Appendix 12A. World nuclear forces, 2007

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I. Introduction

Eight nuclear weapon states possessed roughly 11 530 operational nuclear weapons as of January 2007 (see table 12A.1). Several thousand nuclear weapons are kept on high alert, ready to be launched within minutes. If all nuclear warheads are counted—operational warheads, spares, and those in both active and inactive storage—the United States, Russia, the United Kingdom, France, China, India, Pakistan and Israel together possessed an estimated total of more than 26 000 warheads.[1] A ninth state, the Democratic People's Republic of Korea (DPRK, or North Korea), demonstrated a nuclear weapon capability when it carried out a nuclear test explosion in 2006, but whether it has developed any operational nuclear weapons is not known.

All of the five legally recognized nuclear weapon states, as defined by the 1968 Treaty on the Non-proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT),[2] appear determined to remain nuclear weapon powers for the foreseeable future and are in the midst of or have plans for modernizing their nuclear forces. Russia and the USA are in the process of reducing their operational nuclear forces from cold war levels as a result of two bilateral treaties: the 1991 Treaty on the Reduction and Limitation of Strategic Offensive Arms (START I Treaty) and the 2002 Strategic Offensive Reductions Treaty (SORT).[3] The USA plans to reduce its total stockpile by almost half by 2012. It also intends to begin production of new nuclear warheads for the first time since the end of the cold war. Similarly, Russia has announced a plan to reduce its strategic forces—mainly by eliminating its intercontinental ballistic missiles (ICBMs)—but also to retain for another decade, rather than dismantling, its ICBMs equipped with multiple independently targetable re-entry vehicles (MIRVs). Russia is in the final phases of developing or has introduced a new ICBM, a new class of strategic submarines with a new submarine-launched ballistic missile (SLBM), and a new cruise missile. Tables 12A.2 and 12A.3 show the composition of the deployed nuclear forces of the USA and Russia, respectively.

[1] In this appendix 'stockpile' refers to the total inventory of nuclear warheads, and 'operational warheads' and 'arsenal' refer to that portion of the stockpile that is available for delivery by missiles and aircraft.

[2] The NPT was opened for signature on 1 July 1968 and entered into force on 5 Mar. 1970. According to the treaty, only states that manufactured and exploded a nuclear device prior to 1 Jan. 1967 are legally recognized as nuclear weapon states. By this definition, China, France, Russia, the UK and the USA are the nuclear weapon states parties to the NPT. For a brief description of the NPT and a list of the signatories and parties to the treaty see annex A in this volume.

[3] The START I Treaty was signed on 31 July 1991 by the USA and the USSR; it entered into force on 5 Dec. 1994 for Russia and the USA. Under the 1992 Lisbon Protocol, which also entered into force on 5 Dec. 1994, Belarus, Kazakhstan and Ukraine assumed the obligations of the former USSR under the treaty. For the text of the START I Treaty see URL <http://www.state.gov/www/global/arms/starthtm/start/toc.html>. SORT was signed by Russia and the USA on 24 May 2002 and entered into force on 1 June 2003. For the text of SORT see URL <http://www.state.gov/t/ac/trt/18016.htm>. For brief descriptions of both treaties see annex A in this volume. On the implications of SORT see 'Special section', *Arms Control Today*, vol. 32, no. 5 (June 2002), pp. 3–23.

Table 12A.1. World nuclear forces, by number of deployed warheads, January 2007

Country	Strategic warheads	Non-strategic warheads	Total number of warheads
USA	4 545	500	5 045[a]
Russia	3 284	2 330	5 614[b]
UK	~160	–	~160[c]
France	348	–	348
China	~145	?[d]	~145
India			~50[e]
Pakistan			~60[e]
Israel			≤100[e]
North Korea			~6[f]
Total			**~11 530**

[a] The total US stockpile, including reserves, contains *c*. 10 000 warheads.

[b] The total Russian stockpile contains *c*. 15 000 warheads, of which *c*. 9300 are in storage or awaiting dismantlement.

[c] The British deployed arsenal is said to consist of fewer than 160 warheads, but the UK probably also has a small number of spares for a total stockpile of about 195 warheads. Some warheads on British strategic submarines have sub-strategic missions.

[d] It is not certain whether China has non-strategic warheads.

[e] The stockpiles of India, Israel and Pakistan are thought to be only partly deployed.

[f] North Korea carried out a nuclear test explosion in Oct. 2006, but there is no public information to verify that it has weaponized its nuclear capability. The number shown is an estimate of the number of warheads that North Korea could produce based on calculations of its stockpile of separated plutonium.

The nuclear arsenals of the UK, France and China are considerably smaller than those of the USA and Russia, but all three states have plans to deploy new nuclear weapons or have announced their intention to do so. Data on their delivery vehicles and nuclear warhead stockpiles are presented in tables 12A.4, 12A.5 and 12A.6, respectively. China will soon deploy a new generation of strategic missiles and cruise missiles, but it remains unclear whether it intends to deploy a significantly larger strategic nuclear force or a more modern force of roughly the same size. France is currently engaged in developing and deploying a new generation of nuclear-powered ballistic missile submarines (SSBNs, from 'ship submersible ballistic nuclear'), SLBMs and air-launched nuclear weapons. The number of operational warheads may decrease somewhat with the introduction of the new SLBM around 2010. Unlike any of the other nuclear weapon states, France continues to deploy nuclear weapons on a surface ship in peacetime. The British nuclear weapon stockpile has levelled out at just under 200 warheads. In 2006 the British Government announced its intention to build a new class of strategic submarines to replace its Trident fleet but to make modest reductions in its operational nuclear weapons.

It is particularly difficult to find reliable public information about the operational status of the nuclear arsenals of the three states that are believed to possess nuclear weapons but are not parties to the NPT: India, Pakistan and Israel. What information is available is often contradictory or inaccurate. India and Pakistan are both thought to be expanding their nuclear strike capabilities, while Israel seems to be waiting to

see how the situation in Iran develops. Tables 12A.7, 12A.8 and 12A.9 present information about the status of the Indian, Pakistani and Israeli nuclear arsenals, respectively. The figures in the tables are estimates based on public information and contain some uncertainties, as reflected in the notes.

II. US nuclear forces[4]

The USA maintains approximately 5045 operational nuclear warheads, of which roughly 4545 are strategic and 500 are non-strategic (see table 12A.2).[5] Another 260 warheads are held as spares. In addition to this operational arsenal, roughly 5000 warheads are in the responsive force or the inactive reserve or are awaiting dismantlement. Thus, the USA has a total stockpile of just over 10 000 warheads.

Of the current US stockpile, more than 4000 warheads are expected to be retired by 2012 for eventual dismantlement as a result of the 2004 Nuclear Weapons Stockpile Plan.[6] Most of these excess warheads will come from the large reserve of inactive warheads, while a smaller number will come from warheads removed from operational status as a result of the implementation of SORT. This will leave a stockpile of nearly 6000 warheads by 2012.

In 2006 the administration of President George W. Bush proposed a comprehensive plan to revitalize the US nuclear weapon production complex. The plan, known as Complex 2030, includes the resumption of nuclear warhead production for the first time since the cold war.[7] The new series of warheads will be known as Reliable Replacement Warheads (RRWs). The US Government has said that the RRWs will have wider performance margins, be simpler to maintain and be tailored for the type of deterrence missions envisioned for the 21st century. The design of the first warhead, known as the RRW-1, is based on a primary warhead (the SKUA-9, used to test secondary warheads during the cold war) and a secondary warhead, which were tested together four times in the 1980s. The RRW-1 will use insensitive high explosives, will have a fire-resistant pit and enhanced security features to prevent unauthorized use, and will be encased in the Mk-5 re-entry body, which is used for the W88 warhead (currently deployed on the Trident II (D-5) SLBM). Delivery of the first production unit is planned for 2012–14, when the RRW-1 will begin to replace W76 warheads on the Trident II (D-5). The intention appears to be to replace most or all types of warhead in the stockpile with RRWs.

In an effort to 'ensure that stockpile and infrastructure transformation is not misperceived by other nations as "restarting the arms race"', the Bush Administration

[4] This section draws heavily on information gathered by Hans M. Kristensen, director of the Nuclear Information Project at the Federation of American Scientists (FAS). See URL <http://www.nukestrat.com>.

[5] The 5045 warheads represent a reduction of nearly 500 compared with the estimate in *SIPRI Yearbook 2006*. The reduction is due to the downloading of some ICBMs, the temporary omission of 2 SSBNs from the count during their missile conversion and new information obtained about the composition of the arsenal.

[6] The classified Nuclear Weapons Stockpile Plan was submitted to the US Congress on 3 June 2004. US Department of Energy, National Nuclear Security Administration, 'Administration plans significant reduction in nuclear weapons stockpile', News release, Washington, DC, 3 June 2004, URL <http://www.nnsa.doe.gov/newsreleases.htm>.

[7] US Department of Energy (DOE), National Nuclear Security Administration, *Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threat of the 21st Century*, DOE/NA-0013 (DOE: Washington, DC, Oct. 2006).

announced in 2006 that it would increase warhead dismantlements planned for financial year (FY) 2007 by nearly 50 per cent compared to FY 2006 and would increase the average annual warhead dismantlements at the Pantex Plant by 25 per cent.[8] However, since the rate of dismantlement at Pantex has been slow in recent years (100 or fewer warheads per year), increasing the average rate by 25 per cent would have only a limited effect on reducing the stockpile. In fact, the US Department of Energy (DOE) estimates that dismantlement of the current backlog and warheads retired as a result of the 2004 Nuclear Weapons Stockpile Plan will not be completed until 2023,[9] corresponding to the dismantlement of an average of approximately 250 warheads per year. Instead, the priority is to extend the life of the remaining nearly 6000 warheads indefinitely.

In parallel with these adjustments to the US nuclear forces, the Department of Defense (DOD) has upgraded its nuclear strike plans to reflect new presidential guidance and a transition in war planning from the Single Integrated Operational Plan (SIOP) of the cold war era to a set of smaller and more flexible strike plans. The new central strategic war plan is known as OPLAN (Operations Plan) 8044. General Richard B. Meyers, chairman of the Joint Chiefs of Staff, described some of the planning changes in congressional testimony in February 2005: '[US Strategic Command] has revised [the USA's] strategic deterrence and response plan that became effective in the fall of 2004. This revised, detailed plan provides more flexible options to assure allies, and dissuade, deter, and if necessary, defeat adversaries in a wider range of contingencies'.[10]

One example of these changes is CONPLAN (Concept Plan) 8022, a plan for the quick use of nuclear, conventional or information warfare capabilities to destroy—pre-emptively, if necessary—'time-urgent targets' anywhere in the world. Secretary of Defense Donald Rumsfeld issued an Alert Order in early 2004 that directed the US military to put CONPLAN 8022 into effect. As a result, the pre-emption policy of the Bush Administration is now operational for nuclear forces.

Land-based ballistic missiles

The US ICBM force is undergoing significant changes as part of the USA's implementation of SORT. It is estimated that approximately 900 warheads were deployed on 500 ICBMs as of January 2007, some 150 fewer warheads than the estimated number in 2006. This reduction was due to the downloading of Minuteman III missiles of the 341st Wing at Malmstrom Air Force Base (AFB), Montana, to a single re-entry vehicle (SRV) configuration. The download, which began in mid-2005, involves 150 of the wing's 200 missiles and is scheduled for completion in mid-2008. The 50 remaining missiles will be deactivated in 2007 to implement the decision set out in the 2006 Quadrennial Defense Review to reduce the US ICBM force from 500 to 450 missiles by 2008. The Minuteman III missiles of the 91st Wing

[8] D'Agostino, T. P., Deputy Administrator for Defense Programs, National Nuclear Security Administration, Statement before the House Armed Services Committee Subcommittee on Strategic Forces, 5 Apr. 2006, URL <http://www.nnsa.doe.gov/docs/congressional/2006/2006-04-05_HASC_Transformation_Hearing_Statement (DAgostino).pdf>, p. 10.

[9] D'Agostino (note 8), p. 8.

[10] Myers, R. B., US Air Force, Chairman of the Joint Chiefs of Staff, Posture statement before the Senate Armed Services Committee, URL <http://www.senate.gov/~armed_services/statemnt/2005/February/Myers 02-17-05.pdf>, 17 Feb. 2005, p. 32.

Table 12A.2. US nuclear forces, January 2007

Type	Designation	No. deployed	Year first deployed	Range (km)[a]	Warhead loading	No. of warheads
Strategic forces						
Bombers[b]						
B-52H	Stratofortress	85/56	1961	16 000	ALCM 5–150 kt	984[c]
					ACM 5–150 kt	400
B-2	Spirit	21/16	1994	11 000	Bombs	533[d]
Subtotal		*106/72*				*1 917*
ICBMs[e]						
LGM-30G	Minuteman III					
	Mk-12	50[f]	1970	13 000	3 x 170 kt	150
		150			1 x 170 kt	150
	Mk-12A	150	1979	13 000	2–3 x 335 kt	450
		100			1 x 335 kt	100
	Mk-21 SERV[g]	50	2006	13 000	1 x 300 kt	50
Subtotal		*500*				*900*
SSBNs/SLBMs[h]						
UGM-133A	Trident II (D-5)					
	Mk-4	?	1992	>7 400	6 x 100 kt	1 344
	Mk-5	?	1990	>7 400	6 x 475 kt	384
Subtotal		*288*				*1 728*
Total strategic forces						**4 545**
Non-strategic forces						
B61-3, -4 bombs		n.a.	1979	n.a.	0.3–170 kt	400[i]
Tomahawk SLCM		320	1984	2 500	1 x 5–150 kt	100[j]
Total non-strategic forces						**500**
Total						**5 045**[k]

ALCM = air-launched cruise missile; ACM = Advanced Cruise Missile; ICBM = intercontinental ballistic missile; kt = kiloton; n.a. = not applicable; SERV = security-enhanced re-entry vehicle; SLBM = submarine-launched ballistic missile; SLCM = sea-launched cruise missile; SSBN = nuclear-powered ballistic missile submarine; ? = unknown.

[a] Aircraft range is given for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

[b] The first figure in the *No. deployed* column is the total number of B-52H bombers in the inventory, including those for training, testing and reserve. The second figure is for primary mission inventory aircraft, i.e. the number of operational aircraft assigned for nuclear and conventional wartime missions.

[c] Another 360 ALCM warheads are in reserve.

[d] Available for both the B-52H and B-2A bombers, but the B-2A is thought to be the main bomb-delivery vehicle.

[e] The 2006 Quadrennial Defense Review decided to reduce the ICBM force by 50 missiles to 450 by 2008. The download of most Minuteman ICBMs to a single warhead to meet the warhead ceiling mandated by the 2002 Strategic Offensive Reductions Treaty (SORT) is underway. The W62 (Mk-12) will be retired by 2009. The 450 missiles will carry a total of 500 warheads with hundreds more in reserve for upload if necessary.

[f] The 50 missiles of the 564th Missile Squadron at Malmstrom Air Force Base are scheduled for withdrawal from service in 2007.

[g] The SERV programme converts the W87/Mk-21 warhead previously deployed on the Peacekeeper ICBM for deployment on the Minuteman III ICBM.

[h] Two of 14 SSBNs are undergoing conversion from the C-4 missile.

[i] As many as 400 bombs (including possibly inactive weapons) are deployed in Europe.

[j] Another 190 W80-0 warheads are in inactive storage.

[k] Another 260 warheads are spares and roughly 5000 warheads are kept in the responsive force or inactive stockpile or are awaiting dismantlement, giving a total stockpile of just over 10 000 warheads. In addition, more than 12 000 plutonium pits are stored at the Pantex Plant in Texas.

