RGM-109E (version for equipping launchers on vessels) and UGM-109E (version for submarine launchers).

[35] As of August 2007 it was planned to complete serial manufacturing of SLCM batches ordered during the 2002-2005 financial years (Department of the Navy Fiscal Year (FY) 2009 Budget Estimates, Weapons Procurement, February 2008, Exhibit P-21)

to purchase 2,500 more.[36] In particular, orders were placed for 355 and 394 such missiles in 2007 and 2008 respectively, and there are plans to make 200-240 of these missiles a year over the coming years.[37]

The sea-based cruise missile (SBCM) Tomahawk may be equipped with nuclear[38] or conventional munitions. Missiles of the Block III modification,[39] which constitute the bulk of long range sea-launched cruise missiles in service, are equipped with a WDU-36/B fragmentary-blast-type warhead or a CEB (Combined Effects Bomblet) cluster bomb with self-targeting BLU-97/B munitions. It was reported that a portion of the Block IV SLCM modification will carry WDU–36/B munitions, while another portion will be equipped with penetrating warheads[40] of the WDU–43/B type.[41]

The long-range air-launched ALCM (AGM-86) cruise missile is built by Boeing. It made around 1,700 of these missiles originally to deliver nuclear warheads only, but starting in 1988, around 500 of them were reequipped 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 blast-fragmentation or penetrating (Advanced Unitary Penetrator) warhead at a range of more than 1,000 км.[43] The equivalent explosive power of blast fragmentation munition is about 1,300 kg of TNT, while the mass of the penetrating warhead type is around 540 kg.[44] The CALCM uses an INS/GPS guidance system.

The CALCM was widely used in military conflicts over 1991-2003, with around 360 such missiles used in total .[45] Thus, the current CALCM arsenal comprises of no more than 140 units. In 2007, the U.S. Air Force declared its plans to significantly reduce its arsenal of nuclear ALCMs. In future the plan is to dismantle around 500 ALCMs, so that only 528 of these will remain equipped with nuclear munitions.[46] It is not unlikely that a portion of them will be used for assembling CALCMs. It is possible that 460 nuclear ACMs (AGM–129) will also be refurbished to non-nuclear missiles, as the intention is to remove them completely from the U.S. nuclear arsenal.[47]

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

[37] *Ibid.;*

[38] In accordance with the public data, the US Navy has approximately 320 SBCMs with nuclear munitions (NRDC Notebook: US Nuclear Forces, 2007, *Bulletin of the Atomic Scientists*, January-February 2007, pp. 79-82). However, in accordance with the unilateral declaration by President Bush in 1991 nuclear SBCMs are in storage. Similar response initiatives on sea-based nuclear arms were also adopted in 1991 by President Gorbachev.

[39] The payload mass for Block III modification is approximately 340 kg

[40] Andreas Parsch, Tomahawk, Historical Essay;

[41] This version received the designation RGM/UGM-109H

[42] Barry D. Watts, 2007; *Ibid*.;

[43] U.S. Air Force Successfully Tests Boeing AGM-86D CALCM, Boeing, 29th of November, 2001;

[44] Boeing Selects Lockheed Martin to Provide CALCM Hard-Target Warhead, Boeing, 2d of December, 1999;

[45] Barry D. Watts, 2007; *Ibid.*; These estimates also fit with data indicating that the U.S. Air Force had 1,140 nuclear-armed ALCM-class cruise missiles in 2007 (Adam J. Hebert, Great Expectations, *Air Force Magazine*, August 2007, pp. 32-35).

[46] Adam J. Hebert, 2007; *Ibid.*;

[47] Adam J. Hebert, 2007; *Ibid.*;

Possible Future Composition of U.S. Strategic Delivery Means for Precision-Guided Weapons

B-52H, B-1B and B-2 heavy bombers form the backbone of the U.S. Air Force's strategic attack capability. Until the beginning of the 1990s, strategic bombers could only deliver nuclear weapons and conventional free-fall bombs. But during the last 10 years bomber modernisation programs have made it possible to arm them with high precision-guided aerial 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] Currently there are no plans to buy new strategic bombers. Research and development work is underway to build the next generation of heavy bombers, and they are expected to enter service not later than 2035.[50] All of the U.S. Air Force strategic bombers are based on U.S. territory. However, during military conflicts they can be transferred to airfields of U.S. allies. In particular, B–52H and B–1B aircraft that took part in the NATO military operation against Yugoslavia in the spring of 1999 were based on British territory (Fairford base).

