8. World nuclear forces

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I. Introduction

At the start of 2009 eight states possessed nearly 8400 operational nuclear weapons (see table 8.1). Nearly 2000 of these nuclear weapons are kept at a state of high operational alert. If all nuclear warheads are counted—operational warheads, spares, those in both active and inactive storage, and intact warheads scheduled for dismantlement—the United States, the Russian Federation, the United Kingdom, France, China, India, Pakistan and Israel together possess a total of more than 23 300 warheads.

All five legally recognized nuclear weapon states, as defined by the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT)—China, France, Russia, the UK and the USA—appear determined to remain nuclear powers and are either modernizing or about to modernize their nuclear forces.[1] At the same time, 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 Treaty) and the 2002 Treaty on Strategic Offensive Reductions (SORT).[2] Sections II and III of this chapter discuss the composition of the deployed nuclear forces of the USA and Russia, respectively. The nuclear arsenals of the other three nuclear weapon states are considerably smaller, but all three states are either deploying new weapons or have announced their intention to do so in the future. Sections IV–VI present data on the delivery vehicles and warhead stockpiles of the UK, France and China, respectively.

Reliable information on the operational status of the nuclear arsenals and capabilities of the three states that have never been party to the NPT—India, Israel, and Pakistan—is difficult to find. In the absence of official declarations, the available information is often contradictory or incorrect. India and Pakistan are expanding their nuclear strike capabilities, while Israel appears to be waiting to see how the situation in Iran develops. Sections VII–IX provide information about the Indian, Pakistani and Israeli nuclear arsenals, respectively. The nuclear capabilities of the Democratic

[1] According to the NPT, only states that manufactured and exploded a nuclear device prior to 1 Jan. 1967 are recognized as nuclear weapon states. For a summary and other details of the NPT see annex A in this volume.

[2] For summaries and other details of the START and SORT treaties see annex A in this volume.

Table 8.1. World nuclear forces, by number of deployed warheads, January 2009

All figures are approximate.

Country[a]	Year of first nuclear test	Strategic warheads	Non-strategic warheads	Total deployed warheads
United States	1945	2 202	500	2 702[b]
Russia	1949	2 787	2 047	4 834[c]
United Kingdom	1952	160[d]	–	(160)
France	1960	300	–	(300)
China	1964	(186)	..[e]	(186)
India	1974	–	–	(60–70)[f]
Pakistan	1998	–	–	(60)[f]
Israel	..	–	–	(80)[f]
Total				**(8 392)**

( ) = uncertain figure.

[a] North Korea conducted a nuclear test explosion in 2006 but there is no public information to verify that it has operational nuclear weapons.

[b] The total US inventory is *c.* 9400 warheads, of which *c.* 5200 are in the Department of Defense stockpile (*c.* 2700 operational and *c.* 2500 in reserve) and 4200 warheads are scheduled to be dismantled by 2022.

[c] The total Russian inventory contains *c.* 13 000 warheads, of which *c.* 8166 are in reserve or awaiting dismantlement.

[d] Some warheads on British strategic submarines have sub-strategic missions previously covered by tactical nuclear weapons.

[e] The existence of operational Chinese non-strategic warheads is uncertain.

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

People's Republic of Korea (DPRK, or North Korea) are discussed in section X. Brief conclusions are given in section XI. Appendix 8A provides details of global inventories of fissile materials.

The figures presented here are estimates based on public information and contain some uncertainties, as reflected in the notes to the tables.

II. US nuclear forces

As of January 2009 the USA maintained an estimated arsenal of approximately 2700 operational nuclear warheads, consisting of about 2200 strategic and 500 non-strategic warheads (see table 8.2). In addition to this operational arsenal, approximately 2500 warheads are held in reserve, for a total stockpile of approximately 5200 warheads. Another 4200 retired warheads are awaiting dismantlement.

This force level is a significant change compared with the estimate presented in *SIPRI Yearbook 2007*.[3] The change reflects the rapid withdrawal from deployment of warheads on strategic nuclear delivery vehicles (intercontinental ballistic missiles, ICBMs; submarine-launched ballistic missiles, SLBMs; and long-range bombers), which has allowed the USA to meet the limit set under SORT of 2200 operationally deployed strategic warheads three-and-a-half-years before deadline.[4] The reduction of the total stockpile is occurring more slowly and at this stage is largely on paper, because it consists of transferring ownership of the warheads from the US Department of Defense (DOD) to the Department of Energy (DOE).

Previous US Government proposals—as formulated in the 2001 Nuclear Posture Review (NPR)[5]—to build a new nuclear weapons production facility with a capacity to produce hundreds of nuclear weapons per year (later scaled back to 50–80 per year) were reformulated in December 2008 to a proposal to build a Chemistry and Metallurgy Research Replacement–Nuclear Facility (CMRR–NF) at Los Alamos National Laboratory (LANL) that would have a limited capacity to produce 20 pits (plutonium cores) per year and an emergency capacity of 80 pits.[6] The shift undercuts the vision presented by the 2001 NPR to create a 'responsive infrastructure' capable of quickly producing large numbers of warheads in response to unexpected developments.

Despite failure to convince the US Congress to fund production of the Reliable Replacement Warhead (RRW), officials and military leaders continued in 2008 to include new nuclear weapons in their vision for future US strategic nuclear deterrence requirements.[7] Rather than a formal RRW programme, however, future production of replacement or significantly modified warheads is likely to be done by expanding the scope of life-extension programmes to add new features to existing warheads designs.

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

[3] Kile, S. N., Fedchenko, V. and Kristensen, H. M., 'World nuclear forces, 2008', *SIPRI Yearbook 2008: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2008).