Sources: US Department of Defense, various budget reports and press releases; US Department of Energy, various budget reports; US Department of State, START I Treaty Memoranda of Understanding, 1990–July 2006; US Department of Defense, various documents obtained under the Freedom of Information Act; US Air Force, US Navy and US Department of Energy, personal communications; 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; US Naval Institute, *Proceedings*, various issues; and Authors' estimates.

at Minot AFB, North Dakota, will also begin downloading to meet the SORT limit. Once completed, the ICBM force will carry 500 warheads on 450 missiles with several hundred additional warheads held in reserve for potential upload in a crisis.

In October 2006 the US Air Force (USAF) began replacing 170-kiloton W62 warheads on the Minuteman III ICBMs at Warren AFB with the modified 300-kt W87/Mk-21 security-enhanced re-entry vehicle (SERV). The W87 warhead was previously deployed on the Peacekeeper (MX) ICBM until the missile was withdrawn from service in 2005. Each reconfigured Minuteman III will carry one W87 but can be equipped with up to two warheads. The greater explosive power of the W87 will broaden the range of hardened targets that can be held at risk with the Minuteman force. The last W62 warhead will be retired by 2009.

Work continued in 2006 on modernizing the guidance and propulsion systems of the Minuteman ICBM force. Four Minuteman III missile test launches were conducted in 2006 from Vandenberg AFB, California. The missiles test-launched on 16 February and 7 April each carried one unarmed re-entry vehicle; those test-launched on 14 June and 20 July each carried three unarmed re-entry vehicles. The missiles tested in February and June flew to the normal range of 7725 kilometres to Kwajalein atoll in the Marshall Islands. The missiles launched in July flew 6760 km, also to Kwajalein, but those launched in April flew to an 'extended range' of 8200 km. The purpose of the longer flight was to test the Minuteman III ICBM at a range more in line with actual strike plans. The February launch was the third and final verification flight of the W87/Mk-21 SERV warhead.

Work is continuing on the design of a new ICBM to begin replacing Minuteman III missiles from 2018. The Mission Need Statement (MNS) for the new ICBM states that nuclear weapons will 'continue to play a unique and indispensable role in US security policy' and that a credible and effective land-based nuclear deterrent force 'beyond 2020' will 'prepare the US for an uncertain future by maintaining US qualitative superiority in nuclear war-fighting capabilities in the 2020–2040 time frame'.[11]

[11] US Department of the Air Force, Headquarters, Air Force Space Command/Data Records Management, 'Final mission need statement (MNS), AFSPC 001-00: land-based strategic nuclear deterrent', Acquisition Category One (ACAT I), 18 Jan. 2002, p. 2.

Ballistic missile submarines

The USA continues to retrofit the two remaining SSBNs that carried the Trident I (C-4) SLBM with the longer-range and more accurate Trident II (D-5) missile, with the SSBNs USS *Henry M. Jackson* and USS *Alabama* scheduled to become operational in 2007 and 2008, respectively. The other 12 SSBNs carry 288 Trident II (D-5) SLBMs, each of which is estimated to carry an average of six warheads for a total of roughly1728 warheads. With the completion of the Trident II (D-5) conversion of the *Henry M. Jackson* and the *Alabama*, the SLBM force will increase to 336 Trident II (D-5) missiles in the next two years.[12]

After moving five Atlantic Ocean-based SSBNs to the Pacific Ocean in 2002–2005, thereby boosting the US Pacific SSBN fleet to nine boats, the US Navy announced in 2006 that USS *Alaska* would be moved to Kings Bay, Georgia, in 2008.[13] In the future, eight SSBNs will patrol in the Pacific and six in the Atlantic, which means that the US sea-based deterrent will continue to be focused on China and other countries in the Pacific region.

Procurement of the Trident II (D-5) SLBM ended in 2006. In 2008 the US Navy will begin production of a modified Trident II (D-5) missile known as Trident II (D-5) Life-Extended (D5LE). A total of 108 missiles are to be built by 2011, at a cost of more than $4 billion, with initial deployment planned for 2013. The D5LE will arm the Ohio Class SSBNs for the rest of their service lives, which have been extended from 30 years to 44 years. The oldest ship is scheduled to be retired in 2029, at which point it is planned that a new SSBN class will become operational. The D5LE may also arm the UK's next class of SSBNs.

Four Trident II (D-5) missiles were flight-tested in 2006. On 9 May USS *Alaska* (SSBN-732) launched two Trident II (D-5) missiles towards Kwajalein from a position off the coast of California. USS *Maryland* (SSBN-738) launched two Trident II (D-5) missiles from the waters off Florida on 21 November, marking the 116th and 117th consecutive successful Trident II (D-5) launches conducted by the US Navy since the missile was deployed in 1990. The 21 November test included the third and final development test of the new arming, firing and fusing (AF&F) system for the W76-1 warhead, which is scheduled to begin deployment from September 2007.

The development of the AF&F system for the W76 warhead is part of a three-part upgrade (formally called a life extension) of the warhead. The new fuse will 'enable [the] W76 to take advantage of [the] higher accuracy of the D-5 missile' to hold at risk a wider range of targets, including hardened targets.[14] The increased accuracy of the W76-1 warhead may also permit a reduction of its explosive yield. Another upgrade involves the development of an 'accuracy adjunct' for the Mk-4 re-entry

[12] The USA will count only 12 of its 14 submarines as operational, because 2 are normally in dry dock for refit.

[13] 'Navy to move USS *Alaska* to Kings Bay', News4Georgia.com, 7 June 2006, URL <http://www.news4georgia.com/9334494/detail.html>.

[14] US Department of Energy (DOE), Office of Defense Programs, *Stockpile Stewardship and Management Plan: First Annual Update, October 1997* (DOE: Washington, DC, Oct. 2006), pp. 1–14. See also Nanos, G. P., Director, US Strategic Systems Program, 'Strategic systems update', *Submarine Review*, Apr. 1997, pp. 12–17.

vehicle to enhance the accuracy of the W76-1/Mk-4 and to enable deployment of conventional warheads on the Trident II (D-5) SLBM.[15]

Long-range bombers

The size of the US bomber force remained unchanged in 2006, but the aircraft and their nuclear weapons continued to be upgraded. Close to 2000 nuclear warheads are earmarked for delivery by B-52H and B-2 bombers, including W80-1 warheads for delivery on air-launched cruise missiles (ALCMs) and B61-7, B61-11, B83-0 and B83-1 gravity bombs.

The USAF has decided to retire the Advanced Cruise Missile (ACM), possibly as early as 2008.[16] The decision to retire the missile, which carried the W80 warhead, is part of a larger plan to reduce the number of W80 warheads. The life extension of the warhead has been put on hold (only design work will continue) and the inventory of ALCMs will be reduced to 528 by 2012.[17]

The ongoing Avionics Midlife Improvement (AMI) programme for the B-52H bomber—the only carrier of ALCMs and ACMs—to improve the aircraft's navigation and nuclear weapon delivery capabilities is expected to be completed in September 2008. The existing USAF satellite communications (AFSATCOM) radio will also be replaced by extremely high frequency (EHF) radio to improve communications in nuclear strike scenarios.

The USAF is studying options for a new long-range strike aircraft that would eventually replace the current US bomber force. It is also studying options for a new nuclear cruise missile.

Non-strategic nuclear weapons

As of January 2007 the USA retained approximately 500 active non-strategic nuclear warheads. Another 1155 non-strategic warheads were in inactive storage. Despite the significant numbers of warheads (Russia probably retains many more), neither the 2001 US Nuclear Posture Review nor SORT addresses non-strategic nuclear weapons.[18]

Up to 400 B61 bombs are deployed at eight airbases in six European NATO member states (Belgium, Germany, Italy, the Netherlands, Turkey and the UK). The aircraft of non-nuclear weapon NATO states that are assigned nuclear strike missions

[15] In the 2006 Quadrennial Defense Review the DOC indicated that it would replace nuclear warheads on 24 Trident II (D-5) missiles with 96 conventional warheads for deployment in 2008. However, The US Congress has been unwilling to fund the programme and instead asked the DOD to conduct a study on the implications for crisis stability of mixing nuclear and conventional ballistic missiles.

[16] Kristensen, H. M., 'US Air Force decides to retire advanced cruise missile', Federation of American Scientists Strategic Security blog, 7 Mar. 2007, URL <http://www.fas.org/blog/ssp/2007/03/us_air_force_decides_to_retire.php>.

[17] Burg, R., US Air Force, Strategic Security Directorate, 'ICBMs, helicopters, cruise missiles, bombers and warheads', Presentation to the US Senate Armed Services Committee Subcommittee on Strategic Forces, Washington, DC, 28 Mar. 2007.

[18] On the 2001 Nuclear Posture Review see US Department of Defense, 'Nuclear Posture Review [excerpts], submitted to Congress on 31 December 2001', 8 Jan. 2002, URL <http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm>, p. 17; and Kristensen, H. M. and Kile, S. N., 'World nuclear forces', *SIPRI Yearbook 2003: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2003), pp. 612–13.

with US nuclear weapons include Belgian and Dutch F-16 and German and Italian Tornado combat aircraft.[19] The US arsenal in Europe may include inactive bombs.

Only 100 W80-0 warheads for the Tomahawk cruise missile (TLAM/N, from Tomahawk land attack missile, nuclear) are active; another 190 are in inactive storage. The TLAM/N is earmarked for deployment on selected Los Angeles, Improved Los Angeles and Virginia Class nuclear-powered attack submarines (SSNs, from ship submersible nuclear). It is not deployed at sea under normal circumstances but can be redeployed within 30 days of a decision to do so. All TLAM/N missiles are stored at the strategic weapons facilities at Bangor, Washington, and Kings Bay, Georgia.

Nuclear warhead stockpile management and modernization

The US stockpile of just over 10 000 warheads is organized in two categories: active and inactive warheads. The active category includes intact warheads (with all the components) that are deployed on operational delivery systems, are part of the 'responsive force' of reserve warheads that can be deployed on operational delivery systems in a relatively short time or are spares. The inactive category includes warheads that are held in long-term storage as a reserve with their limited-life components (tritium) removed. As SORT and the 2004 Nuclear Weapons Stockpile Plan are implemented over the next five years, the 'responsive force' will gradually increase to contain roughly twice as many warheads as there are operationally deployed warheads. In addition to the approximately 10 000 active and inactive warheads, the USA keeps about 5000 plutonium cores (pits) in storage at the Pantex Plant as a strategic reserve. Approximately the same number of canned assemblies (thermonuclear secondaries) are kept at the Oak Ridge Y-12 Plant in Tennessee. Another 10 000 pits held at Pantex make up most of the 34 tonnes of weapon-grade plutonium previously declared in excess of military needs by the administration of President Bill Clinton. All of the nearly 15 000 pits at Pantex come from retired warheads. Production of plutonium pits has resumed at Los Alamos on a small scale and the current US Administration has proposed building a consolidated plutonium facility with the capacity to produce about 125 pits per year by 2013.

III. Russian nuclear forces

In 2006 Russia continued to reduce its strategic nuclear forces in accordance with its commitments under SORT and as part of a doctrinal shift away from a 'substantially redundant' (*suschestvenno izbytochnyi*) towards a 'minimally sufficient' (*garantirovanno dostatochnyi*) deterrence posture. At the same time, Russia reaffirmed that it would retain for the foreseeable future all three elements—ICBMs, SLBMs and strategic bombers—of its nuclear 'triad' (see table 12A.3). According to a senior Russian military planner, Russia's strategic nuclear forces can still guarantee 'minimally sufficient' deterrence until 2015–20 within the force ceilings imposed by SORT, even

[19] On the history and status of US nuclear weapons in Europe see Kristensen, H. M., *U.S. Nuclear Weapons in Europe: A Review of Post-Cold War Policy, Force Levels, and War Planning* (Natural Resources Defense Council: Washington, DC, Feb. 2005), URL <http://www.nrdc.org/nuclear/euro/contents.asp>.

if the USA develops a ballistic missile defence (BMD) system.[20] However, he said that qualitative upgrades would be needed to enhance the Russian nuclear triad's survivability and ability to penetrate missile defences. Accordingly, Russia would prioritize the procurement of the SS-27 Topol-M land-based and SS-NX-30 Bulava SLBM systems, while continuing efforts to extend the service lives of older missile systems as an interim measure.[21]

In early 2007 Russia announced plans to procure another 10 SS-N-23 Skiff SLBMs and 7 SS-27 Topol-M ICBMs, 3 of them road-mobile and 4 silo-based.[22]

There were unconfirmed reports in the Russian press that part of the A-135 anti-ballistic missile interceptor system around Moscow may have been withdrawn from service.[23] The system became operational in 1968 and was modernized in 1989. The long-range SH-11 Gorgon (51T6) interceptors may have been retired in full or in part, leaving only four (or possibly five) shorter-range SH-10 Gazelle (53T6) interceptor sites operational. An SH-10 Gazelle missile was test-launched at Sary-Shagan on 5 December 2006.[24]

Land-based ballistic missiles

The ICBMs assigned to the Russian Strategic Rocket Forces (SRF) have traditionally made up the largest element of the Soviet/Russian strategic nuclear forces. The SRF currently consists of three missile armies with 13 missile divisions: the 27th Guards Missile Army (headquarters in Vladimir, five divisions), the 31st Missile Army (Orenburg, three divisions) and the 33rd Guards Missile Army (Omsk, five divisions).[25]

Russia has on combat duty 76 SS-18 Satan (R-36M) heavy ICBMs in two versions: the R-36MUTTKh and the R-36M2 Voevoda, deployed in Dombarovsky and Uzhur.[26] The former was first deployed in 1979–83 and the latter in 1988–92. Both are silo-based, two-stage, liquid-propellant ICBMs.[27]

As of January 2007 Russia's roughly 40 remaining R-36MUTTKh missiles had been in service for approximately 25 years.[28] Russia is reportedly pursuing a technical programme, called Zaryad'ye, to extend the service life of both versions of the SS-18 ICBM. As part of this programme, some SS-18 ICBMs that have reached the end of their service life are refurbished as space launch vehicles (SLVs) and used to place

[20] Umnov, S., 'SYaS Rossii: naraschivaniye vozmozhnostey po preodoleniyu protivoraketnoy oborony' [Russia's SNF: building up ballistic missile defence penetration capacities], Interview with Lieutenant General Vladimir Vasilenko, head of the Fourth Central Scientific Research Institute of the Russian Ministry of Defence, *Voenno-Promyshlennyi Kur'er*, 8–14 Mar. 2006, URL <http://www.vpk-news.ru/article.asp?pr_sign=archive.2006.125.articles.conception_01>.

[21] Umnov (note 20).

[22] Khudoleev, V., 'Nash otvet: "Topol'-M"' [Our response: 'Topol-M'], *Krasnaya Zvezda*, 20 Feb. 2007, URL <http://www.redstar.ru/2007/02/20_02/1_01.html>.

[23] 'Raketu ispytali bez tseli' [Missile was tested without the target], *Kommersant*, 6 Dec. 2006, p. 4.

[24] 'Raketu ispytali bez tseli' (note 23).

[25] US Department of State, START I Treaty Memorandum of Understanding, Jan. 2007.

[26] US Department of State (note 25).

[27] Lennox, D. (ed.), *Jane's Strategic Weapon Systems* (Jane's Information Group: Coulsdon, July 2006), pp. 128–30.