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 too under certain circumstances in countries in the Trans-Caucasus and Central Asia, could make them a threat for Russia's ICBMs.

The four Ohio-class strategic missile submarines will soon become capable to carry a conventional precision strike. 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. Submarines of the Los Angeles class, built before 1985, can launch the cruise missiles only from torpedo tubes, but starting with the submarine Providence, all submarines of this class have been equipped with 12 vertical launchers accommodating sea-launched cruise missiles. Submarines of the Virginia class have similar capability. The Seawolf class submarine does not have vertical launchers, but its number of torpedo tubes has been doubled and the submarine can carry up to 50 weapons. By the end of 2006, the U.S. Navy had in service 2 Virginia-class submarines, 3 Seawolf-class submarines and 31 Los Angeles-class submarines carrying cruise missile vertical launchers.[52] By 2015 the plan is to retain about 50 attack submarines, while up to 12 "Virginia" class submarines will be built. In the longer term the number of attack submarines may be reduced 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

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[48] Susan H.H. Young, 2007; *Ibid.*;

[49] Statement of Maj. Gen Roger Burg before the Senate Arms Services Committee, Subcommittee on Strategic Forces, 28th of March, 2007;

[50] *Ibid.*;

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

[52] Ronald O'Rourke, Navy Attack Submarine Force-Level Goal and Procurement Rate: Background and Issues for Congress, CRS Report RL32418, Updated 11th of June, 2007;

[53] Ronald O'Rourke, 2007; *Ibid.*;

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Arleigh Burke-class and DD-963 Spruance-class destroyers, and cruisers of the CG-47 Ticonderoga class. At the end of 2006, the Navy had 88 cruisers and destroyers.[54] The CG-47 cruiser has 127 vertical launchers, and the DDG-51 and DD-963 destroyers have 90 and 61 respectively.[55] The ships' vertical launchers accommodate not just land-attack cruise missiles but also anti-submarine and anti-aircraft defense weapons, so that the number of cruise missiles actually deployed in them is usually from one third to one half of the maximum load capability.

In 2008, the Navy had 11 aircraft carriers in service, and it plans to maintain this number through to 2015. There are plans to build 2 new nuclear aircraft carriers, the CVN-77 George H. W. Bush, and the CVN-78 Gerald Ford, which will replace the CV-63 Kitty Hawk and CV-65 Enterprise.[56] Fighters of the F/A-18C/D (Hornet) and F/A-18 E/F (Super Hornet) class play the role of attack aircraft. Aircraft carriers usually carry 36 planes of these types.[57]

The data presented in the Table 1 illustrates potential U.S. conventional counterforce capability by 2015. It assumes that relatively hard-to-detect delivery systems are primary platforms to carry out neutralizing strikes (planes of the stealth type, submarine-launched and air-launched cruise missiles). Potential for using air bombs and air-land 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, 'invisible' B-2 bomber would seem to be the most effective platform among existing ones.

Table 1. 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 deployed PGMs
B–2	20	320
SSN–688 (Los Angeles) class	7	56
SSN–719 (Providence) class	31	620
SSN–774 (Virginia) class	10–12	200–240
SSGN (Ohio) class	4	616
B–52H	56	1120
Total	128-130	2932 – 2956

If the U.S. Navy and Air Force carry out their programs to deploy ballistic missiles with conventional warheads, the number of PGMs posing a threat to Russia's Strategic Nuclear Force (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

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

[55] This data is published on the website GlobalSecurity.org: http://www.globalsecurity.org/military/systems/ship/index.html

[56] Aircraft Carriers, U.S. Navy Fact File;

[57] V. N. Shunkov, Avianesushchiye Korabli I Morskaya Aviatsiya (Aircraft Carriers and Naval Aviation), "Popurri", Minsk, 2003, 576 p.

[58] The existing US Navy plan envisages deployment of up to four conventional warheads on each of the 28 submarine-launched "Trident" ballistic missiles (two SLBMs on each of the 14 submarines). The US Air Force plans to deploy a few dozen ICBM "Minitmen-2" or "MX". See: Anatoli Diakov and Eugene Miasnikov, 2007; *Ibid.*;

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 be theoretically used too to carry out a disarming strike. The strategic B-1B bombers alone would be capable of delivering more than 1,600 PGMs to their targets.