[4] Norris, R. S. and Kristensen, H. M., 'Nuclear notebook: U.S. nuclear forces, 2009', *Bulletin of the Atomic Scientists*, vol. 65, no. 2 (Mar. 2009). Under SORT, Russia and the USA are obligated to reduce their aggregate number of operationally deployed strategic nuclear warheads to no more than 1700–2200 each by 31 Dec. 2012.

[5] US Department of Defense, 'Special briefing on the Nuclear Posture Review', Transcript, 9 Jan. 2002, <http://www.defenselink.mil/transcripts/transcript.aspx?transcriptid=1108>. See also Kristensen, H. M. and Handler, J., 'World nuclear forces', *SIPRI Yearbook 2002: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2002), pp. 527–28.

[6] US Department of Energy, National Nuclear Security Administration, 'Record of decision for the complex transformation supplemental programmatic environmental impact statement: operations involving plutonium, uranium, and the assembly and disassembly of nuclear weapons', *Federal Register*, vol. 73, no. 245 (19 Dec. 2008), pp. 77 647–56.

[7] See e.g. US departments of Energy (DOE) and Defense (DOD), *National Security and Nuclear Weapons in the 21st Century* (DOE/DOD: Sep. 2008), pp. 18–22.

Table 8.2. US nuclear forces, January 2009

Type	Designation	No. deployed	Year first deployed	Range (km)[a]	Warheads x yield	No. of warheads
Strategic forces						**2 202**
Bombers[b]		*113/60*				*500*
B-52H	Stratofortress	93/44	1961	16 000	ALCM 5–150 kt	350[c]
B-2	Spirit	20/16	1994	11 000	B61-7, -11, B83-1 bombs	150[d]
ICBMs		*450*				*550*
LGM-30G	Minuteman III					
	Mk-12[e]	(0)	1970	13 000	1–3 x 170 kt	(0)
	Mk-12A	250	1979	13 000	1–3 x 335 kt	350
	Mk-21 SERV	200	2006	13 000	1 x 300 kt	200
SSBNs/SLBMs		*228*				*1 152*
UGM-133A	Trident II (D-5)[f]					
	Mk-4	. .	1992	>7 400	4 x 100 kt	718
	Mk-4A	. .	2008	>7 400	4 x 100 kt	50
	Mk-5	. .	1990	>7 400	4 x 475 kt	384
Non-strategic forces						**500**
B61-3, -4 bombs[g]		. .	1979	. .	0.3–170 kt	400
Tomahawk SLCM		320	1984	2 500	1 x 5–150 kt	100[h]
Total						**2 702**[i]

. . = not applicable; ( ) = uncertain figure; ALCM = air-launched cruise missile; ICBM = intercontinental ballistic missile; kt = kiloton; SERV = security-enhanced re-entry vehicle; SLBM = submarine-launched ballistic missile; SLCM = sea-launched cruise missile; SSBN = nuclear-powered ballistic missile submarine.

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

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

[c] All advanced cruise missiles (ACMs) have been retired and the total ALCM inventory has been reduced to 528, of which 350 are deployed. ACLMs, unlike sea-launched Tomahawk cruise missiles (TLAM/N, from Tomahawk land attack missile, nuclear), are counted under START and SORT and classified as strategic weapons.

[d] Operational gravity bombs are only included for the B-2A, which is believed to be the main bomb delivery aircraft.

[e] The W62 warhead (which is loaded in the Mk-12 re-entry vehicle) will be retired in 2009 and all have probably been removed from operational missiles.

[f] Although D-5 missiles are counted under START as carrying 8 warheads each, the US Navy is estimated to have downloaded each missile to an average of 4 warheads to meet the SORT-mandated warhead ceiling. Delivery of the W76-1 warhead began in Oct. 2008.

[g] The number of B61 bombs deployed in Europe was reduced by half between 2005 and 2006, to roughly 200.

[h] Another 190 W80-0 warheads are in inactive storage; the life-extension programme for the warhead has been deferred. The TLAM/N is no longer deployed at sea.

[i] Including the additional *c*. 2500 warheads in reserve, the total stockpile is *c*. 5200 warheads. There are another 4200 additional warheads awaiting dismantlement and a further *c*. 15 000 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 and plans; US Department of State, START I Treaty Memoranda of Understanding, 1990–Jan. 2009; US Department of Defense, various documents obtained under the Freedom of Information Act; US Air Force, US Navy and US Department of Energy, personal communication; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

announced in 2008 that the dismantlement of retired warheads had increased by 20 per cent, in addition to the 146 per cent increase reported in 2007.[8] Although the percentage increases look impressive, the actual number of dismantled warheads appears to be modest compared with the 1990s. Based on previously declassified or released information, it is possible to estimate that nearly 350 warheads are being dismantled each year at the Pantex Plant in Texas. In comparison, the average number of warheads dismantled per year during the 1990s was nearly 1200.[9] At the current rate, dismantling the current backlog of retired nuclear warheads will not be completed until 2022.