[28] Interfax-AVN, 'Russian commander says "heavy" ICBMs to remain in service another decade', 12 Nov. 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

Table 12A.3. Russian nuclear forces, January 2007

Type and Russian designation (NATO/US designation)	No. deployed	Year first deployed	Range (km)[a]	Warhead loading	No. of warheads
Strategic offensive forces					
Bombers					
Tu-95MS6 (Bear H-6)	32	1981	6 500–10 500	6 x AS-15A ALCMs, bombs	192
Tu-95MS16 (Bear-H16)	32	1981	6 500–10 500	16 x AS-15A ALCMs, bombs	512
Tu-160 (Blackjack)	14	1987	10 500–13 200	12 x AS-15B ALCMs or AS-16 SRAMs, bombs	168
Subtotal	*78*				*872*
ICBMs					
RS-20 B/V (SS-18 Satan)	76	1979	11 000–15 000	10 x 500–750 kt	760
RS-18 (SS-19 Stiletto)	123	1980	10 000	6 x 500–750 kt	738
RS-12M Topol (SS-25 Sickle)	243	1985	10 500	1 x 550 kt	243
RS-12M2 Topol-M (SS-27)	44	1997	10 500	1 x 550 kt	44
RS-12M1 Topol-M (SS-27)	3	2006	10 500	1 x 550 kt	3
Subtotal	*489*				*1 788*
SLBMs					
RSM-50 (SS-N-18 M1 Stingray)	80	1978	6 500	3 x 200 kt	252
RSM-54 Sineva (SS-N-23 Skiff)	96	1986	9 000	4 x 100 kt	384
Subtotal	*180*				*636*
Total strategic offensive forces	**743**				**3 284**
Strategic defensive forces					
ABMs[b]					
51T6 (SH-11 Gorgon)	32	1989		1 x 1000 kt	32
53T6 (SH-08 Gazelle)	68	1986		1 x 10 kt	68
Non-strategic forces					
Land-based non-strategic bombers					
Tu-22M (Backfire)	116	1974		2 x AS-4 ASMs, bombs	
Su-24 (Fencer)	371	1974		2 x bombs	
Subtotal	*487*				*974*[c]
Naval non-strategic attack aircraft					
Tu-22M (Backfire)	58	1974		2 x AS-4 ASMs, bombs	
Su-24 (Fencer)	58	1974		2 x bombs	
Subtotal	*116*				*232*[c]
SLCMs					
SS-N-12, SS-N-19, SS-N-21, SS-N-22					266
ASW and SAM weapons					
SS-N-15/16, torpedoes, SA-N-3/6					158
Total strategic defensive and non-strategic forces					**2 330**
Total					**5 614**

ABM = anti-ballistic missile; ALCM = air-launched cruise missile; ASM = air-to-surface missile; ASW = anti-submarine warfare; ICBM = intercontinental ballistic missile; kt = kiloton; NATO = North Atlantic Treaty Organization; SAM = surface-to-air missile; SLBM = submarine-launched ballistic missile; SLCM = sea-launched cruise missile; SRAM = short-range attack missile.

[a] Aircraft range is given for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

[b] The Gorgon missile may have been retired. The SA-10 Grumble, SA-12A Gladiator, SA-12B Giant and S-400 Triumf may have some capability against some ballistic missiles. About 600 nuclear warheads may be associated with them.

[c] Figure includes warheads for all land-based and naval aircraft.

Sources: US Department of State, START I Treaty Memoranda of Understanding, 1990–Jan. 2007; US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, Ohio, Mar. 2006), URL <http://www.nukestrat.com/us/afn/threat.htm>; US Central Intelligence Agency, National Intelligence Council, 'Foreign missile developments and the ballistic missile threat through 2015' (unclassified summary), Dec. 2001, URL <http://www.fas.org/spp/starwars/CIA-NIE.htm>; US Department of Defense, 'Proliferation: threat and response', Washington, DC, Jan. 2001, URL <http://www.fas.org/irp/threat/prolif00.pdf>; World News Connection, National Technical Information Service (NTIS), US Department of Commerce, various issues; 'Russia: general nuclear weapons developments', Nuclear Threat Initiative/Monterey Institute Center for Nonproliferation Studies, URL <http://www.nti.org/db/nisprofs/russia/weapons/gendevs.htm>; Russianforces.org; International Institute for Strategic Studies, *The Military Balance 2005–2006* (Routledge: London, 2005); Cochran, T. B. et al., *Nuclear Weapons Databook Volume IV: Soviet Nuclear Weapons* (Harper & Row: New York, N.Y., 1989); *Proceedings*, US Naval Institute, various issues; 'NRDC nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; Safronov, I., 'Raketu ispytali bez tseli' [The rocket was tested without a target], *Kommersant*, 6 Dec. 2006, p. 4; and Authors' estimates.

commercial or military satellites into space.[29] On 12 July 2006 the SRF successfully launched a Dnepr SLV—a modified R-36MUTTKh missile—which put into orbit a US satellite, the Genesis 1.[30] The missile used had been on combat alert for 'over 20 years'.[31] On 26 July another Dnepr SLV, built from an R-36MUTTKh missile that had been on combat alert for 25 years, was launched from Baikonur, Kazakhstan. It was supposed to put into orbit 18 satellites but exploded shortly after lift-off.[32]

The service life of the newer R-36M2 Voevoda missile was originally set at 15 years but was extended to 20 years in 2006 after successful testing in the Zaryad'ye programme. On 21 December 2006 an R-36M2 missile that had been on combat alert for 19 years was successfully launched from Dombarovsky in Orenburg oblast. The simulated warheads reportedly reached their targets at the Kura test range in Kamchatka. Following the test, the SRF reiterated its intention to extend the mis-

[29] Safronov, I. and Lantratov, K., 'Ukrainskaya "Satana" razbilas' vmeste so sputnikami' [Ukrainian 'Satana' crashed along with satellites], *Kommersant*, 28 July 2006; and Umnov (note 20).

[30] Alekseev, V., 'Mirnyi naryad "Voevody"' [Peaceful guise of 'Voevoda'], *Nezavisimoe Voennoe Obozrenie*, 21 July 2006, URL <http://nvo.ng.ru/armament/2006-07-21/6_voevoda.html>.

[31] Interfax-AVN, 'Russia to keep RS-20 missile in service for at least another 10 years', 12 July 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[32] Safronov and Lantratov (note 29).

sile's service life to 25 years and to keep it on combat alert until 2016.[33] On 3 March 2006, Russia had signed an agreement with Ukraine on a joint programme to extend the service life of the R-36M2.[34]

Russia has 123 SS-19 Stiletto (RS-18) missiles deployed at Kozelsk and Tatischevo.[35] The SS-19 is a silo-based, two-stage, liquid-propellant ICBM capable of carrying up to six warheads. The SS-19 Stiletto is considered to be the most reliable of Russia's missiles. Of 159 test launches performed up to January 2007, only three are reported to have failed.[36] On 9 November 2006 an SS-19 missile was launched from Baikonur. A single dummy warhead was reported to have hit its target at the Kura range.[37] Based on the results of the test the SRF decided to extend the missile's service life to 30 years. Russia also has programmes to convert SS-19 missiles to Rokot and Strela SLVs.[38] A Rokot SLV was successfully launched on 28 July 2006 from the Plesetsk test site and put a satellite into orbit.[39]

Russia has 243 SS-25 Sickle (RS-12M) ICBMs deployed in nine missile divisions across the country.[40] The SS-25 is a road-mobile, three-stage solid-propellant ICBM that carries a single warhead. The missile was first deployed in 1985 and production ceased in 1994. According to Russian press reports, 144 SS-25s are expected to be in service in 2010.[41] The SRF intends to extend the SS-25 missile's original 10-year service life to 23 years or more, in which case it will remain operational until 2016–18. As part of the service life-extension programme, an SS-25 missile was successfully launched from the Plesetsk test site on 3 August 2006.[42]

The SS-27 Topol-M missile is a three-stage solid-propellant ICBM developed in both road-mobile (RS-12M1) and silo-based (RS-12M2) versions, which the missile's designers say use standardized and interoperable components.[43] As of January 2007 the SRF had deployed 47 Topol-M missiles of both versions.[44] The Russian Minister of Defence, Sergei Ivanov, has announced plans to procure 'tens of silo-based . . . and

[33] 'Pusk mezhkontinental'noy ballisticheskoy rakety RS-20V ("Voevoda")' [Launch of the intercontinental ballistic missile RS-20V ('Voevoda')], Information and Public Relations Service, Russian Strategic Rocket Forces, 21 Dec. 2006, URL <http://www.mil.ru/848/1045/1275/rvsn/19220/index.shtml?id=19753>.

[34] Matarykin, V., 'Ukraine, Russia sign contract to extend RS-20 service life', ITAR-TASS, 3 Mar. 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[35] US Department of State (note 25).

[36] 'Russian company to make ICBM into space rocket', ITAR-TASS, 10 Nov. 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[37] Interfax-AVN, 'Intercontinental ballistic missile successfully hits target at training range', 9 Nov. 2006, URL <http://www.interfax.ru/e/B/politics/28.html?id_issue=11 619144>.

[38] Zaytsev, Y., 'Kosmos: puti konversii' [Outer space: ways of conversion], RIA Novosti, 21 Nov. 2006, URL <http://www.rian.ru/analytics/20061121/55853307.html>.

[39] Russian Federal Space Agency, 'Kompsat-2 launch', 28 July 2006, URL <http://www.roscosmos.ru/Start1Show.asp?STARTID=611>.

[40] US Department of State (note 25).

[41] Safronov, I., 'Russian missiles will die of old age', *Kommersant*, 1 Apr. 2005.

[42] 'Raketa "Topol" porazila uslovnuyu tsel'' ['Topol' missile has hit a simulated target], Vesti.ru, 3 Aug. 2007, URL <http://www.vesti.ru/news.html?id=97109>.

[43] Pulin, G., 'Formiruetsya perspektivnyi oblik SYaS' [The future look of SNF is being shaped], *Voenno-Promyshlennyi Kur'er*, 5–11 Apr. 2006, URL <http://www.vpk-news.ru/article.asp?pr_sign=archive.2006.129.articles.army_02>.

[44] US Department of State (note 25).

more than 50 road-mobile Topol-M missiles between 2007 and 2015'.[45] The RS-12M2 was first deployed in 1997 with the 60th Missile Division in Tatischevo, Saratov oblast. In 2006 two additional missiles entered service there, bringing the total number deployed at Tatischevo to 44.[46] On 10 December 2006 Russia deployed for the first time three RS-12M1 missiles, which entered service at the 54th Missile Division in Teikovo, Ivanovo region.[47]

Russia is working to enhance the capability of the SS-27 ICBM's warheads to penetrate ballistic missile defences.[48] On 22 April 2006 the SRF successfully launched a K65M-R missile (a modification of the Kosmos-3M SLV) from the Kapustin Yar test site, Arkhangelsk oblast, to the Balkhash test range in Kazakhstan. According to press reports, the launch was a part of a programme to develop a new re-entry vehicle that would be mountable on both the SS-27 and SS-NX-30 ICBMs (see below). It is reported to be capable of manoeuvring in flight in order to penetrate missile defence systems.[49] In March 2006, options for equipping the SS-27 missile with three warheads, using the technology developed for the phased-out intermediate-range ballistic missile (IRBM) SS-20 Saber, were demonstrated for Ivanov by the Moscow Institute of Thermal Technology.[50]

Ballistic missile submarines

The Russian Navy operates 13 SSBNs in its Northern and Pacific fleets. Of these, six are Delta III Class (Project 667BDR Kalmar) submarines.[51] Some Russian experts have suggested that the ships of this class, which entered service in 1982, may be retired by 2010.[52] However, it was reported in November 2004 that the Russian Navy plans to have 208 SLBMs by 2010, which will not be possible if the Delta III Class is retired.[53] The Russian Navy also operates six Delta IV Class (Project 667BDRM Delfin) submarines, all of which are based in the Northern Fleet. Four of these—the *Bryansk*, the *Tula*, the *Verkhotur'e* and the *Yekaterinburg*—are currently in service, the *Bryansk* and the *Tula* having returned from overhaul in January and October

[45] Russian State Duma, Transcript of the Plenary Session, 7 Feb. 2007, URL <http://wbase.duma.gov.ru/steno/nph-sdb.exe> (Author's translation). See also Isachenkov, V., 'Russia plans new ICBMs, nuclear subs', *Washington Post*, 7 Feb. 2007.

[46] ARMS-TASS, 'RVSN budut poluchat' ezhegodno po 5–6 MBR "Topol'-M"' [SRF will be receiving 5–6 Topol-M ICBMs annually], 15 Dec. 2006, URL <http://armstass.su/?page=article&aid=34150&cid=25>.

[47] Babkin, S. and Kuznetsov, V., 'Russian strategic troops to get MIRVed missiles', ITAR-TASS, 15 Dec. 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[48] RIA Novosti, 'Russia to re-equip its new mobile ICBMs with multiple warheads -1', 15 Dec. 2006, URL <http://en.rian.ru/russia/20061215/56980585.html>.

[49] Safronov, I., 'Rossiya skreschivayet boegolovki' [Russia interbreeds warheads], *Kommersant*, 24 Apr. 2006. The new re-entry vehicle was first tested on 1 Nov. 2005.

[50] Safronov, I., 'Sergei Ivanov ukreplyaet raketno-yadernyi schit rodiny' [Sergei Ivanov strengthens nuclear missile shield], *Kommersant*, 15 Mar. 2006.

[51] The *Petropavlovsk-Kamchatskii*, *Svyatoi Georgii Pobedonosets*, *Zelenograd* and *Podol'sk* submarines are deployed with the Pacific Fleet, and the *Ryazan'* and *Borisoglebsk* are with the Northern Fleet.

[52] 'Iz-pod vody dostali' [Reached from under water], *Kommersant Business Guide*, 4 July 2006, URL <http://www.kommersant.ru/application.html?DocID=686179>.

[53] 'Mnogoletnie plany Miniborony' [Long-term plans of the Defence Ministry], *Kommersant*, 18 Nov. 2004, p. 3.

2006, respectively. In November 2006 two Delta IV Class submarines—the *Kareliya* and the *Novomoskovsk*—entered the Zvezdochka shipyard to undergo service life-extension overhauls and refitting with upgraded SS-N-23 Skiff missiles.[54] The six Delta IV Class submarines may remain in service until 2015–20.

The Russian Navy operates one Typhoon Class submarine, renamed the *Dmitrii Donskoi* following its overhaul and relaunch in June 2002, as a test platform for the new SS-NX-30 Bulava missile.[55] Russian military officials indicated in 2005 that this and the two remaining Typhoon Class submarines—the *Arkhangel'sk* and the *Severstal'*, which were laid up in 2004 for financial reasons—are to be upgraded by replacing their obsolete SS-N-20 Sturgeon SLBMs with the SS-NX-30.[56]

Russia is building three SSBNs of a new class, the Project 955 Borei, which does not yet have a NATO designation. The first submarine in the class, the *Yurii Dolgorukii*, was launched on 15 April 2007, 11 years after the keel was laid down. The second and third ships in the new class, the *Aleksandr Nevskii* and the *Vladimir Monomakh*, were laid down at the Sevmash shipyard in March 2004 (tentatively commissioned for 2009) and March 2006 (tentatively commissioned for 2011), respectively.[57] These SSBNs will be longer than the *Yurii Dolgorukii* and will be armed with 16 rather than 12 SS-NX-30 SLBMs.[58] The construction of the fourth Borei Class submarine is expected to begin in 2007.[59] According to Ivanov, the government plans to have eight Borei Class SSBNs by 2015.[60]

Russia's SLBM force currently consists of two types of missile. The SS-N-18 M1 Stingray (RSM-50) is deployed on Delta III Class submarines. It has two liquid-fuelled stages and carries three warheads.[61] On 10 September 2006 the Delta III Class SSBN the *Svyatoi Georgii Pobedonosets* launched a Stingray SLBM from waters off Simushir Island in the Pacific Ocean. The simulated warheads reportedly hit their target at the Chizha test range in north-western Russia.[62]

The SS-N-23 Skiff (RSM-54 Sineva) SLBM, a successor to the SS-N-18, was first test-launched in 1983. The missile underwent a modernization programme in 1996–2002, including the development of an improved warhead. The upgraded version of

[54] Interfax-AVN, 'SSBN *Kareliya* enters Zvezdochka yard for medium repair', 2 Nov. 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce; 'Tula rejoins Russian Navy fleet after refit', *Jane's Missiles & Rockets*, vol. 10, no. 3 (Mar. 2006), p. 14; and Popov, A., '"Begemot" ego proslavil' ['Begemot' made him famous], *Severnyi Rabochii*, 30 Nov. 2006, URL <http://www.nworker.ru/article.phtml?id=4616>.