3. Precision-guided weapons in a strategic context

In making a thorough study and analysis of the potential dangers arising from development of PGMs, we should not go to the other extreme and exaggerate their impact on the nuclear deterrent's viability. For a start, unlike a nuclear counterforce strike, mass use of PGM to neutralize the 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, an operations using PGMs takes much longer to carry out (at least several days rather than several hours), and during such an operation the other side may respond with its surviving nuclear forces in accordance with its stated military doctrine. Of course, it is a lot more difficult to make the decision to launch a nuclear strike in response to an attack using only conventional weapons than to a nuclear attack, since the aggressor could follow with a nuclear strike in return. But the aggressor can never be sure that its attack using only PGM would not provoke a nuclear strike in response, not to mention the fact the missile attack warning systems would not be able to distinguish initially between a conventional and a nuclear attack. The United States' different approach in its operations against Yugoslavia and Iraq on the 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 conflict putting the U.S.A. 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 a completely out-of-the-blue attack, the silo-based ICBMs are capable to carry out a counterstrike. If the warning comes with enough time still to act, dispersed, camouflaged mobile missiles protected by anti-aircraft defenses can act as backup in the case of rapid strikes against silos by PGM with short flight times or using stealth technology. The time it takes to deploy mobile ICBMs and equip them with MIRV (multiple independently-targeted re-entry vehicle) warheads can be rapidly decreased 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 rapidly find and destroy, and which could be used to attack the U.S. allies and the forward troops and forces supporting the disarming strike operation. 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 PGM is completely out of proportion with the real or imagined advantages to be gained from the operation, especially with the Cold War now over and a world in which the big powers are ever-more economically and politically interdependent, whatever the particular international contradictions that divide them.

The growing counterforce capability of PGM in the USA, and in the future in other countries too, most likely, stems objectively from the development of attack and information means and technology, which is practically impossible to stop or substantially restrict, all the more so when one considers the great diversity of their possible uses. This capability can indeed threaten the viability of Russia's strategic nuclear forces, and the Russian leadership will take this account in assessing its nuclear deterrent needs. With the nuclear deterrent still a force to be reckoned with, it is not worth exaggerating the direct military threat of PGM and the likelihood of their being used in a mass attack against Russia. But if this threat remains even only at a hypothetical level, it will create a serious obstacle to further reductions of nuclear arms and associated efforts to strengthen the nuclear non-proliferation 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 increase combat effectiveness at regional and local level, and to counter WMD proliferation and international terrorism, these weapons have begun to have a destabilizing effect on military relations between the USA, Russia and other great powers. In so doing they are starting to undermine the nuclear non-proliferation regime and the prospects for cooperation between countries to deal with 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 they developed new weapons systems on a unilateral or bloc basis.

Along with prospective development of missile defense and space weapon systems, the development of PGM will help to create even greater obstacles on the road to full nuclear disarmament. Complete disarmament has once again came to a focus 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.

4. Outlook for an Agreement on precision-guided weapons

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 arms reduction treaty between the USA and Russia that is supposed to replace START after 2009, to maintain the principle of counting warheads on strategic delivery systems irrespective of whether they are nuclear or conventional, which would also 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, and probably new partners on other continents (this ban should be also maintained with regard to deploying strategic delivery systems outside national territory, and should be subsequently extended to tactical nuclear weapons too.

Another measure could be to limit the areas where submarines carrying cruise missiles can patrol in order to prevent the possibility of large-scale deployment of U.S. submarines near Russian territory and vice versa. This would at the same time resolve other problems raised on numerous occasions by Russia during strategic arms limitation talks: a ban on concealed anti-submarine activity in areas where strategic missile submarines are deployed, and 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 strategic and attack submarines when underwater) an agreement of this kind would have an even greater stabilizing effect: it would limit capability for launching a counterforce strike with a short flight duration, and would reduce incentives to keep strategic nuclear forces on high state of readiness in order to launch a retaliatory strike upon receiving the alert from the early warning system.

Of course, verifying compliance with such an agreement would be very difficult, given that concealment is the main tactics of submarine fleets. But the required 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 party with concerns, 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 the party with concerns requests that the other party's submarine be ordered to surface, the risk of violations being caught out is quite high if the order comes and the other party's submarine surfaces in a prohibited area or chooses not to surface at all. Such an agreement could be necessary in any case given that other countries are also developing submarine fleets now and the danger of a provocative submarine-launched strike is increasing.

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The threats that mass-scale deployment of PGM pose to the nuclear non-proliferation regime are not limited to the problems examined here. If one country or bloc gains overwhelming superiority in these effective types of weapons, it could encourage threshold states to speed up their efforts to acquire nuclear weapons as an asymmetrical form of protection. 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 non-proliferation issues.