In parallel with reducing the nuclear stockpile, the 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 to a set of smaller and more flexible strike plans. In February 2008 a new strategic war plan—known as OPLAN (Operations Plan) 8010-08 Global Deterrence and Strike—was put into effect, which was updated in December 2008 as OPLAN 8010-08 Strategic Deterrence and Global Strike. The plan focuses on China and Russia but also includes a series of strike options against states in other regions armed with weapons of mass destruction. OPLAN 8010-08 replaces OPLAN 8044 Revision 05 from October 2004. The new plan offers greater flexibility for a wider range of scenarios, including nuclear and conventional strike options.[10]

[8] D'Agostino, T., NNSA Deputy Administrator, 'The Reliable Replacement Warhead and the future U.S. nuclear weapons program', Speech, National Defense University Capitol Hill Breakfast Seminar Series, 9 May 2007, <http://nnsa.energy.gov/news/968.htm>; US Department of Energy, National Nuclear Security Administration, 'Nuclear weapons dismantlements up 20 percent', *NNSA Monthly News*, Oct. 2008; and US Department of Energy, National Nuclear Security Administration, 'Nuclear weapons dismantlement rate up 146 percent', *NNSA Monthly News*, Nov./Dec. 2007.

[9] Kristensen, H. M., 'Nuclear weapons stockpile secrecy and confusion', FAS Strategic Security Blog, Federation of American Scientists, 21 Oct. 2008, <http://www.fas.org/blog/ssp/2008/10/>.

[10] Kristensen, H. M., Norris, R. S. and Oelrich, I., *From Counterforce to Minimal Deterrence: A New Nuclear Policy on the Path Toward Eliminating Nuclear Weapons* (Federation of American Scientists/Natural Resources Defense Council: Washington, DC, Apr. 2009).

Land-based ballistic missiles

The US ICBM force is changing significantly as part of the implementation of SORT. Approximately 550 warheads were deployed on 450 ICBMs as of January 2009, a reduction of 214 warheads compared with 2008. All W62 warheads have probably been removed from operational missiles in preparation for retirement in 2009, and W78 warheads will continue to be downloaded (i.e. removed from the missile and moved to storage) until the total number deployed on ICBMs is reduced to 500 in 2010. As the 170-kiloton W62 is removed from the missiles, the modern 300-kt Mk-21/W87 Security Enhanced Re-entry Vehicle (SERV) is being installed. The increased power of the W87 warhead broadens the range of targets of the Minuteman ICBM force. A previous plan to convert the force to single-warhead configuration has been modified: 25 missiles will continue to carry two warheads each. Several hundred additional warheads will be kept in storage for possible future upload. The service life of the Minuteman III missile has been extended to 2030, delaying plans to deploy a replacement ICBM in 2018. Development work on a follow-on missile continues, and an ICBM Future Warhead Concepts Study is scheduled for 2008–2009.[11]

There were four Minuteman III flight tests launched in 2008, compared to only one in 2007. In a test on 22 May, a Minuteman flew about 1000 nautical miles (1852 kilometres) farther west than the usual impact area, near Kwajalein Atoll in the Marshal Islands, to reach approximately 5250 nautical miles (9720 km) from the launch point at Vandenberg Air Force Base, California.[12]

Ballistic missile submarines

In 2008 the USS *Alabama* completed its upgrade from the Trident I C-4 SLBM to the longer-range and more accurate Trident II D-5 SLBM. All 14 US Navy Ohio Class SSBNs now carry D-5 missiles. Twelve operational SSBNs carry a total of 288 D-5 SLBMs, each of which is estimated to carry 4 warheads for a total of about 1152 warheads. (Two additional SSBNs are undergoing overhaul at any given time, and their 48 missiles and 192 warheads are not included in the total.) With eight SSBNs based in the Pacific Ocean and six in the Atlantic Ocean, and a patrol rate comparable to that during the cold war, nearly 60 per cent of US SSBN patrols now take place in the Pacific (compared to an average of only 15 per cent during the

[11] US Department of the Air Force, *Fiscal Year (FY) 2009 Budget Estimates: Research, Development, Test and Evaluation (RDT&E) Descriptive Summaries*, vol. 2, *Budget Activities 4–6* (Department of the Air Force: Feb. 2008), p. 737.

[12] Geoffroy, R., 'Missile successfully launches from Vandenberg', 30th Space Wing Public Affairs, Air Force Space Command, 22 May 2008, <http://www.afspc.af.mil/news/story.asp?id=123099783>.

1980s). This change reflects a shift in focus of the USA's post-cold war planners to China and other potential adversaries in the Pacific region.

During 2008 the Trident II D-5 SLBM reached a record 124 consecutive successful launches since 1989. Two missiles were launched off the California coast on 21 May and another two on 25 August.[13] This was the first time that all US SLBM test flights in a given year were carried out in the Pacific.

The production of a modified D-5 SLBM began in 2008 with the procurement of 12 missiles. A total procurement of 108 missiles is planned by 2011, at a cost of more than $4 billion, and initial deployment is scheduled for 2013.[14] The modified D-5 will arm the Ohio Class SSBNs for the rest of their service lives, which have been extended from 30 to 44 years. The oldest submarine is scheduled to retire in 2029, at which point a new SSBN class is planned to become operational. Deployment of the W76-1/Mk-4A warhead, a modernized version of the existing W76/Mk-4, is now underway.[15] The first warhead was delivered to the US Navy in late October 2008, and production of approximately 2000 W76-1 warheads by 2021 is scheduled.

Strategic bombers

The US Air Force lost two strategic bombers in 2008. A B-2 crashed on Guam on 23 February, leaving a force of 20, of which 16 are thought to have nuclear missions. A B-52H crashed off Guam on 21 July, leaving a force of 93, of which approximately 44 may be assigned nuclear missions.

Approximately 500 nuclear warheads are estimated to be deployed with B-52H and B-2 bombers, including the aircraft-delivered B61-7, B61-11 and B83-1 gravity bombs and the W80-1 warhead carried on air-launched cruise missiles (ALCMs). Two-thirds of US Air Force ALCMs have been withdrawn from service due to the accelerated implementation of the 2004 Nuclear Weapons Stockpile Plan and to meet the SORT limit.[16] The Air Force is designing a next-generation nuclear-armed cruise missile known as the Enhanced Cruise Missile.