[55] The Soviet Union built 6 Typhoon Class (Project 941 Akula) SSBNs in 1976–89. Russia decommissioned 3 in 1996.

[56] Tul'ev, M., 'V interesah triady' [In the interest of the triad], *Voenno-Promyshlennyi Kur'ier*, 11 May 2005, URL <http://www.vpk-news.ru/article.asp?pr_sign=archive.2005.83.articles.army_03>; and Interfax-AVN, 'Russian defense minister on plans to equip new submarines with Bulava missiles', 28 Sep. 2005, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[57] 'Iz-pod vody dostali' (note 52).

[58] 'Atomnyi podvodnyi kreiser "Yurii Dolgorukii" gotovitsya k spusku' [SSBN 'Yurii Dolgorukii' is being prepared for launch], Lenta.ru, 26 July 2006, URL <http://lenta.ru/news/2006/07/26/submarine/>.

[59] 'Novyye podvodnyye lodki' [New submarines], *Vzglyad*, 19 Mar. 2006, URL <http://www.vz.ru/society/2006/3/19/26532.html>; and Nikol'skii, A., 'Oruzhiya ne khvatit' [Coming short of weapons], *Vedomosti*, 7 Aug. 2006.

[60] Isachenkov (note 45).

[61] Lennox (note 27), pp. 149–50.

[62] Russian Federal Space Agency, 'Ob uspeshnykh ucheniyakh morskikh strategicheskikh yadernykh sil Rossii' [On successful manoeuvres of Russian sea-based strategic nuclear forces], 28 July 2006, URL <http://www.federalspace.ru/NewsDoSele.asp?NEWSID=1809>.

the missile, known in Russia as Sineva ('the Blue'), is being installed on Delta IV Class SSBNs undergoing overhaul. The Sineva missile has the same range as the SS-N-23 but can carry up to 10 warheads, according to the US Air Force.[63] Four Sineva SLBMs were delivered in 2006 and there are plans to procure another 10 in 2007.[64] The missile was test-launched three times in 2006. On 24 May 2006 an attempt to launch the Shtil SLV (a modified SS-N-23) from the *Yekaterinburg* SSBN at an underwater position in the Barents Sea was reportedly postponed due to a technical failure. A successful launch two days later put the COMPASS-2 satellite into orbit.[65] On 30 June 2006 a Delta IV Class SSBN identified in press reports as the *Tula* launched an SS-N-23 from an underwater position in the Barents Sea. A single simulated unarmed re-entry vehicle hit its target at the Kura range.[66] On 9 September 2006 the *Yekaterinburg* reportedly successfully fired an SS-N-23 SLBM from a position near the North Pole to the Chizha test range.[67]

Russia is giving high priority to the development of a new three-stage, solid-propellant SLBM, the SS-NX-30 (RSM-56 Bulava).[68] The missile will reportedly have a maximum range of 8300 km.[69] Russia has declared that the Bulava will be attributed under START counting rules as carrying six warheads.[70] All three test launches of the Bulava in 2006 ended in failure. On 7 September and 25 October 2006 the Typhoon Class SSBN the *Dmitrii Donskoi* launched Bulava missiles from submerged positions in the Barents Sea towards the Kura test range, but in both cases the missiles failed shortly after launch. On 24 December 2006 the *Dmitrii Donskoi* attempted to launch a Bulava missile from a surface location, but this time the third stage of the missile exploded before it reached the Kura test range.[71]

Prior to the 2006 failures, the Bulava test programme was scheduled to include 10 flight tests, which were to be completed by the end of 2007, in time for the launch of the first Borei Class SSBN.[72] The head of the Russian Space Agency, Anatolii Per-

[63] US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, Ohio, Mar. 2006), URL <http://www.nukestrat.com/us/afn/threats.htm>.

[64] Khudoleev (note 22).

[65] Safronov, I., 'Severnyi flot pomog seismologam' [The Northern Fleet helped seismologists], *Kommersant*, 29 May 2006.

[66] ITAR-TASS, 'Nose cone of RSM-54 ballistic missile hits target on Kamchatka', 30 June 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce; and RIA Novosti, 'Atomnyi raketonosets "Tula" sovershil pusk ballisticheskoi rakety' ['Tula' SSBN launched a ballistic missile], 30 June 2006, URL <http://www.rian.ru/defense_safety/weapons/20060630/50709481.html>.

[67] Russian Federal Space Agency (note 62).

[68] President Vladimir Putin declared in his 2006 Annual Address to the Federal Assembly that the Russian Navy would soon commission new SSBNs carrying strategic weapons for the first time since 1990, and that those submarines would be equipped with the 'new Bulava missile system, which together with the Topol-M system will form the backbone of our strategic deterrent force'. Putin, V., President of the Russian Federation, Annual Address to the Federal Assembly of the Russian Federation, 10 May 2006, URL <http://www.kremlin.ru/eng/sdocs/speeches.shtml>.

[69] Lennox (note 27), p. 166.

[70] US Department of State (note 25).

[71] '"Bulava" s plech' ['Bulava' off shoulders], *Kommersant*, 26 Dec. 2006; and '"Bulavu" razberut na dvukh komissiyakh' ['Bulava' to be examined by two commissions], *Kommersant*, 27 Dec. 2006. On previous tests see Kile, S. N., Fedchenko, V. and Kristensen, H. M., 'World nuclear forces, 2006', *SIPRI Yearbook 2006: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2006), p. 652.

[72] 'Russia's Bulava undergoes fast-track test programme', *Jane's Missiles & Rockets*, vol. 10, no. 6 (June 2006).

minov, was quoted as saying after the third launch failure in 2006 that the Bulava would require 12–14 additional test launches, which would delay the operational deployment of the missile.[73]

Strategic aviation

Russia's strategic aviation units are grouped under the 37th Air Army of the Supreme High Command (Strategic) of the Russian Air Force. They include the 22nd Guards Heavy Bomber Division based in Engels and Ryazan, with 14 Tu-160 Blackjack, 17 Tu-95MS16 Bear-H16 and 7 Tu-95MS6 Bear-H6 aircraft; and the 326th Heavy Bomber Division, based in Ukrainka, Khabarovsk kray, with 15 Tu-95MS16 and 25 Tu-95MS6 aircraft.[74] The 37th Air Army also comprises four divisions of Tu-22M3 Backfire C bombers.[75] Ivanov announced in February 2007 that Russia plans to have a total of 50 Tu-160 and Tu-95MS bombers in service by 2015.[76]

In July 2006, one Tu-160 was returned to combat duty after modernization.[77] All remaining Tu-160s will undergo similar modernization.[78] The 2006 State Defense Order allocated funds for deployment of another Tu-160, but it did not enter service in 2006.[79]

In 2006 Russian strategic aviation participated in a number of military exercises. In March, 15 Tu-95MS bombers, accompanied by Il-78 Midas tanker aircraft and Su-27 Flanker support aircraft, took part in an exercise in northern Russia that reportedly included eight successful launches of cruise missiles.[80] On 14 April 2006 four Tu-95MS bombers from the 326th Heavy Bomber Division were joined at the Pemboy test range near Vorkuta by two Tu-160 and two Tu-95MS bombers of the 22nd Guards Heavy Bomber Division, with each aircraft successfully launching one cruise missile.[81] On 24 August 2006 two Tu-160 and two Tu-95MS bombers conducted training launches of cruise missiles during an exercise in northern Russia.[82] During the large-scale strategic aviation exercise held on 26–30 September 2006,

[73] '"Bulavu" razberut na dvukh komissiyakh' (note 71).

[74] US Department of State (note 25).

[75] 'Strategic Aviation', Russian Nuclear Forces Project, 2 Nov. 2005, URL <http://www.russianforces.org/eng/aviation/>; and Khudoleev, V., '37-ya derzhit kurs' [37th Army is following the course], *Krasnaya Zvezda*, 23 Dec. 2005, URL <http://www.redstar.ru/2005/12/23_12/1_02.html>.

[76] State Duma of the Russian Federation, Transcript of plenary session, 7 Feb. 2007, URL <http://wbase.duma.gov.ru/steno/nph-sdb.exe> (in Russian).

[77] Khudoleev, V., '37-ya derzhit kurs' [37th Army is following the course], *Krasnaya Zvezda*, 23 Dec. 2005, URL <http://www.redstar.ru/2005/12/23_12/1_02.html>; and Gavrilov, Y., '"Belyi aist" poluchaet imya' ['White stork' is given a name], *Rossiiskaya Gazeta*, 6 July 2006 .

[78] Pulin, G., 'Nam otvoditsya osnovnaya rol' v politike uprezhdeniya' [We are assigned to play a major role in the policy of pre-emption], *Voenno-Promyshlennyi Kur'ier*, 15 Feb. 2006, URL <http://www.vpk-news.ru/article.asp?pr_sign=archive.2006.122.articles.names_01>.

[79] 'Fradkov distributes defense order', *Kommersant*, 1 Dec. 2005.

[80] RIA Novosti, 'Russian bombers launch cruise missiles during exercises in Far North', 22 Mar. 2006, URL <http://en.rian.ru/russia/20060322/44647211.html>.

[81] ITAR-TASS, 'Eight strategic planes launch cruise missiles at targets near Vorkuta', 14 Apr. 2006, Translation from Russian, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[82] RIA Novosti, 'Russian strategic bombers launch cruise missiles in exercises', 22 Mar. 2006, URL <http://en.rian.ru/russia/20060824/53088583.html>.

Tu-160 and Tu-95MS aircraft launched at least three ALCMs at the Pemboy test range.[83]

IV. British nuclear forces

The UK possesses an arsenal of about 160 warheads that are available for use by a fleet of four Vanguard Class Trident SSBNs (see table 12A.4). It leases 58 Trident II (D-5) SLBMs, including spares, from the US Navy. Under a system of 'mingled asset ownership', Trident II (D-5) missiles to be loaded onto British submarines are randomly selected from the stockpile at the US Navy's Trident facility in Kings Bay, Georgia. The submarines then go to the Royal Naval Armaments Depot at Coulport, near Faslane in Scotland, where the missiles are fitted with warheads designed and manufactured at the UK's Atomic Weapons Establishment, Aldermaston. Each SSBN is equipped with 16 Trident II (D-5) missiles carrying up to 48 warheads. The warhead is similar to the US W76 warhead and has an explosive yield of about 100 kt. It is believed that a number of the Trident II (D-5) missiles are deployed with only one warhead instead of three; this warhead may also have a greatly reduced explosive yield, possibly produced by the detonation of only the fission primary.[84] The reduced force loading is in accordance with the sub-strategic role given to the Trident fleet in the British Ministry of Defence's 1998 Strategic Defence Review.[85] A 2002 addendum to the Strategic Defence Review extended the role of nuclear weapons to include deterring 'leaders of states of concern and terrorist organizations'.[86]

In a posture known as Continuous At Sea Deterrence (CASD), one British SSBN is on patrol at all times. The second and third SSBNs can be put to sea fairly rapidly with similar loadings. There are not enough missiles in the British inventory to arm the fourth submarine. Since the end of the cold war, the SSBN on patrol has been kept at a level of reduced readiness with a 'notice to fire' measured in days and its missiles de-targeted. There are reports that some patrol coordination takes place with France. The 300th British deterrent patrol will be completed in 2007.

The four Vanguard Class SSBNs were each designed to operate for almost another 20 years before reaching the end of their nominal service lives, beginning in the early 2020s. In March 2007 the British Parliament approved the government's plan to replace the Vanguard SSBNs in order to maintain a 'minimum nuclear deterrent capability necessary to provide effective deterrence'.[87] The British Government had

[83] Russian Nuclear Forces Project, 'Large-scale bomber exercise', 29 Sep. 2006, URL <http://russianforces.org/blog/2006/09/largescale_bomber_exercise.shtml>.

[84] Quinlan, M., 'The future of United Kingdom nuclear weapons: shaping the debate', *International Affairs*, vol. 82, no. 4 (July 2006).

[85] The 1998 Strategic Defence Review stated that 'the credibility of deterrence also depends on retaining an option for a limited strike that would not automatically lead to a full scale nuclear exchange' as a means of demonstrating resolve or conveying a political message. British Ministry of Defence (MOD), '*The Strategic Defence Review: Modern Forces for the Modern World*, Cm 3999 (MOD: London, July 1998), URL <http://www.mod.uk/DefenceInternet/AboutDefence/CorporatePublications/PolicyStrategyandPlanning/StrategicDefenceReview.htm>, p. 63.

[86] British Ministry of Defence, *The Strategic Defence Review: A New Chapter*, Cm 5566, vol. 1 (Stationery Office: London, July 2002), URL <http://www.mod.uk/DefenceInternet/AboutDefence/CorporatePublications/PolicyStrategyandPlanning/StrategicDefenceReviewANewChaptercm5566.htm>, p. 12.

[87] British Ministry of Defence and British Foreign and Commonwealth Office, *The Future of the United Kingdom's Nuclear Deterrent*, CM 6994 (Stationery Office: London, Dec. 2006), URL <http://

Table 12A.4. British nuclear forces, January 2007

Type and designation	No. deployed	Year first deployed	Range (km)	Warhead loading	No. of warheads
SLBMs					
Trident II (D-5)	48	1994	>7 400	1–3 x 100 kt	~160[a]

kt = kiloton; SLBM = submarine-launched ballistic missile; SSBN = nuclear-powered ballistic missile submarine.

[a] Fewer than 160 warheads are operationally available, up to 144 to arm 48 missiles on 3 of 4 SSBNs. Only 1 submarine is on patrol at any time, with up to 48 warheads. The UK—like the other 4 nuclear weapon states—probably also has a small reserve of inactive warheads. The size of this reserve is unknown but might include enough warheads to arm 1 submarine. This would give a total stockpile of close to 200 warheads.

Sources: British Ministry of Defence (MOD), White Papers, press releases and the MOD web-site, URL <http://www.mod.uk/issues/sdr/>; British House of Commons, *Parliamentary Debates (Hansard)*; Omand, D., 'Nuclear deterrence in a changing world: the view from a UK perspective', *RUSI Journal*, June 1996, pp. 15–22; Norris, R. S. et al., *Nuclear Weapons Databook*, vol. 5, *British, French, and Chinese Nuclear Weapons* (Westview: Boulder, Colo., 1994), p. 9; 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

concluded in its December 2006 White Paper, after 'an exhaustive review of possible future threats and deterrent options', that 'renewing the Trident system, by replacing the existing submarines and extending the life of the Trident missiles, is the best and most cost effective way to maintain our ability to deter future threats to the UK'.[88] Critics complained that the government had taken the decision to renew the Trident system without a public debate on whether the UK still needed a nuclear deterrent.[89]

In the 2006 White Paper, the government also proposed starting, in the near future, the design and construction work on a successor SSBN to the Vanguard Class that would enter service in the 2020s. It held out the possibility of purchasing three rather than four submarines but emphasized that this would not entail any change from the current CASD posture, which was deemed to be essential for 'invulnerability and assuredness' and to 'motivate the crews'.[90] The government proposed that the new SSBN might be equipped with the modified Trident II (D-5LE) SLBMs that the USA is building, thereby keeping the Trident II (D-5) missile in service until the early 2040s. To assuage concerns that the UK was not complying with its commitment under Article VI of the NPT to work in good faith towards nuclear disarmament, the government also proposed making a small reduction in its nuclear stockpile to 160

www.mod.uk/NR/rdonlyres/AC00DD79-76D6-4FE3-91A1-6A56B03C092F/0/DefenceWhitePaper2006_Cm6994.pdf>.

[88] British Ministry of Defence, 'Government announces intention to maintain the UK's nuclear deterrent', *Defence News*, 4 Dec. 2006, URL <http://www.mod.uk/DefenceInternet/DefenceNews/DefencePolicyAndBusiness/GovernmentAnnouncesIntentionToMaintainTheUksNuclearDeterrent.htm>.