[13] Lockheed Martin, 'Lockheed Martin-built Trident II D5 missile achieves 124 successful test launches in a row', Press release, 26 Aug. 2008, <http://www.lockheedmartin.com/news/press_releases/2008/8-26-trident.html>.

[14] Norris, R. S. and Kristensen, H. M., 'Nuclear notebook: U.S. nuclear forces, 2007', *Bulletin of the Atomic Scientists*, vol. 63, no. 1 (Jan./Feb. 2007).

[15] The W76-1/Mk4 warhead is equipped with a new fuse that allows more flexibility in setting the height of burst to 'enable W76 to take advantage of [the] higher accuracy of [the] D-5 missile' and bring more targets, including hard targets, within range. US Department of Energy, Office of Defense Programs, *Stockpile Stewardship and Management Plan: First Annual Update*, partially declassified and released under the US Freedom of Information Act (DOE: Washington, DC, Oct. 1997), p. 1-14

[16] 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, 3 June 2004, <http://nnsa.energy.gov/news/1502.htm>.

Non-strategic nuclear weapons[17]

As of January 2009 the USA retained approximately 500 active non-strategic nuclear warheads. These consisted of approximately 400 B61 gravity bombs and 100 W80-0 warheads for the sea-launched Tomahawk cruise missiles (TLAM/Ns, from tomahawk land-attack missiles, nuclear). Another 800 non-strategic warheads, including 190 W80-0 warheads, are in inactive storage.

Approximately 200 B61 bombs are deployed in Europe at six airbases in five European members of the North Atlantic Treaty Organization (NATO): Belgium, Germany, Italy, the Netherlands and Turkey.[18] The aircraft of non-nuclear weapon NATO countries that are assigned nuclear strike missions with US nuclear weapons include Belgian and Dutch F-16 aircraft and German and Italian Tornado combat aircraft. The US arsenal in Europe may include inactive bombs. A portion of the new Joint Strike Fighter (F-35 Block IV) force may eventually be nuclear-capable.

TLAM/Ns are earmarked for deployment on selected Los Angeles, Improved Los Angeles and Virginia Class nuclear-powered attack submarines (SSNs, from ship submersible nuclear). TLAM/Ns are not deployed at sea under normal circumstances but can be redeployed within 30 days of a decision to do so. All are stored at the strategic weapon facilities at Bangor, Washington, and Kings Bay, Georgia. The W80-0 warhead may be retired in the near future.

Nuclear warhead stockpile management and modernization

The total US stockpile of roughly 5200 warheads is organized in two overall categories: active and inactive warheads. The active category includes 2702 intact warheads (with all the components) that are either (*a*) deployed on operational delivery systems, (*b*) assigned to the 'responsive force' of reserve warheads that can be deployed on operational delivery systems in a relatively short time, or (*c*) classified as spare warheads. The inactive category includes 2500 warheads that are held in long-term storage as a reserve with their limited-life components (e.g. tritium) removed. In addition to these warheads, approximately 4200 other warheads are awaiting dismantlement.

[17] Neither START nor SORT place limits on Russian and US inventories of non-strategic nuclear weapons.

[18] All B61 bombs apparently were withdrawn from Ramstein Air Force Base Germany in 2005 and RAF Lakenheath in the UK in 2008. On the history and status of US nuclear weapons in Europe see Kristensen, H. M., 'U.S. nuclear weapons removed from the United Kingdom', FAS Strategic Security Blog, Federation of American Scientists, 26 June 2008, <http://www.fas.org/blog/ssp/2008/06/us-nuclear-weapons-withdrawn-from-the-united-kingdom.php>.

The USA keeps nearly 5000 pits (cores) in storage at the Pantex Plant as a strategic reserve. Another 10 000 pits held at Pantex make up most of the weapon-grade plutonium previously declared in excess of military needs since 1993.[19] All of these pits come from retired warheads. Approximately 5000 canned assemblies (thermonuclear secondaries) are kept at the Oak Ridge Y-12 Plant, Tennessee.

III. Russian nuclear forces

As of January 2009 Russia had an estimated 4834 operational nuclear warheads (see table 8.3). Russia continues 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. According to a senior Russian military planner, Russia's strategic nuclear forces can guarantee 'minimally sufficient' deterrence until 2015–20 within the force ceilings imposed by SORT, even if the USA develops a ballistic missile defence (BMD) system. However, he added that the strategic forces would need qualitative improvements to enhance their survivability and ability to penetrate missile defences in the future.[20] As explained by a Russian missile designer, given all the above conditions 'enhanced survivability' refers to the newer missile systems' ability to deliver both launch-on-warning and second-strike capabilities in response to a nuclear attack.[21]

Russia has prioritized the procurement of the land-based RS-12M1/2 Topol-M ICBMs, as well as the development of the MIRVed (i.e. fitted with a multiple independently targetable reentry vehicle, MIRV) road-mobile RS-24 and the sea-launched RSM-56 Bulava missile systems, while continuing to extend the service lives of older missiles as an interim measure. In 2008 four missile types had their service lives extended: the RS-12M to 21 years, the RS-18 to 33 years, the RS-20B to 25 years and the RS-20V to 20 years. Plans exist to keep the RS-12M1/2 in service for up to 20 years.[22]

Land-based ballistic missiles

The Russian Strategic Rocket Forces (SRF) consist of three missile armies: the 27th Guards Missile Army (five divisions based in Vladimir), the

[19] On the USA's stocks of weapon-grade plutonium and uranium see appendix 8A.

[20] Umnov, S., [Russia's SNF: building up ballistic missile defence penetration capacities], *Voenno-Promyshlennyi Kur'er*, 8–14 Mar. 2006.

[21] Pulin, G., [Reliability of the nuclear shield], *Voenno-Promyshlennyi Kur'er*, 18–24 June 2008.

[22] Troitskii, A., [Mobile component of SRF], *Voenno-Promyshlennyi Kur'er*, 4–10 June 2008; [Service life in SRF of the ICBM "Stiletto" are extended to 33 years], ARMS-TASS, 1 Dec. 2008, <http://arms-tass.su/?page=article&aid=63338&cid=25>.

Table 8.3. Russian nuclear forces, January 2009

Type/Russian designation (NATO designation)	No. deployed	Year first deployed	Range (km)[a]	Warhead loading	No. of warheads
Strategic offensive forces	**620**				**2 787**
Bombers	*77*				*856*
Tu-95MS6 (Bear-H6)	32	1981	6 500–10 500	6 x AS-15A ALCMs, bombs	192
Tu-95MS16 (Bear-H16)	31	1981	6 500–10 500	16 x AS-15A ALCMs, bombs	496
Tu-160 (Blackjack)	14	1987	10 500–13 200	12 x AS-15B ALCMs or AS-16 SRAMs, bombs	168
ICBMs[b]	*383*				*1 355*
RS-20 B/V (SS-18 Satan)	68[b]	1986–92	11 000–15 000	10 x 500–750 kt	680[b]
RS-18 (SS-19 Stiletto)	72	1980	10 000	6 x 500–750 kt	432
RS-12M Topol (SS-25 Sickle)	180	1985	10 500	1 x 550 kt	180
RS-12M2 Topol-M (SS-27)	50	1997	10 500	1 x 550 kt	50
RS-12M1 Topol-M (SS-27)	13	2006	10 500	1 x 550 kt	13
RS-24 modified Topol-M	0	2009?	10 500	3 x 550 kt?	0
SLBMs	*160*				*576*
RSM-50 (SS-N-18 M1 Stingray)	64	1978	6 500	3 x 200 kt	192
RSM-54 (SS-N-23 Skiff/Sineva)	96	1986/2007	9 000	4 x 100 kt	384
RSM-56 (SS-N-30 Bulava)	0	2010?	>8 050	6 x 100 kt?	0
Strategic defensive forces					
Anti-ballistic missiles[c]	*1968*				*701*
51T6 (SH-11 Gorgon)	0	1989	–	1 x 1000 kt	0
53T6 (SH-08 Gazelle)	68	1986	–	1 x 10 kt	68
S-300 (SA-10/20 Grumble)	1900	1980	–	low kt	633
Non-strategic forces[d]					
Land-based non-strategic bombers	*524*				*648*
Tu-22M (Backfire)	124	1974	–	2 x AS-4 ASM, bombs	
Su-24 (Fencer)	400	1974	–	2 x bombs	
Naval non-strategic attack aircraft	*179*				*237*
Tu-22M (Backfire)	58	1974		2 x AS-4 ASM, bombs	
Su-24 (Fencer)	58	1974		2 x bombs	
Be-12 (Mail)/Il-38 (May)	63	1967/68		1 x depth bomb	
Sea-launched cruise missiles					
SS-N-9. SS-N-12, SS-N-19, SS-N-21, SS-N-22					276
Anti-submarine warfare weapons and surface-to-air missiles					
SS-N-15/16, SA-N-1/3/6, depth bombs, torpedoes[d]					185
Total defensive and non-strategic					**2 047**
Total					**4 834**[e]

ALCM = air-launched cruise missile; ASM = air-to-surface missile; ICBM = intercontinental ballistic missile; kt = kiloton; NATO = North Atlantic Treaty Organization; SERV = security-

enhanced re-entry vehicle; SLBM = submarine-launched ballistic missile; SRAM = short-range attack missile; SSBN = nuclear-powered ballistic missile submarine.

[a] Aircraft range is for illustrative purposes only; actual mission range will vary.

[b] A few ICBMs may be RS-20B (R-36MUTTH or SS-18 M5) each with a single 20-megaton warhead.

[c] The SH-11 Gorgon is no longer operational. The SA-10 Grumble, SA-12A Gladiator, SA-12B Giant and S-400 Triumf may have some capability against some ballistic missiles. Only a third of 1900 deployed SA-10s are counted as having nuclear capability.

[d] These figures assume that only half of land-based strike aircraft have nuclear missions. Surface ships are not estimated to be assigned nuclear torpedoes.

[e] An additional *c.* 8166 warheads are estimated to be in reserve or awaiting dismantlement for a total stockpile of *c.* 13 000 warheads.