[89] Johnson, R., 'The UK White Paper on renewing Trident: the wrong decision at the wrong time', *Disarmament Diplomacy*, no. 83 (winter 2006), URL <http://www.acronym.org.uk/dd/dd83/83uk.htm>; and British House of Commons, Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent: The White Paper*, 2 vols (Stationery Office: London, 7 Mar. 2007), URL <http://www.publications.parliament.uk/pa/cm/cmdfence.htm>.

[90] British Ministry of Defence and British Foreign and Commonwealth Office (note 87).

warheads. Additional warheads may be held in reserve. The White Paper deferred a decision until the next parliament on whether to refurbish or replace the current warheads. In the meantime, the MOD is to conduct a review of the optimum service life of the existing stockpile and examine a range of replacement options.

According to the White Paper, the procurement costs of the new submarines and associated infrastructure would be about £15–20 billion ($28.5–38 billion), at 2006 prices, for a four-boat fleet. Most of this cost (*c.* £1 billion, or $1.9 billion, per annum) would be incurred during the period 2012–27.[91]

V. French nuclear forces

France continues to modernize and upgrade its nuclear forces. It maintains an operational arsenal of about 348 nuclear warheads for delivery by SLBMs, carrier-based strike aircraft and land-based aircraft (see table 12A.5).

The backbone of France's nuclear deterrent is the Force Océanique Stratégique (FOST), which consists of a fleet of four operational SSBNs, of which three are of the new Triomphant Class and one is of the L'Inflexible Class (formerly Redoutable Class). The last L'Inflexible Class SSBN will be retired when the fourth and final vessel of the Triomphant Class, *Le Terrible*, enters service in 2010. The French Navy's SSBNs are armed with 16 Aérospatiale M45 missiles carrying up to six TN-75 warheads.[92] In 2010–15, beginning with *Le Terrible*, Triomphant Class SSBNs will be retrofitted with the longer-range M51.1 SLBM. The new missile will be armed with up to six TN-75 nuclear warheads and have a maximum range of 8000 km.[93] On 9 November 2006 an unarmed M51.1 missile was test-launched for the first time from the Landes Missile Launch Test Centre at Biscarosse, Aquitaine, over the Bay of Biscay.[94] The first flight test of the M51.1 with an unarmed re-entry vehicle is scheduled for 2007, and simulated underwater test launches are due to start in late 2008 at Toulon, Provence-Alpes-Côte d'Azur. The first underwater launch from a submarine is planned for 2010. A total of 10 test launches are planned.[95] On 29 December 2006 the French Ministry of Defence signed a €270 million ($349.6 million) contract with EADS Astirum for a follow-on version, the M51.2, which will carry the new Tête Nucléaire Océanique (TNO) warhead.[96] The M51.2 is scheduled to replace the M51.1 in 2015–17. The M51 SLBM will remain in service until after 2030.

[91] British Ministry of Defence and British Foreign and Commonwealth Office (note 87).

[92] Norris, R. S. and Kristensen, H. M., 'French nuclear forces, 2005', *Bulletin of the Atomic Scientists*, vol. 61, No. 4 (July/Aug. 2005), pp. 73–75.

[93] 'France's nuclear-powered *Le Vigilant* prepares for patrol', *Jane's Missiles & Rockets*, vol. 9, no. 2 (Feb. 2005), p. 5.

[94] 'France tests strategic missile', Global Security Newswire, 10 Nov. 2006, URL <http://www.nti.org/d_newswire/issues/2006_11_10.html>; and Agence France-Presse, 'France tests ballistic missile for nuclear deployment', Spacewar.com, 9 Nov. 2006, URL <http://www.spacewar.com/reports/France_Tests_Ballistic_Missile_For_Nuclear_Deployment_999.html>.

[95] Isby, D., 'M51 tests set to begin on schedule', *Jane's Missiles & Rockets*, vol. 10, no. 12 (Dec. 2006), p. 10.

[96] Tran, P., 'France inks missile, Link 16 contracts', *Defense News*, 19 Jan. 2007.

Table 12A.5. French nuclear forces, January 2007

Type	No. deployed	Year first deployed	Range (km)[a]	Warhead loading	No. of warheads
Land-based aircraft					
Mirage 2000N	60	1988	2 750	1 x 300 kt ASMP	50
Carrier-based aircraft					
Super Étendard	24	1978	650	1 x 300 kt ASMP	10
SLBMs[b]					
M45	48	1996	6 000[c]	6 x 100 kt	288
Total					**348**

ASMP = Air–Sol Moyenne Portée; kt = kiloton; SLBM = submarine-launched ballistic missile; SSBN = nuclear-powered ballistic missile submarine.

[a] Aircraft range is given for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

[b] The fourth and final Triomphant Class SSBN, *Le Terrible*, will replace *L'Inflexible* in 2010 and be retrofitted with the longer-range M51.1 SLBM.

[c] The range of the M45 SLBM is listed as only 4000 km in a 2001 report from the National Defence Commission of the French National Assembly.

Sources: French Ministry of Defense website, URL <http://www.defense.gouv.fr/>, various policy papers, press releases and force profiles; French National Assembly, various defence bills and reports; Norris, R. S. et al., *Nuclear Weapons Databook*, vol. 5, *British, French, and Chinese Nuclear Weapons* (Westview: Boulder, Colo., 1994), p. 10; *Air Actualités*, various issues; *Aviation Week & Space Technology*, various issues; 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

The air component of the French nuclear force consists of two types of aircraft: approximately 60 Mirage 2000N aircraft, which equip the three Air Force squadrons with nuclear strike roles; and about 24 Super Étendard aircraft deployed on the aircraft carrier *Charles de Gaulle*. Both types of aircraft carry the Air–Sol Moyenne Portée (ASMP) cruise missile. A total of 90 ASMP missiles have been produced, along with 80 TN81 300-kt warheads for them. It is estimated that France currently has about 60 operational ASMP missiles equipped with nuclear warheads, but additional missiles may be in inactive storage.[97] A new follow-on cruise missile, the ASMP-A (Air–Sol Moyenne Portée Améliorée), is under development by the company MBDA and will enter service in December 2008, one year later than originally expected. The nuclear-capable missile will initially equip one Mirage 2000N squadron and then a second squadron in September 2010. An Air Force Rafale F3 squadron is reportedly scheduled to receive the ASMP-A in December 2009, and the Navy's Rafale F3 combat aircraft will receive the missile in 2010.[98]

There has been a gradual evolution in France's nuclear doctrine since the end of the cold war. Although French officials continue to reject adoption of a no-first-use posture, they have emphasized the need for greater flexibility in meeting a widening range of plausible deterrence scenarios. On 19 January 2006 President Jacques Chirac

[97] Fiszer, M., 'French MoD to develop nuclear missile', *Journal of Electronic Defense*, vol. 26, no. 12 (Dec. 2003), p. 21.

[98] Isby (note 95).

delivered a speech at L'Ile-Longue nuclear submarine base setting out a new rationale for France's *force de frappe* (nuclear deterrent force).[99] In the speech he cited the dangers of regional instability, growing extremism and the proliferation of weapons of mass destruction (WMD) and said that France's nuclear deterrent remained the fundamental guarantor of its security. He threatened to retaliate with nuclear weapons against any state found to be supporting terrorism against France or considering the use of WMD. Chirac revealed that French nuclear forces had already been reconfigured to enable them to destroy the power centres of any state sponsoring a terrorist attack against France. This involved, among other measures, reducing the number of nuclear warheads on SLBMs to allow more precisely targeted strikes. He did not say whether France was prepared to carry out pre-emptive nuclear strikes against a country that it regarded as a threat. The doctrinal change announced by Chirac was similar to one made by the UK in 2002 and, to a lesser extent, the USA.

VI. Chinese nuclear forces

China is estimated to have an arsenal of approximately 145 operational nuclear weapons for delivery mainly by ballistic missiles and aircraft. Additional warheads may be in reserve, giving a total stockpile of some 200 warheads. The size of the Chinese nuclear stockpile is thought not to have changed significantly for many years. In February 2006 the director of the US Defense Intelligence Agency repeated an estimate that has been cited by various US government agencies since the mid-1990s that China has over 100 nuclear warheads operationally deployed on ballistic missiles and some additional warheads in storage.[100] Some non-governmental analysts have calculated that China's operational arsenal may be as small as 80 warheads.[101] In 2004 the Chinese Foreign Ministry stated that China possessed 'the smallest nuclear arsenal' of all the legally recognized nuclear weapon states.[102]

China has a long-term nuclear force modernization programme under way. According its 2006 Defence White Paper, China 'upholds the principles of counterattack in self-defense and limited development of nuclear weapons, and aims at building a lean and effective nuclear force' while pledging not to enter into a nuclear arms race with any other country.[103] It also reiterates that China 'remains firmly committed to the policy of no first use of nuclear weapons at any time and under any circumstances'.

[99] Chirac, J., 'Speech by Jacques Chirac, President of the French Republic, during his visit to the Strategic Air and Maritime Forces at Landivisiau/L'Ile Longue', 19 Jan. 2006, URL <http://www.elysee.fr/elysee/elysee.fr/anglais/speeches_and_documents/2006/speech_by_jacques_chirac_president_of_the_french_republic_during_his_visit_to_the_stategic_forces.38447.html>.

[100] Maples, M. D., Director, US Defense Intelligence Agency, 'Current and projected national security threats to the United States', Statement for the record, US Senate Armed Services Committee, 28 Feb. 2006, URL <http://www.dia.mil/publicaffairs/Testimonies/statement24.html>; and Kristensen, H. M., Norris, R. S. and McKinzie, M. G., *Chinese Nuclear Forces and U.S. Nuclear War Planning* (Federation of American Scientists and Natural Resources Defense Council: Washington, DC, Nov. 2006), URL <http://www.fas.org/nuke/guide/china/Book2006.pdf>, p. 37.

[101] Lewis, J., 'The ambiguous arsenal', *Bulletin of the Atomic Scientists*, vol. 61, no. 3 (May/June 2005), pp. 52–59.

[102] Chinese Ministry of Foreign Affairs, 'Fact sheet: China: nuclear disarmament and reduction of [nuclear weapons (?)]', Beijing, 27 Apr. 2004, URL <http://www.fmprc.gov.cn/eng/wjb/zzjg/jks/cjjk/2622/t93539.htm>.

[103] Chinese State Council, *China's National Defence in 2006* (Information Office of the State Council of the People's Republic of China: Beijing, Dec. 2006), URL <http://www.china.org.cn/english/features/book/194421.htm>.

Table 12A.6. Chinese nuclear forces, January 2007

Type and Chinese designation (US designation)	No. deployed	Year first deployed	Range (km)[a]	Warhead loading	No. of warheads
Strategic weapons					
Land-based missiles					
DF-3A (CSS-2)	16	1971	3 100[b]	1 x 3.3 Mt	16
DF-4 (CSS-3)	22	1980	>5 500	1 x 3.3 Mt	22
DF-5A (CSS-4)	20	1981	13 000	1 x 4–5 Mt	20
DF-21A (CSS-5)	35	1991	2 100[b]	1 x 200–300 kt	35
DF-31 (?)	0	(2007)	~7 250	1 x ?	0
DF-31A (?)	0	(2008–2010)	~11 270	1 x ?	0
Subtotal	*93*				*93*
SLBMs					
JL-1 (CSS-NX-3)[c]	12	1986	>1 770	1 x 200–300 kt	12
JL-2 (?)	0	(2008–2010)	>8 000	1 x ?	0
Subtotal	*12*				*12*
Aircraft[d]					
H-6 (B-6)	20	1965	3 100	1 x bomb	~20
Attack (Qian-5, others?)	?	1972–?	?	1 x bomb	~20
Subtotal	*>20*				*~40*
Total strategic weapons					**~145**
Non-strategic weapons[e]					
Short-range ballistic missiles (DF-15 and DF-11)					?
Total					**~145**[f]

kt = kiloton; Mt = Megaton; SLBM = submarine-launched ballistic missile; ? = unknown.

[a] Aircraft range is given for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

[b] The range of the DF-3A and the DF-21A missiles may be longer than is normally reported.

[c] The JL-1 SLBM has never been fully operational.

[d] A small stockpile of bombs with yields between 10 kt and 3 Mt is thought to exist for delivery by aircraft. Chinese aircraft are not believed to have nuclear weapon delivery as a primary role. Figures for aircraft are for nuclear-configured versions only.

[e] The existence of tactical warheads is highly uncertain, but several low-yield nuclear tests in the 1970s and US Government statements in the 1980s and 1990s suggest that some tactical warheads may have been developed.

[f] Additional warheads are thought to be in storage. The total stockpile is believed to comprise *c.* 200 warheads.

Sources: Chinese Ministry of Foreign Affairs, various documents; US Department of Defense (DOD), Office of the Secretary of Defense, 'Military power of the People's Republic of China', Annual Report to Congress, various years, URL <http://www.defenselink.mil/pubs/china.html>; US Air Force, National Air and Space Intelligence Center (NASIC), various documents; US Central Intelligence Agency, various documents; US Department of Defense, 'Proliferation: threat and response', Washington, DC, Jan. 2001, URL <http://www.fas.org/irp/threat/prolif00.pdf>; Kristensen, H. M., Norris, R. S. and McKinzie, M. G., *Chinese Nuclear Forces and U.S. Nuclear War Planning* (Federation of American Scientists and Natural Resources Defense Council: Washington, DC, Nov. 2006), URL <http://www.fas.org/

nuke/guide/china/Book2006.pdf>; Norris, R. S. et al., *Nuclear Weapons Databook*, vol. 5, *British, French, and Chinese Nuclear Weapons* (Westview: Boulder, Colo., 1994); 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

There continues to be considerable uncertainty in the US intelligence community and among non-governmental researchers about the scope and pace of China's nuclear modernization programme.[104] In particular, it is unclear whether China intends to expand its force of nuclear-armed ballistic missiles significantly or to deploy newer, more survivable missiles in a force of roughly the same size as it has today.

China's land-based ballistic missiles are operated by the People's Liberation Army's Second Artillery Corps (SAC). According to data published annually by the US DOD, in 2006 the SAC had two types of operationally deployed ICBM: the liquid-propellant, silo-based DF-5A (CSS-4) and the smaller, silo-based or transportable DF-4 (CSS-3).[105] China is developing two solid-propellant, road/rail-mobile ICBMs: the DF-31 and the longer-range DF-31A. On 4 September 2006 a DF-31 missile was successfully test-launched from the Wuzhai launch site towards the Taklimakan desert.[106] The US DOD forecast that that the DF-31 would achieve initial operational capability in 2006, but the missile was still not operational in early 2007. The deployment of the longer-range DF-31A is not expected before 2008–2010.

China currently deploys as part of its nuclear forces one type of medium-range ballistic missile (MRBM)[107]—the solid-propellant, road-mobile DF-21A (CSS-5)—and one type of IRBM—the liquid-propellant, surface-based DF-3A (CSS-2). In 2006 the US DOD increased its estimate of the size of the DF-21A stockpile.[108] The DF-21A supplements China's ageing DF-3A missiles.[109] The DF-3A and the DF-4 are expected to be completely replaced by the DF-31 once the latter enters service. The deployment of road-mobile ICBMs is intended to improve the survivability of China's long-range nuclear forces. The US intelligence community has stated that China might deploy multiple warheads on its DF-5A missiles to ensure the effectiveness of its deterrent against missile defence systems, but neither the DF-31 nor its variants are thought to be designed to carry multiple warheads.

The SAC celebrated its 40th anniversary in July 2006.[110] Shortly before this event Chinese President Hu Jintao announced a decision to 'carry out reforms and innovations' on the SAC, which would include improved military training and would focus

[104] Kristensen, Norris and McKinzie (note 100), p. 43; and Nuclear Threat Initiative, 'Expert study finds smaller Chinese nuclear arsenal', Global Security Newswire, 4 May 2006, URL <http://www.nti.org/d_newswire/issues/2006_5_4.html>.