Sources: US Department of State, START I Treaty Memoranda of Understanding, 1990–Jan. 2009; US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, Ohio, Mar. 2006); US Central Intelligence Agency, National Intelligence Council, 'Foreign missile developments and the ballistic missile threat through 2015' (unclassified summary), Dec. 2001, <http://www.fas.org/spp/starwars/CIA-NIE.htm>; US Department of Defense, 'Proliferation: threat and response', Washington, DC, Jan. 2001, <http://www.fas.org/irp/threat/wmd.htm>; World News Connection, National Technical Information Service (NTIS), US Department of Commerce, various issues; Russian Strategic Nuclear Forces, <http://www.russianforces.org/>; International Institute for Strategic Studies, *The Military Balance 2008* (Routledge: London, 2008); Cochran, T. B. et al., *Nuclear Weapons Databook*, vol. 4, *Soviet Nuclear Weapons* (Harper & Row: New York, 1989); *Proceedings*, US Naval Institute, various issues; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

31st Missile Army (two divisions, in Orenburg) and the 33rd Guards Missile Army (Omsk, four divisions).[23] In 2008 it was announced that the SRF would be reduced to two missile armies (four silo-based and five mobile divisions) by 1 January 2016.[24]

As of January 2009, Russia had on combat duty 68 RS-20 heavy ICBMs in two versions: the RS-20B and the RS-20V Voevoda.[25] The RS-20B and the RS-20V are silo-based, two-stage, liquid-propellant ICBMs, which entered into service in 1979–83 and in 1988–92, respectively.[26] The RS-20B missiles are being gradually retired from service. Instead of dismantlement, the SRF sometimes refurbishes them as Dnepr space launch vehicles (SLVs) and uses the launches for both profit and as tests to extend the service life of the RS-20B. In 2008 the Dnepr SLV put a Thai satellite and the German RapidEye satellites into orbit.[27]

[23] US Department of State, 'Russian Federation MOU Data', 1 Jan. 2009.

[24] Isby, D. C., 'Russian SRF plans structural changes', *Jane's Missiles and Rockets*, vol. 13, no. 2 (Feb. 2009).

[25] US Department of State (note 23), pp. 13–52.

[26] Lennox, D. (ed.), *Jane's Strategic Weapon Systems*, issue 49 (Jane's Information Group: Coulsdon, July 2008), pp. 164–66.

[27] 'Russia launches RapidEye remote sensing satellites', RIA Novosti, 29 Aug. 2008, <http://en.rian.ru/russia/20080829/116369611.html>; Russian Strategic Rocket Forces, Information and Public Relations Service, [Launch of RS-20 missile with simultaneous putting of the 'THEOS' satellite into orbit is planned from 'Dombarovskii' base], 4 Aug. 2008, <http://www.mil.ru/848/1045/1275/rvsn/

As of January 2009 Russia had a total of 72 RS-18 missiles deployed.[28] The RS-18 is a silo-based, two-stage, liquid-propellant ICBM capable of carrying up to six warheads, which entered into service in 1980.[29] On 22 October 2008 the RS-18 missile was successfully test-launched from Baikonur to its target at the Kura test range, Kamchatka. As a result of the test, it was decided to start the procedures to extend the RS-18's service life to 33 years.[30]

Reportedly, the RS-18 missile is to be supplanted by the RS-24 missile, for which testing began in May 2007. On 26 November 2008 an RS-24 was successfully test-launched from Plesetsk to its target at Kura.[31] The SRF commander, Nikolai Solovtsov, has stated that the RS-24 testing programme should be finished soon and the missile should enter into service in December 2009.[32]

Russia has 180 RS-12M Topol ICBMs deployed in eight missile divisions.[33] The RS-12M is a road-mobile, three-stage, solid-propellant ICBM with a single warhead, which entered into service in 1985.[34] It is expected to be in service until 2015, which requires a service life extension programme, including test launches.[35] On 28 August and 12 October 2008 the missile was test-launched from Plesetsk and was reported both times as having hit its target at Kura.[36]

The RS-12M2/1 Topol-M missile is a three-stage solid-propellant ICBM that has been developed in both road-mobile (RS-12M1) and silo-based

19220/index.shtml?id=48880>; and 'Russia launches Thai satellite on converted missile', RIA Novosti, 1 Oct. 2008, <http://en.rian.ru/russia/20081001/117363703.html>.

[28] US Department of State (note 23), pp. 12.

[29] Lennox (note 26), pp. 162–63.

[30] 'Russia test launches RS-18 ICBM from Baikonur in Kazakhstan', RIA Novosti, 22 Oct. 2008, <http://en.rian.ru/russia/20081022/117885862.html>.

[31] 'Russia test-launches new-generation RS-24 ballistic missile', RIA Novosti, 26 Nov. 2008, <http://en.rian.ru/russia/20081126/118554536.html>.

[32] [New ICBM RS-24 will enter service in December 2009], ARMS-TASS, 16 Dec. 2008, <http://arms-tass.su/?page=article&aid=64084&cid=25>. The RS-24 is a modified version of the RS-12M1 Topol-M missile with MIRV capability. Since this would violate the START Treaty, the RS-24 must either be significantly modified and declared as a new type or maintained as a 'prototype' until the treaty expires on 5 Dec. 2009. RIA Novosti (note 30); and Richardson, D., 'Russia flies second RS-24 test', *Jane's Missiles & Rockets*, vol. 12, no. 2 (Feb. 2008). On legal issues concerning MIRVs see Podvig, P., 'Is RS-24 a new missile?', Russian Strategic Nuclear Forces, 6 July 2007, <http://Russianforces.org/blog/2007/07/is_rs24_a_new_missile.shtml>; and Sokov, N., 'Russia tests a new ground-launched cruise missile and a new strategic missile on the same day', Monterey Institute of International Studies, James Martin Center for Nonproliferation Studies, 1 June 2007, <http://cns.miis.edu/pubs/week/070601.htm>. On the renewal or replacement of the START Treaty see chapter 9, section V, in this volume.

[33] US Department of State (note 23), pp. 11.

[34] Lennnox (note 21), pp. 158–60.

[35] 'Russia fires intercontinental ballistic missile', ITAR-TASS, 18 Oct. 2007.

[36] [The warhead of the ICBM 'Topol', launched from Plesetsk cosmodrome, launched simulated target in Kamchatka], ARMS-TASS, 28 Aug. 2008, <http://arms-tass.su/?page=article&aid=59211&cid=25>; and 'Russia's Medvedev observes test launch of Topol ICBM', RIA Novosti, 12 Oct. 2008, <http://en.rian.ru/russia/20081012/117687736.html>.

(RS-12M2) versions. As of January 2009 Russia had 13 RS-12M1 missiles and 50 RS-12M2 missiles.[37]

Ballistic missile submarines

As of January 2009, the Russian Navy operated 12 SSBNs in its Northern and Pacific fleets. Of these, five are Project 667BDR Kalmar (Delta III Class) submarines, all of which are deployed with the Pacific Fleet.[38] One Project 667BDR submarine, the *Borisoglebsk*, was decommissioned in 2008.[39] The Russian Navy also operates six Project 667BDRM Delfin (Delta IV Class) submarines, all part of the Northern Fleet. As of January 2009 two of these Project 667BDRM submarines were undergoing service life-extension overhauls.[40] One Project 941 Akula (Typhoon Class) submarine remains in service as a test platform for the RSM-56 Bulava missile, but is not armed.[41]

Russia has been building three SSBNs of a new class, the Project 955 Borei. The first, the *Yurii Dolgorukii*, is preparing for sea trials in 2009.[42] The second and third submarines were laid down at the Sevmash shipyard in March 2004 and March 2006, respectively.[43]

Russia tested SLBMs four times in 2008. The RSM-50 SLBM was launched on 1 August from an SSBN in the Barents Sea to its target at Kura and on 12 November from the Sea of Okhotsk to its target at the Chizha test range.[44] On 11 and 12 October SSBNs launched RSM-54 SLBMs from the Barents Sea to targets in the 'equatorial region in the Pacific' and Kura, respectively. The first of these flew 11 547 km, a record range for this type.[45]

Russia is giving high priority to the troubled development of the RSM-56 Bulava, a three-stage, solid-propellant SLBM. Once fitted on the Project

[37] US Department of State (note 23), pp. 11.

[38] US Department of State (note 23), pp. 53, 54; and Ptichkin, S., [Secret sailing under the Arctic], *Rossiiskaya Gazeta*, 1 Oct. 2008.

[39] ['Borisoglebsk' submarine will be dismantled in Arkhangel'sk region], REGNUM, 10 Dec. 2008, <http://www.regnum.ru/news/1097107.html>.

[40] Zvezdochka Ship Repair Centre, [SSBN 'Karelia' moved out of the dry dock], Press release, 22 Nov. 2008, <http://www.star.ru/index.php?page=183>.

[41] Kile, Fedchenko and Kristensen (note 3), p. 378.

[42] Richardson, D., 'Borey-class ballistic missile submarine takes to water', *Jane's Missiles & Rockets*, vol. 12, no. 4 (Apr. 2008); JSC Sevmash, [Reactor launch], 21 Nov. 2008, <http://www.sevmash.ru/?id=4881>; and 'Sea trials of Russia's Yury Dolgoruky submarine postponed', RIA Novosti, 30 Dec. 2008, <http://en.rian.ru/russia/20081230/119234378.html>.

[43] [Reached from under water], *Kommersant Business Guide*, 4 July 2006.

[44] Makeyev Design Bureau, [Successful launch of RSM-50], News release, 4 Aug. 2008, <http://makeyev.ru/comment.php?comment.news.100>; and Myasnikov, V., ['Sineva' of asymmetrical range], *Nezavisimaya Gazeta*, 13 Oct. 2008. The SS-N-18 M1 entered service in 1978 and is deployed on Delta III Class submarines. It has 2 liquid-fuelled stages and carries 3 warheads. Lennox (note 26), pp. 152–53.

[45] Myasnikov (note 44). The SS-N-23 Skiff SLBM was first test-launched in 1983. On the upgraded Sineva ('the Blue') version see Kile, Fedchenko, and Kristensen (note 3), pp. 378–79.

955 SSBNs, it is supposed to form the backbone of the future Russian naval deterrent force. During 2008 the RSM-56 was test-launched from an SSBN on 18 September, 28 November and 23 December. Only the second of these tests was 'fully successful', with warheads reaching targets at Kura.[46] These brought the total number of test flights of the RSM-56 missile to 10, with an additional two pop-up tests (i.e. tests of the mechanism which ejects the missile from the submarine), but only two are referred to as having been completely successful. This represents a major setback, not only for the missile development programme, but also for the plans to bring Project 955 submarines into service.[47]

Strategic bombers

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 at Engels and Ryazan, with 14 Tu-160, 16 Tu-95MS16 and 7 Tu-95MS6 aircraft; and the 326th Heavy Bomber Division at Ukrainka, with 15 Tu-95MS16 and 25 Tu-95MS6 aircraft. The 37th Air Army also comprises four divisions of Tu-22M3 bombers.[48] In 2008 Russia continued to conduct regular strategic bomber patrols.[49]

In 2007 the Kazan Aviation Plant completed the production of a new Tu-160 bomber, which was delivered to the Air Force on 29 April 2008.[50] Russia plans to have a total of 30 Tu-160 aircraft by 2025–30.[51] During 2008 two Tu-160 aircraft were sent for overhaul under an ongoing upgrade programme and plans to upgrade Tu-95MS aircraft were announced.[52]

Non-strategic nuclear weapons

Since the end of the cold war, Russia has significantly reduced its inventory of non-strategic nuclear weapons pursuant to a 1992 unilateral initiative on

[46] [How Bulava trials ended], *Kommersant*, 24 Dec. 2008.