[105] US Department of Defense (DOD), Office of the Secretary of Defense, *Military Power of the People's Republic of China 2006*, Annual report to Congress (DOD: Washington, DC, 2006), p. 50. This and previous years' reports are available at URL <http://www.defenselink.mil/pubs/china.html>.

[106] ITAR-TASS, 'China test launches intercontinental ballistic missile', 5 Sep. 2006.

[107] Although China has its own system for defining missile ranges, the US DOD definitions are used here: short-range = <1100 km; medium-range = 1100–2750 km; intermediate-range = 2750–5500 km; and intercontinental range = >5500 km. See Kristensen, Norris and McKinzie (note 100), p. 218.

[108] US Department of Defense (note 105). See also table 12.A.6; and Kile, Fedchenko and Kristensen (note 71), p. 658.

[109] US Department of Defense (DOD), Office of the Secretary of Defense, *Military Power of the People's Republic of China 2004*, Annual report to Congress (DOD: Washington, DC, 2004), p. 37.

[110] Xinhua, 'Account of Party Central Committee's care and concern for the strategic missile units', 5 July 2006, Translation from Chinese, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

on increasing the force's effectiveness and survivability in modern, high-intensity, information-centric conflicts.[111] The 2006 White Paper states that the SAC 'aims at progressively improving its force structure of having both nuclear and conventional missiles, and raising its capabilities in strategic deterrence and conventional strike under conditions of informationization'.[112]

As of early 2007 the Chinese submarine force consisted of approximately 55 operational ships, including about 50 diesel-powered ships, 3–5 nuclear-powered Han Class attack submarines and a single Type 092 (Xia Class) SSBN armed with 12 intermediate-range solid-propellant, single-warhead JL-1 (CSS-N-3) SLBMs. The Type 092 SSBN has never conducted a deterrent patrol.[113] This may change in the future because, according to the 2006 White Paper, the Chinese Navy 'aims at gradual extension of the strategic depth for offshore defensive operations and enhancing its capabilities in integrated maritime operations and nuclear counterattacks'.[114] To this end, China is developing the Type 094 (Jin Class) SSBN. The Type 094 ship is not expected to enter service before 2011 at the earliest. It will carry the intercontinental-range JL-2 SLBM, which is a modified DF-31 ICBM with a range of more than 8000 km.[115] In 2005 China carried out a successful test-launch of the JL-2 from a submerged submarine in the Pacific Ocean near the Shandong Peninsula.[116]

It is generally thought that China has a small stockpile of nuclear bombs earmarked for delivery by aircraft. Although the Chinese Air Force was not believed to have units whose primary purpose was to deliver nuclear bombs, the US National Security Council asserted in 1993 that 'some units [of the Chinese Air Force] may be tasked for nuclear delivery as a contingency mission'.[117] The most likely aircraft to have a nuclear role today are the H-6 bomber and perhaps a fighter-bomber. China is also developing land-attack cruise missiles that may be for delivery by the H-6. In 2005 a US DOD report stated that, once developed, there 'are no technological bars to placing on these systems a nuclear payload'.[118] The cruise missiles in development include the DH-10 and the YJ-63; the latter is capable of delivering a 500-kg warhead within a range of 400–500 km.[119]

[111] Nuclear Threat Initiative, 'China announces strategic missile plans', Global Security Newswire, 4 May 2006, URL <http://www.nti.org/d_newswire/issues/2006_6_30.html>; 'PLA 2nd Artillery Corps focuses on survivability', *Jane's Missiles & Rockets*, vol. 10, no. 9 (Sep. 2006), p. 7; and [Editorial: vigorously promoting innovation and development of military training in the new century and new stage], *Jiefangjun Bao*, 28 June 2006, URL <http://www.chinamil.com.cn/site1/ztpd/2006-06/28/content_511633.htm>, quoted in Chase, M., 'China's Second Artillery Corps: new trends in force modernization, doctrine and training', *China Brief*, vol. 6, no. 25 (19 Dec. 2006), URL <http://jamestown.org/images/pdf/ cb_006_025.pdf>.

[112] Chinese State Council (note 103).

[113] Kristensen, Norris and McKinzie (note 100), pp. 77–80.

[114] Chinese State Council (note 103).

[115] Different estimates suggest that the Type 094 SSBN would carry either 12 or 16 SLBMs. Kristensen, Norris and McKinzie (note 100), p. 83.

[116] 'China test-fires new submarine-launched missile', *Daily Yomiuri*, 18 June 2005; and 'China test fires long-range missile from submarine', *Jane's Missiles and Rockets*, vol. 9, no. 8 (Aug. 2005), p. 4.

[117] US National Security Council, 'Report to Congress on status of China, India and Pakistan nuclear and ballistic missile programs', [28 July 1993], p. 2.

[118] US Department of Defense (DOD), Office of the Secretary of Defense, *Military Power of the People's Republic of China 2005*, Annual report to Congress (DOD: Washington, DC, 2005), p. 29.

[119] Kristensen, Norris and McKinzie (note 100), p. 104–106.

VII. Indian nuclear forces

On the basis of an upper-bound estimate of its inventory of weapon-grade plutonium—520 kg at the end of 2005[120]—India has the material capacity to build an arsenal of more than 100 nuclear weapons. The estimate presented here, that the Indian arsenal holds about 50 nuclear weapons, is conservative. It is based on the lower range of a widely cited estimate of India's military plutonium inventory as well as on unclassified assessments made by the US intelligence community.[121]

Most published estimates of the size of the Indian nuclear stockpile are based on calculations of the total amount of weapon-grade plutonium that India has produced. There are several factors that introduce uncertainty into these calculations. First, there are different assessments of the lifetime operating capacity (the reliability and efficiency) of the 100-megawatt-thermal (MW(t)) Dhruva reactor and the ageing 40-MW(t) CIRUS reactor, which are dedicated to producing plutonium for military use.[122] Second, it is not known whether India has used non-weapon-grade plutonium (either in the form of reactor-grade plutonium or a mix of isotopes closer to weapon-grade plutonium) to manufacture nuclear weapons. Finally, there are different views on how to calculate the losses of nuclear material that occur during production, processing and testing.

Estimates of the size of the Indian nuclear stockpile must also take into account the evidence that India is not seeking to build the largest nuclear arsenal that it can. Numerous media and government reports have suggested that India has not manufactured as many nuclear weapons as it could given its material resources. Moreover, India appears to be separating less weapon-grade plutonium annually than it could, given the nominal capacities of its reprocessing plants.[123]

In 2006 there was considerable debate about the potential impact of the Indian–US Civil Nuclear Cooperation Initiative on India's nuclear weapon production capabilities.[124] Critics of the deal expressed concern about the unwillingness of the Indian Department of Atomic Energy to place the prototype fast breeder reactor (PFBR) under International Atomic Energy Agency (IAEA) safeguards as part of the plan to separate the country's nuclear programme into civilian and military components, pointing out that India's annual capacity to produce weapon-grade pluto-

[120] See appendix 12C, table 12C.2.

[121] Albright, D., 'India's military plutonium inventory, end of 2004', 7 May 2005, Institute for Science and International Security (ISIS), *Global Stocks of Nuclear Explosive Materials*, URL <http://www.isis-online.org/global_stocks/end2003/india_military_plutonium.pdf>. The estimate assumes that each warhead would require at least 5 kg of plutonium. See also US Defense Intelligence Agency, 'A primer on the future threat: the decades ahead: 1999–2020', July 1999, p. 38, reproduced in Scarborough, R., *Rumsfeld's War* (Regnery: Washington, DC, 2004), pp. 194–223.

[122] In 2006 India announced that it would shut down the CIRUS reactor in 2010. 'Implementation of India–United States Joint Statement of July 18, 2005: India's separation plan', Embassy of India, Press release, Washington, DC, 7 Mar. 2006, URL <http://www.indianembassy.org/newsite/press_release/2006/Mar/sepplan.pdf>.

[123] Tellis, A., *Atoms for War? U.S.–Indian Civilian Nuclear Cooperation and India's Nuclear Arsenal* (Carnegie Endowment for International Peace: Washington, DC, June 2006), URL <http://www.carnegie
endowment.org/files/atomsforwarfinal4.pdf>.

[124] On the CNCI see chapter 12; and Ahlström, C., 'Legal aspects of the Indian–US Civil Nuclear Cooperation Initiative', *SIPRI Yearbook 2006* (note 71), pp. 669–85.

Table 12A.7. Indian nuclear forces, January 2007

Type	Range (km)[a]	Payload (kg)	Status
Land-based ballistic missiles			
Prithvi I (P-I)	150	800	Entered service in 1994, widely believed to have a nuclear delivery role
Agni I[b]	>700	1 000	Inducted into Indian Army service in 2004
Agni II	>2 000	1 000	Inducted into Indian Army service in 2004[c]
Sea-based ballistic missiles[d]			
Dhanush	400	1 000	Inducted into service in 2006
Aircraft[e]			
Mirage 2000H Vajra	1 850	6 300	Aircraft has reportedly been certified for delivery of nuclear gravity bombs
Jaguar IS Shamsher	1 400	4 760	Some of the 4 squadrons may have nuclear delivery role

[a] Missile payloads may have to be reduced in order to achieve maximum range. Aircraft range is given for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

[b] The original Agni I, now known as the Agni, was a technology demonstrator programme that ended in 1996.

[c] The US Air Force reported in Mar. 2006 that Agni II was 'not yet deployed'.

[d] The Indian Government stated in 2006 that it did not have a submarine-launched ballistic missile (the Sagarika) in development.

[e] Other aircraft in the Indian Air Force's inventory that are potentially suitable for a nuclear role are the MiG-27 (Bahadur) and the Su-30MKI. The Su-30MKI can be refuelled by the IL-78 aerial tanker.

Sources: Indian Ministry of Defence, annual reports and press releases; International Institute for Strategic Studies (IISS), *The Military Balance 2005–2006* (Routledge: Abingdon, 2005); US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, Ohio, Mar. 2006), URL <http://www.nukestrat.com/us/afn/threats.htm>; US Central Intelligence Agency, 'Unclassified report to Congress on the acquisition of technology relating to weapons of mass destruction and advanced conventional munitions, 1 January through 30 June 2002', Apr. 2003, URL <http://www.fas.org/irp/threat/bian_apr_2003.htm>; US Central Intelligence Agency, National Intelligence Council, 'Foreign missile developments and the ballistic missile threat through 2015' (unclassified summary), Dec. 2001, URL <http://www.fas.org/spp/starwars/CIA_NIE.htm>; Lennox, D. (ed.), *Jane's Strategic Weapon Systems* (Jane's Information Group: Coulsdon, 2004); Bharat Rakshak consortium of Indian military websites, URL <http://www.bharat-rakshak.com>; Raghuvanshi, V., *Defense News*, various articles; and Authors' estimates.

nium will dramatically increase with the PFBR's scheduled completion in 2010.[125] Critics also claimed that, by allowing the sale to India of foreign nuclear fuel for power reactors designated as civilian facilities, the deal would free the country's limited domestic uranium supplies for military purposes. A study released in 2006

[125] Mian, Z. et al., *Fissile Materials in South Asia and the Implications of the U.S.–Indian Nuclear Deal*, Report for the International Panel on Fissile Materials, 11 July 2006, URL <http://www.armscontrol.org/pdf/20060711_IPFM-DraftReport-US-India-Deal.pdf>.

disputed this, based on calculations showing that India already has sufficient indigenous reserves of natural uranium to build the largest possible nuclear arsenal it might desire to build.[126]

It is not publicly known whether India has produced highly enriched uranium (HEU) for weapon purposes. It operates two gas centrifuge facilities: a pilot-scale plant at the Bhabha Atomic Research Centre (BARC) complex; and a larger plant, known as the Rare Materials Project (RMP), which has been operating since about 1990 near Mysore. The primary purpose of the RMP is believed to be production of HEU for an indigenous nuclear-powered submarine (Advanced Technology Vessel, ATV) that is currently in development. The Department of Atomic Energy reportedly plans to increase the RMP's capacity to produce enriched uranium in order to meet both civilian and military requirements.[127]

According to the draft document published in 1999 and subsequent statements, India's nuclear doctrine is 'based on the principle of a minimum credible deterrence and no-first-use'.[128] How the doctrine will evolve in the future remains to be seen, but there are already indications that the no-first-use principle is eroding. Additional guidelines published in January 2003 stated that India would use nuclear weapons to deter or retaliate against the use of chemical or biological weapons.[129] Such use would amount to first use of nuclear weapons. There have been no official statements specifying the size of the nuclear stockpile required for 'credible minimum deterrence' but, according to the Indian Ministry of Defence, it involves 'a mix of land-based, maritime and air capabilities'.[130] Most observers believe that India maintains a recessed nuclear posture—that is, nuclear warheads are not mated to their delivery vehicles, and some nuclear warheads may be stored in an unassembled or inactive form.

Strike aircraft

At present, aircraft are the core of India's nuclear strike capabilities. The Indian Air Force (IAF) has reportedly certified the Mirage 2000H Vajra ('Divine Thunder') multi-role aircraft for delivery of nuclear gravity bombs. The IAF deploys two squadrons of Mirage 2000H aircraft at the Gwalior Air Force Station in north-central India. In October 2006 the IAF was reportedly negotiating with France over the purchase of an unspecified number of Mirage 2000-5 aircraft.[131] These could potentially be used to augment the IAF's nuclear strike capability, although this has not been confirmed by reliable sources. In addition to the Mirage 2000H, some of the IAF's four

[126] Tellis (note 123).

[127] Albright, D. and Basu, S., 'India's gas centrifuge enrichment program: growing capacity for military purposes', Institute for Science and International Security (ISIS) Report, 18 Jan. 2007, URL <http://www.isis-online.org/publications/southasia/indiagrowingcapacity.pdf>.

[128] Indian Ministry of External Affairs (MEA), *Draft Report of National Security Advisory Board on Indian Nuclear Doctrine* (MEA: New Delhi, 17 Aug. 1999), URL <http://meaindia.nic.in/disarmament/dm17Aug99.htm>.

[129] Indian Ministry of External Affairs, 'Cabinet Committee on Security reviews operationalization of India's nuclear doctrine', Press release, 4 Jan. 2003, URL <http://meaindia.nic.in/pressrelease/2003/01/04pr01.htm>.

[130] Indian Ministry of Defence (MOD), *Annual Report 2004–05* (MOD: New Delhi, 2005), URL <http://mod.nic.in/reports/report05.htm>, p. 14.

[131] 'IAF mulls purchase of French Mirage fighters', *Tribune of India*, 5 Oct. 2006. In Aug. 2005 Qatar and India suspended negotiations on India's purchase of 12 secondhand Mirage 2000-5 aircraft.

squadrons of Jaguar IS Shamsher ('Sword') fighter-bombers may have a nuclear delivery role.[132] India's MiG-27 and u-30 MKI aircraft are also potentially suitable for a nuclear role.

Ballistic missiles

For many years the Prithvi ('Earth') was the only operational ballistic missile in India's arsenal and the first believed to have a nuclear capability. The Prithvi I (SS-150) is a single-stage, road-mobile ballistic missile capable of delivering a 1000-kg warhead to a maximum range of 150 km. The missile was first flight-tested in 1988 and entered service with the Indian Army in 1994. It is currently deployed with the Army's 333, 444 and 555 missile groups. On 11 June 2006 a Prithvi I missile was successfully test-launched at the Integrated Test Range (ITR) at Chandipur-on-Sea, Orissa, on the Bay of Bengal. Officials at India's Defence Research and Development Organisation (DRDO) described the test, which involved the Indian Army, as a 'user trial'.[133] A number of Prithvi I missiles are widely believed to have been modified to deliver nuclear warheads, although this has never been officially confirmed.

There are two newer versions of the Prithvi missile with improved range, accuracy and handling. The Prithvi II (SS-250), which has entered into service with the air force, can carry a 500–700-kg warhead to a maximum range of 250 km. It is nuclear capable but is not believed to be assigned a nuclear role. On 20 November 2006 India successfully test-fired a Prithvi II missile from the ITR into the Bay of Bengal.[134] The Prithvi III (SS-350), a two-stage solid-fuel missile designed to deliver a 1000-kg warhead to a range of up to 350 km, is in development.

Indian defence sources indicate that the family of longer-range Agni ('Fire') ballistic missiles, which are designed to provide short reaction time launch capability, has largely taken over the Prithvi's nuclear role.[135] The original Agni missile was a technology demonstrator that was flight-tested several times between 1989 and 1994 up to a range of 1500 km but was never operationally deployed. The short-range Agni I is a single-stage, solid-fuel missile that can deliver a 1000-kg warhead to a maximum range of 700–800 km. The two-stage Agni II can deliver a similar payload to a range of up to 2000–2500 km. The missiles are road- and rail-mobile and both can carry nuclear as well as conventional warheads. In 2004 the Agni I and Agni II were inducted into service with the Indian Army's 334 and 335 missile groups, respectively. The Indian Army is reported to believe that the DRDO's pre-induction testing of the Agni I and Agni II was inadequate.[136] Numerous Indian Government statements and press reports indicate that the Agni II missile has been deployed, but a March 2006 US Air Force report claimed that it had not.[137]

[132] Norris, R. and Kristensen, H., 'India's nuclear forces', *Bulletin of the Atomic Scientists*, vol. 61, no. 5 (Sep./ Oct. 2005), pp. 73–75.

[133] Press Trust of India, 'Prithvi test-fired', *The Hindu*, 12 June 2006.

[134] Press Trust of India, 'Prithvi-II test fired', *The Hindu*, 20 Nov. 2006.

[135] Vishwakarma, A., 'Prithvi SRBM', Bharat Rakshak consortium of Indian military websites, updated 28 Dec. 2005, URL <http://www.bharat-rakshak.com/MISSILES/Prithvi.html>.

[136] 'Panel reviews Agni III ballistic missile failure', *Jane's Missiles & Rockets*, vol. 11, no. 1 (Jan. 2007), p. 2.

[137] E.g. Press Trust of India, 'India begins deploying Agni missiles', *Express India*, 31 Aug. 2004; and US Air Force (note 63).

On 12 April 2007 the DRDO conducted the first successful flight test of the intermediate-range Agni III ballistic missile. The two-stage, solid-fuel missile was launched on a 15-minute trajectory into the Indian Ocean from a rail-mobile launcher system at the missile testing facility on Wheeler Island.[138] The Agni III has a range of 3000–3500 km and is capable of delivering a payload of up to 1.5 tonnes against targets in most of China, although Indian officials have denied that the Agni III was designed with China in mind. The Ministry of Defence press release on the launch does not mention a nuclear capability, but media reports widely accredited such a statement to the ministry.[139] An earlier launch attempt, on 9 July 2006, failed when the second stage did not separate, causing the missile to crash into the sea.

Shortly after the 2007 Agni III test, Indian newspapers quoted engineers as saying that India was capable of producing a long-range ballistic missile, possibly with a range of about 5000 km. According to some reports, India is working on an ICBM with a range of 9000–12 000 km. The missile might be a three-stage design, with the first two stages using solid propellant and the third stage using liquid propellant, and could have a range of 9000–12 000 km. It may carry two or three nuclear warheads with yields of 15–20 kt.[140] In any case, it is not expected to enter service until after 2015. This ICBM, known as the Surya ('Sun'), is believed to be based on India's Polar Space-Launch vehicle (PSLV).[141] In 2006 a former senior US official warned that 'unwise' US space cooperation with India would facilitate India's final steps towards developing an ICBM, which could destabilize international relations and potentially even threaten the USA.[142]

India continues to develop the naval component of its planned 'triad' of nuclear forces. The Indian Navy is acquiring a rudimentary nuclear capability with the Dhanush ('Bow') ship-based launcher system. The system uses a modified version of the Prithvi II missile and will be capable of carrying both conventional and nuclear warheads.[143] Western analysts had speculated that India was developing a more advanced sea-based nuclear strike capability in the form of an SLBM called the Sagarika ('Oceanic'), which has sometimes been reported to be a sea-launched cruise missile. However, in 2006 the Indian Ministry of Defence stated that 'There is no missile project of by name "Sagarika".'[144]

VIII. Pakistani nuclear forces

The estimate presented here—that Pakistan possesses approximately 60 nuclear weapons—is conservative. On the basis of recent estimates of the size of Pakistan's

[138] Indian Ministry of Defence, 'Agni III launched successfully', Press release, 12 Apr. 2007.

[139] See e.g. Naqvi, M., 'India test-fires nuclear-capable missile', *The Guardian*, 12 Apr. 2007; and Associated Press, 'India successfully test fires nuclear-capable missile', *Jerusalem Post*, 12 Apr. 2007.

[140] Madhuprasad, N., DH News Service, 'India to develop intercontinental ballistic missile', *Deccan Herald*, 25 Aug. 2005, URL <http://www.deccanherald.com>.

[141] 'Indian press reports potential for ICBM development', *Jane's Missiles & Rockets*, vol. 9, no. 10 (Oct. 2005), pp. 10–11.

[142] Speier, R., 'U.S. space aid to India: on a "glide path" to ICBM trouble?', *Arms Control Today*, vol. 36, no. 2 (Mar. 2006).

[143] Indian Ministry of Defence, 'Dhanush successfully test fired', Press release, New Delhi, 8 Nov. 2004, URL <http://mod.nic.in/pressreleases/content.asp?id=853>.

[144] Indian Ministry of Defence, 'Development and trials missiles', Press release, New Delhi, 2 Aug. 2006, URL <http://pib.nic.in/release/rel_print_page1.asp?relid=19395>.

military inventory of HEU and separated plutonium, the country could in theory produce 70–100 nuclear weapons.[145] However, Pakistan is believed to have used only part of this HEU and plutonium inventory to manufacture warheads, so it is likely to have produced fewer weapons than this. US intelligence sources estimate the size of the Pakistani nuclear arsenal to be 50–60 warheads.[146] Pakistani officials claim that the country has already produced more warheads than needed to satisfy its current 'minimum deterrence requirement' but note that this requirement is subject to review 'according to situation'.[147] Pakistani Prime Minister Shaukat Aziz asserted in January 2007 that, since the Indian–US CNCI could result in more fissile material becoming available for India's military stockpile, and since India has expressed interest in acquiring missile defences, Pakistan 'would need to take measures to ensure the credibility of our deterrence'.[148] Those measures may involve an expansion of the country's capabilities to produce fissile material for nuclear weapons.

Pakistan's current nuclear arsenal is based primarily on HEU, which is produced by a gas centrifuge uranium-enrichment facility at the Kahuta Research Laboratories (also called the A. Q. Khan Research Laboratories). There is evidence that Pakistan may be moving towards a plutonium-based arsenal.[149] Pakistan is currently operating the 50-MW(t) Khushab I reactor, which is capable of producing about 10–12 kg of weapon-grade plutonium per year.[150] In 2006 commercial satellite imagery showed the construction of a second heavy-water reactor inside the nuclear complex in the Khushab district of Punjab. According to one estimate by non-governmental experts, the new reactor, dubbed Khushab II, would be 'capable of operating in excess of 1000 megawatts-thermal' and 'could produce over 200 kilograms of weapon-grade plutonium per year'.[151] Both US and Pakistani officials confirmed that a plutonium-producing reactor was being built at that location but disputed this estimate as substantially overstating the reactor's power and production capacity.[152] A subsequent analysis produced by another non-governmental expert concluded that the reactor's

[145] As estimated in appendix 12C, Pakistan might have 1.3 ± 0.2 tonnes of HEU and about 64 kg of separated plutonium at the end of 2006. It is assumed that Pakistan's HEU weapons are of solid core, implosion-type designs requiring 15–20 kg of HEU each: plutonium weapons require at the very least *c.* 4–5 kg of plutonium metal.

[146] Koch, A., 'Pakistan moves towards a plutonium-based arsenal', *Jane's Intelligence Review*, vol. 18, no. 9 (Sep. 2006), pp. 48–49. These weapons are thought to be stored in partially disassembled form, separately from their delivery systems.

[147] Interview with Gen. Ehsanul Haq, Chairman of Joint Chiefs of Staff Committee, *Today with Kamran Khan* TV programme, Karachi Geo News TV, 24 Nov. 2006, Translation from Urdu, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[148] Press Trust of India, 'Pak apprehensive about Indo-US nuclear deal: Aziz', *Economic Times*, 31 Jan. 2007.

[149] To achieve the same yield, plutonium-based nuclear warheads are normally lighter and more compact than those using HEU. Plutonium warheads can be fitted into smaller missiles, possibly including cruise missiles, or can provide for longer ranges of already deployed ballistic missiles.

[150] Mian, Z. et. al., 'Fissile materials in South Asia: the implications of the U.S.–India nuclear deal', International Panel on Fissile Materials (IPFM) Research Report no. 1, Sep. 2006, URL <http://www.fissilematerials.org/ipfm/site_down/ipfmresearchreport01.pdf>.

[151] Albright, D. and Brannan, P., 'Commercial satellite imagery suggests Pakistan is building a second, much larger plutonium production reactor: is South Asia headed for a dramatic buildup in nuclear arsenals?', Institute for Science and International Security (ISIS) Report, 24 July 2006, URL <http://www.isis-online.org/publications/southasia/newkhushab.pdf >.

[152] Warrick, J., 'Pakistani reactor not as significant as was reported, administration says', *Washington Post*, 5 Aug. 2006. According to the US State Department, 'the reactor will be over ten times less capable' than the estimate by Albright and Brannan (note 151). Jillani, S., 'Pakistan nuclear report disputed', BBC News, 7 Aug. 2006, URL <http://news.bbc.co.uk/2/5251936.stm>.

'power level is more likely to be in the 40 to 100 MWt range'.[153] The new reactor would still allow Pakistan to increase its plutonium production at least two- or three-fold, provided that the country has sufficient spent fuel-reprocessing capacity.

According to Pakistani officials, the country's nuclear command and control organization has three layers. At the top is the National Command Authority (NCA), which was established in 2000. The NCA consists of the highest-level members of the government and is headed by the president, currently General Pervez Musharraf. The second layer is the NCA's secretariat, the Strategic Plans Division (SPD), which is 'in charge of developing and managing Pakistan's nuclear capability in all dimensions'.[154] The third layer consists of a Strategic Force Command in each of the army, the navy and the air force, which are responsible for planning, control and 'operational directives for nuclear weapons deployment and use'. While affiliated with their respective armed forces, the strategic force commands are subordinated to the NCA.[155]

In 2006 the Pakistani prime minister reaffirmed that the country subscribes 'to the doctrine of minimum credible deterrence and [is] opposed to any nuclear proliferation as well as an arms race in the region'.[156] Pakistan has consistently rejected a no-first-use nuclear policy because of its fears of being overrun by India's larger conventional forces in a military conflict. However, Pakistan has pledged that it will 'not use or threaten to use nuclear weapons against non-nuclear weapon states'.[157]

Ballistic and cruise missiles

Pakistan is working to increase and diversify its missile inventory. It is developing short- and medium-range ballistic missiles as well as cruise missiles, some of which are known to have a nuclear delivery role. Pakistani military officials denied in 2006 that they were seeking to develop long-range ballistic missiles that could strike targets outside the region.[158] In 2006 Pakistan carried out a number of ballistic missile flight tests. It notified India of its intention to carry out the tests, in accordance with an October 2005 bilateral agreement requiring each country to provide the other with at least 72 hours' notice before conducting a flight test of a surface-to-surface ballistic missiles launched from land or sea.[159]

[153] Cochran, T. B., 'What is the Size of Khushab II?', Natural Resources Defense Council, 8 Sep. 2006, URL <http://docs.nrdc.org/nuclear/nuc_06090801A.pdf>.

[154] Kidwai, K., Director-General of Pakistan's Strategic Plans Division, quoted in 'Pakistan's evolution as a nuclear weapons state', *Strategic Insights*, 1 Nov. 2006, URL <http://www.ccc.nps.navy.mil/news/kidwaiNov06.pdf>.

[155] Khan, S. and Tsuchiya, T., 'Pakistan sets up tri-command nuclear force: officials', Kyodo News, 10 Aug. 2006, URL <http://www.chugoku-np.co.jp/abom/2006e/kyodo/Ak06081001.html>.

[156] Aziz, S., Prime Minister of Pakistan, quoted in 'PM warns of arms race in South Asia', *The Dawn*, 25 Jan. 2006, URL <http://www.dawn.com/2006/01/25/top3.htm>.

[157] Khan, M., Pakistan's Permanent Representative to the UN, quoted in United Nations Office in Geneva, 'Conference on Disarmament starts debate on negative security assurances', Press Release, 3 Aug. 2006, URL <http://www.unog.ch/unog/website/news_media.nsf/(httpNewsByYear en)/B0B499EF402F3050C12571BF00332A50>.

[158] Haq, E., Chairman of Joint Chiefs of Staff Committee, Interview on *Today with Kamran Khan* TV programme, Karachi Geo News TV, 24 Nov. 2006, Translation from Urdu, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[159] Creegan, E., 'India, Pakistan sign missile notification pact', *Arms Control Today*, Nov. 2005, URL <http://www.armscontrol.org/act/2005_11/NOV-IndiaPak.asp>. The text of the agreement is available at URL <http://www.stimson.org/?SN=SA20060207949>.

Table 12A.8. Pakistani nuclear forces, January 2007

Type	Range (km)[a]	Payload (kg)	Status
Short-range ballistic missiles			
Abdali (Hatf-2)	180–200	250–450	Test-launched on 19 Feb. 2006
Ghaznavi (Hatf-3)	90[b]	500–700	Entered service in 2004; fewer than 50 launchers have been deployed
Shaheen I (Hatf-4)	>450[c]	750–1 000	Entered service in 2003; fewer than 50 launchers have been deployed
Medium-range ballistic missiles			
Ghauri I (Hatf-5)	~1 300	700–1 000	Entered service with the Pakistani Army in 2003. Fewer than 50 launchers deployed
Aircraft			
F-16A/B	1 600	4 500	34 aircraft, deployed in 3 squadrons; most likely aircraft to have a nuclear delivery role

[a] Missile payloads may have to be reduced in order to achieve maximum range. Aircraft range is given for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

[b] The US National Air and Space Intelligence Center (NASIC) gives the maximum range as 400 km.

[c] Some unofficial sources claim that the range is 600–1500 km.

Sources: US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, Ohio, Mar. 2006), URL <http://www.nukestrat.com/us/afn/NASIC2006.pdf>; US Central Intelligence Agency, 'Unclassified report to Congress on the acquisition of technology relating to weapons of mass destruction and advanced conventional munitions, 1 January through 30 June 2002', Apr. 2003, URL <https://www.cia.gov/cia/reports/archive/reports_2002.html>; US Central Intelligence Agency, National Intelligence Council, 'Foreign missile developments and the ballistic missile threat through 2015' (unclassified summary), Dec. 2001, URL <http://www.fas.org/spp/starwars/CIA-NIE.htm>; Lennox, D. (ed.), *Jane's Strategic Weapon Systems* (Jane's Information Group: Coulsdon, 2007); Office of the Press Secretary to the President of Pakistan, 'Pakistan successfully test fire surface to surface Hatf-II Abdali missile', Press release, 19 Feb. 2006, URL <http://www.presidentofpakistan.gov.pk/NewsEventsDetail.aspx?NewsEventID=2960>; and Authors' estimates.

Pakistan is known to deploy two types of road-mobile, solid-propellant, single-warhead short-range ballistic missile (SRBM): the Ghaznavi (Hatf-3) and the Shaheen I (Hatf-4). A third SRBM, the Abdali (Hatf-2), may also have begun to be deployed in 2005. The Abdali programme was thought to have been cancelled due to technical problems, but on 19 February 2006 Pakistan conducted a test launch of the missile. A press release from President Musharraf's office stated that the Abdali can carry a nuclear warhead.[160] The Ghaznavi SRBM formally entered service with the

[160] Office of the Press Secretary to the President of Pakistan, 'Pakistan successfully test fire surface to surface Hatf-II Abdali missile', Press release, 19 Feb. 2006, URL <http://www.presidentofpakistan.gov.pk/NewsEventsDetail.aspx?NewsEventID=2960>.

Pakistani Army in 2004. It is believed to be a domestically produced copy of the Chinese M-11 missile. A Ghaznavi missile was successfully test-launched on 9 December 2006.[161] The Shaheen I SRBM, which has been declared to be nuclear capable, entered service with the Pakistani Army in 2003. A Shaheen I missile was test-launched on 29 November 2006.[162]

Pakistan's only MRBM currently in service is the Ghauri I (Hatf-5), a road-mobile, liquid-propellant, single-warhead ballistic missile. It has been declared by Pakistani defence officials to be nuclear capable. The Ghauri I is believed to be based on North Korea's Nodong 1/2 missile technology and was reportedly developed with extensive design and engineering assistance from North Korea. Pakistani defence sources indicate that limited production of the Ghauri I began in late 2002 and that it entered into service in January 2003, although it was still in development. A Ghauri I missile was successfully test-launched on 16 November 2006.[163] Pakistan is also developing the two-stage, road-mobile, solid-propellant Shaheen II (Hatf-6) MRBM. On 29 April 2006 it conducted the third test launch of this missile. Its reported range of 2000–2500 km means that it can reach targets across India.[164]

On 11 August 2005 Pakistan carried out the first test flight of a ground-launched cruise missile, designated the Babur (Hatf-7), at a new test range in Baluchistan.[165] Pakistani officials indicated that the Babur had a range of 500 km and was capable of carrying a nuclear warhead. A second successful test flight of the Babur was conducted on 21 March 2006. Both trials were made from a ground launcher, but Pakistan also plans to deploy the missile on surface ships and submarines.[166]

Strike aircraft

The aircraft of the Pakistani Air Force that is most likely to be used in the nuclear weapon delivery role is the F-16. Other aircraft, such as the Mirage V and the Chinese-produced A-5, could also be used. Pakistan currently maintains 32 F-16 aircraft in service, deployed in three squadrons. On 26 March 2005, the US Administration announced that it was notifying the US Congress of plans to sell 75 F-16s to Pakistan.[167] US officials said that the deal, which was intended to reward Pakistan for its cooperation in the 'global war on terrorism', would not affect the military balance in the region. In 2005 the USA gave Pakistan two additional F-16 aircraft as a

[161] 'Pakistan successfully test fires Hatf-III ballistic missile', *PakTribune,* 10 Dec. 2006, URL <http://www.paktribune.com/news/index.shtml?162642>.

[162] Office of the Press Secretary to the President of Pakistan, 'Pakistan successfully launches Shaheen-1 missile', Press release, 29 Nov. 2006, URL <http://www.presidentofpakistan.gov.pk/NewsEventsDetail.aspx?NewsEventID=3411>.

[163] 'Pakistan tests "nuclear" missile', BBC News, 16 Nov. 206, URL <http://news.bbc.co.uk/2/6153242.stm>.

[164] Agence France-Presse, 'Pakistan "successfully" test fires long-range nuclear capable missile', 29 Apr. 2006, Translation from French, World News Connection, National Technical Information Service (NTIS), US Department of Commerce.

[165] Associated Press, 'Pakistan test fires nuclear-capable cruise missile', *International Herald Tribune*, 11 Aug 2005.

[166] 'Pakistan's Babur completes test firing', *Jane's Missiles and Rockets*, vol. 10, no. 5 (May 2006), p. 9.

[167] Baker, P., 'Bush: US to sell F-16s to Pakistan', *Washington Post*, 25 Mar. 2005.

Table 12A.9. Israeli nuclear forces, January 2007

Type	Range (km)[a]	Payload (kg)	Status
Aircraft[b]			
F-16A/B/C/ D/I Falcon	1 600	5 400	205 aircraft in the inventory; some are believed to be certified for nuclear weapon delivery
Ballistic missiles[c]			
Jericho II	1 500–1 800	750–1 000	*c.* 50 missiles; first deployed in 1990; test-launched 27 June 2001
Submarines			
Type 800 Dolphin			Rumoured to be equipped with nuclear-capable cruise missiles, but this is denied by Israeli officials

[a] Missile payloads may have to be reduced in order to achieve maximum range. Aircraft range is given for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

[b] Some of Israel's 25 F-15I aircraft may also have a long-range nuclear delivery role.

[c] The Shavit space launch vehicle, if converted to a ballistic missile, could deliver a 775-kg payload a distance of 4000 km. The Jericho I, first deployed in 1973, is no longer thought to be operational.

Sources: Cohen, A. and Burr, W., 'Israel crosses the threshold', *Bulletin of the Atomic Scientists*, May/June 2006, pp. 22–30; Cohen, A., *Israel and the Bomb* (Columbia University Press: New York, N.Y., 1998); Albright, D., Berkhout, F. and Walker, W., SIPRI, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press: Oxford, 1997); Lennox, D. (ed.), *Jane's Strategic Weapon Systems* (Jane's Information Group: Coulsdon, 2007); Fetter, S., 'Israeli ballistic missile capabilities', *Physics and Society*, vol. 19, no. 3 (July 1990), pp. 3–4 (see 'Ballistic missile primer' (unpublished) for an updated analysis, URL <http://www.puaf.umd.edu/Fetter/1990-MissilePrimer.pdf>); 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

goodwill gesture.[168] In 2006 Pakistan signed a deal with the USA to buy 18 Block 52 F-16C/D aircraft, with an option for 18 more. Under the terms of the agreement, the 32 F-16A/B aircraft already in Pakistani service are to receive a midlife update. Pakistan is also to receive 26 secondhand F-16 aircraft at a later date.[169]

IX. Israeli nuclear forces

The size of the Israeli nuclear weapon stockpile is unknown but is widely believed to consist of 100–200 plutonium warheads. According to one estimate, Israel possessed up to 0.56 tonnes of military plutonium as of December 2005,[170] or the equivalent of

[168] 'F-16 deal update', PakistaniDefence.com, Aug. 2005, URL <http://www.pakistanidefence.com/news/MonthlyNewsArchive/2005/August2005.htm>.

[169] Schanz, M. V., 'Aerospace World: US and Pakistan hammer out new F-16 deal', *Air Force Magazine*, Dec. 2006, p. 12.

[170] See appendix 12C, table 12C.2.

about 110 warheads, assuming that each contains 5 kg of plutonium. However, only part of this plutonium may have been used to produce warheads. The US Defense Intelligence Agency estimated in 1999 that Israel had assembled 60–80 nuclear warheads.[171] Many analysts believe that it has a recessed nuclear arsenal (one that is stored but not armed, requiring some preparation before use). If this is true, the warheads for Israel's purported nuclear weapon delivery systems may not actually be deployed. These delivery systems are believed to be strike aircraft, land-based ballistic missiles and possibly sea-launched cruise missiles (see table 12A.8). There has been speculation that Israel may have produced non-strategic nuclear weapons, including artillery shells and atomic demolition munitions.

On 6 July 2006 Israel signed a contract for the procurement of two Type 800 Dolphin Class diesel-electric attack submarines from Germany, with an option for a third. When the new submarines are delivered, after 2012, they will augment Israel's current fleet of three submarines of the same class. Germany's decision to sell the submarines to Israel has been controversial. Some reports suggest that Israel may have developed a nuclear-capable SLCM, based on the US-made Harpoon missile, and has modified the submarine's torpedo tubes to launch the missile.[172]

Israel continues to maintain its long-standing policy of nuclear ambiguity, neither officially confirming nor denying that it possesses nuclear weapons. However, in December 2006 Israeli Prime Minister Ehud Olmert made a statement that was widely interpreted as tacitly acknowledging that Israel possessed a nuclear arsenal. Speaking to German television, Olmert included Israel in a list of countries possessing nuclear weapons.[173] The remark was quickly disavowed by Olmert and other Israeli officials, who reiterated that Israel 'will not be the first country that introduces nuclear weapons to the Middle East'.[174]

X. North Korea's military nuclear capabilities

There is little publicly available information about North Korea's nuclear weapon programme. In February 2005 North Korea declared for the first time that it had produced nuclear weapons,[175] and in October 2006 it unambiguously demonstrated a nuclear weapon capability by carrying out an underground nuclear test explosion.[176] However, the unexpectedly low yield of the explosion led many foreign experts to believe that it ended in a 'fizzle'—an inefficient detonation releasing less explosive energy than expected. This has raised doubts about whether North Korea has

[171] US Defense Intelligence Agency (note 121). The US DOD predicted that the Israeli stockpile in 2020 would consist of 65–85 weapons, suggesting that the stockpile is not increasing in size.

[172] Ben-David, A., 'Israel orders two more Dolphin subs', *Jane's Defense Weekly*, 30 Aug. 2006, p. 5; and Katz, Y., 'Exclusive: Israel buys 2 German subs', *Jerusalem Post*, 22 Aug. 2006.

[173] 'Was Olmert über Atomwaffen sagte' [What Olmert said about nuclear weapons], N24 television channel, 12 Dec. 2006, URL <http://www.n24.de/politik/article.php?articleId=88274>.

[174] Boudreaux, R., 'Fallout rains on Israel's Olmert after nuclear remark', *Los Angeles Times*, 13 Dec. 2006.

[175] Korea Central News Agency, 'DPRK FM on its stand to suspend its participation in Six-Party Talks for indefinite period', 10 Feb. 2005, URL <http://www.kcna.co.jp/item/2005/200502/news02/11.htm>.

[176] On the North Korean explosion and the methods used to determine its nature see appendix 12B.

mastered the design and engineering skills needed to manufacture an operational nuclear weapon.[177]

North Korea is widely believed to have produced and separated enough plutonium from the spent fuel of its 5-megawatt-electric (MW(e)) graphite-moderated research reactor at Yongbyon to be able to build a small number of nuclear warheads.[178] One non-governmental expert has estimated that the Yongbyon reactor produces about 6 kg of weapon-grade plutonium per year and that, as of November 2006, North Korea possessed 40–50 kg of separated plutonium, with an additional 4–8 kg of plutonium contained in the nuclear fuel currently loaded into the reactor.[179] Other non-governmental experts have estimated that, as of February 2007, North Korea had a total plutonium stock of 46–64 kg of plutonium, of which about 28–50 kg was believed to be in separated form and usable in nuclear weapons.[180] Based on these estimates, North Korea could have produced about six nuclear explosive devices by the end of 2006, assuming that 8 kg of plutonium would be used to manufacture each device.[181]

Apart from the plutonium weapon programme, there have been allegations that North Korea is pursuing a clandestine gas centrifuge programme aimed at producing HEU for use in nuclear weapons. On 16 October 2002 the US State Department issued a statement declaring that North Korea had acknowledged that it had such a programme.[182] North Korea denied having done so, but the ensuing controversy led to the collapse of the 1994 Agreed Framework.[183] Pakistani President Musharraf acknowledged in September 2006 that the Abdul Qadeer Khan network had provided North Korea with 'nearly two dozen P-1 and P-2 centrifuges', other equipment and

[177] Sanger, D. and Broad, W., 'Small blast, or "big deal"? U.S. Experts look for clues', *New York Times*, 11 Oct. 2006.

[178] In addition to the 5-MW(e) reactor at Yongbyon, North Korea began work in the early 1990s on a 50-MW(e) reactor at Yongbyon and a 200-MW(e) reactor at Taechon, about 20 km from Yongbyon; both reactors remain unfinished and have reportedly been abandoned since 1994. Hecker, S., 'Report on North Korean nuclear program', Nautilus Institute, Policy Forum Online, 06-97A, 15 Nov. 2006, URL <http://www.nautilus.org/fora/security/0697Hecker.html>.

[179] Hecker (note 178).

[180] Albright, D. and Brannan, P., 'The North Korean plutonium stock, February 2007', Institute for Science and International Security (ISIS), 20 Feb. 2007, URL <http://www.isis-online.org/publications/dprk/DPRKplutoniumFEB.pdf>.

[181] The IAEA has established 8 kg as a 'significant quantity' of plutonium—i.e. 'the approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded'. International Atomic Energy Agency (IAEA), 'IAEA safeguards glossary: 2001 edition', International Nuclear Verification Series no. 3 (2001), URL <http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_prn.pdf>, p. 3. Some researchers suggest that the significant quantity should be considerably lower. Cochran, T. B. and Paine, C. E., *The Amount of Plutonium and Highly-Enriched Uranium Needed for Pure Fission Nuclear Weapons* (Natural Resources Defense Council: New York, N.Y., Apr. 1995), URL <http://www.nrdc.org/nuclear/fissionw/fissionweapons.pdf>.

[182] Boucher, R., Spokesman, US Department of State, Bureau of Public Affairs, 'North Korean nuclear program', Press statement, 16 Oct. 2002, URL <http://www.state.gov/r/pa/prs/ps/2002/14432.htm>. On uranium enrichment in North Korea see Kile, S. N., 'Nuclear arms control, non-proliferation and ballistic missile defence', *SIPRI Yearbook 2003* (note 18), pp. 583–85; and Niksch, L. A., *North Korea's Nuclear Weapons Program*, US Library of Congress, Congressional Research Service (CRS) Report for Congress RL33590 (CRS: Washington, DC, 5 Oct. 2006), URL <http://fpc.state.gov/documents/organization/74904.pdf>, pp. 11–12.

[183] IAEA, 'Agreed Framework between the United States of America and the Democratic People's Republic of Korea', 21 Oct. 1994, INFCIRC/457, 2 Nov. 1994. See Kile (note 182), pp. 578–92.

'coaching on centrifuge technology'.[184] There is no open-source evidence that North Korea has produced HEU, and in February 2007 US intelligence officials backed away from earlier claims that North Korea had a covert, production-scale uranium enrichment programme.[185]

North Korea deploys approximately 500–600 road-mobile SRBMs of three types—Hwasŏng-5 (Scud B), Hwasŏng-6 (Scud Mod-C) and Hwasŏng-7 (Scud Mod-D)—and 50–200 road-mobile Nodong MRBMs.[186] It is also developing the longer-range Taepodong-1 and the Taepodong-2 missiles. On 5 July 2006 North Korea test-launched seven missiles from the test facility at Musudan-ri into the Sea of Japan: three Hwasŏng-6s, three Nodongs and one Taepodong-2.[187] The launch of the Taepodong-2 ended in failure.[188] Most analysts consider it unlikely that North Korea has developed a nuclear warhead that is light and compact enough to fit onto a ballistic missile delivery system.[189]

[184] Musharraf, P., *In the Line of Fire: A Memoir* (Free Press: New York, N.Y., Sep. 2006), p. 296.

[185] Kessler, G., 'New doubts on nuclear efforts by North Korea', *Washington Post*, 1 Mar. 2007.

[186] US Air Force (note 63); Lennox (note 27), pp. 91–100; and Nuclear Threat Initiative, 'Missile capabilities', North Korea Profile, Dec. 2006, URL <http://www.nti.org/e_research/profiles/NK/Missile/62.html>.

[187] Priest, D. and Faiola, A., 'North Korea tests long-range missile', *Washington Post*, 6 July 2006.

[188] Richardson, D., 'Transonic buffeting may have doomed Taepo Dong-2', *Jane's Missiles & Rockets*, vol. 10, no. 9 (Sep. 2006), p. 8.

[189] See e.g. Hecker (note 178).