[47] ['Yurii Dolgorukii' is incapacitated by the absence of missiles], *Kommersant*, 24 Dec. 2008.

[48] US Department of State (note 23), pp. 61–62; Khudoleev, V., [37th Army is following the course], *Krasnaya Zvezda*, 23 Dec. 2005.

[49] Petrov, V., 'Russian training exercises set to include live missile fire', *Jane's Missiles & Rockets*, vol. 12, no. 12 (Dec. 2008).

[50] Sitdikova, E.,'Kazan aircraft producer delivers Tu-160 to Russian Air Force', Tatar-Inform, 29 Apr. 2008, <http://www.eng.tatar-inform.ru/news/2008/04/29/15587/>.

[51] 'Gorbunov aircraft plant tests new Tu-160', Tatar-Inform, 9 Jan. 2008, <http://www.eng.tatar-inform.ru/news/2008/1/9/10685/>.

[52] [Russian Air Force plans to modernize up to 3 Tu-160 per year], RIA Novosti, <http://www.rian.ru/society/20080426/105973093.html>; and 'Russia to upgrade strategic bombers in 2009', RIA Novosti, 23 Dec. 2008, <http://en.rian.ru/russia/20081223/119141502.html>.

non-strategic nuclear weapons.[53] However, there is considerable uncertainty in estimates of this inventory, which continues to be characterized by a high degree of secrecy and a lack of transparency.[54] On the basis of the number of available delivery platforms, it can be estimated that Russia has approximately 2050 operational warheads for delivery by air-defence missiles, tactical aircraft and naval cruise missiles, depth bombs and torpedoes.[55] In addition, Russia is believed to have up to several thousand non-strategic warheads held in reserve or awaiting dismantlement.

In 2008 General Nikolai Makarov, Chief of the General Staff of the Russian Armed Forces, affirmed Russia's commitment to non-strategic nuclear weapons: 'We will keep nonstrategic nuclear forces as long as Europe is instable and packed with armaments. That is a guarantee of our security.'[56] Russian officials also warned that Russia would make new deployments of tactical nuclear weapons in Kaliningrad if the USA proceeded with its planned deployment of missile defence interceptors and radar in Poland and the Czech Republic.[57]

IV. British nuclear forces

The United Kingdom's nuclear deterrent consists of a sea-based component only: Vanguard Class Trident SSBNs, Trident II (D-5) SLBMs and associated warheads, and support infrastructure. The UK possesses an arsenal of about 160 nuclear warheads available for use by a fleet of four Trident SSBNs based at Faslane, Scotland (see table 8.4).[58] The UK 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 are randomly selected from the stockpile at the US Navy's Trident facility in Kings Bay, Georgia, and loaded onto British submarines. The submarines then go to

[53] See Fieldhouse, R., 'Nuclear weapon developments and unilateral reduction initiatives', *SIPRI Yearbook 1992: World Armaments and Disarmament* (Oxford University Press: Oxford, 1992), pp. 72–73, 89–92.

[54] In 2007 the top Russian Ministry of Defence official responsible for nuclear weapon custody reported on the progress made in reducing this inventory but did not give specific numbers of warheads. Volgin, V., [Strategic monitoring], *Rossiiskaya Gazeta*, 31 Oct. 2007.

[55] Russia's total inventory of intact non-strategic nuclear weapons, including reserve and those awaiting dismantlement, includes an estimated 5390 weapons. Kristensen, H. M., 'Russian tactical nuclear weapons', FAS Strategic Security Blog, Federation of American Scientists, 25 Mar. 2009, <http://www.fas.org/blog/ssp/2009/03/russia-2.php>. Warheads for ships and submarines are stored on land in depots and can be deployed if necessary. See also Kile, Fedchenko and Kristensen (note 3), pp. 380–81.

[56] 'Russian military chief defends nonstrategic nukes', *Global Security Newswire,* 17 Dec. 2008, <http://www.globalsecuritynewswire.org/gsn/nw_20081217_4724.php>.

[57] Baigin, S., 'Russia, spurred by Georgia war, plans arms upgrade', Reuters, 22 Dec. 2008 <http://www.reuters.com/article/GCA-Russia/idUSTRE4BL3WT20081222>.

[58] In 2007 the Secretary of State for Defence, Des Browne, confirmed that the UK's inventory of 'operationally available warheads' had been reduced 'from fewer than 200 to fewer than 160'. British House of Commons, 'Trident missiles', *Hansard*, column C363W, 15 Nov. 2007. A small number of non-operational reserve warheads presumably also exists.

Table 8.4. British nuclear forces, January 2009

Type	Designation	No. deployed	Year first deployed	Range (km)[a]	Warheads x yield	Warheads in stockpile
Submarine-launched ballistic missiles						
D-5	Trident II	48	1994	>7 400	1–3 x 100 kt	185[b]

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

[b] Fewer than 160 warheads are operationally available, *c.* 144 to arm 48 missiles on 3 of 4 SSBNs. The operational stockpile may consist of *c.* 185 warheads, with additional warheads in reserve. Only 1 boat is on patrol at any time, with up to 48 warheads.

Sources: British Ministry of Defence (MOD), White Papers, press releases and the MOD website, <http://www.mod.uk/>; British House of Commons, *Parliamentary Debates (Hansard)*; Norris, R. S. et al., *Nuclear Weapons Databook*, vol. 5, *British, French, and Chinese Nuclear Weapons* (Westview: Boulder, CO, 1994), p. 9; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimate.

the Royal Naval Armaments Depot at Coulport, Scotland, where the missiles are fitted with warheads designed and manufactured at the Atomic Weapons Establishment (AWE), Aldermaston, England.

In a posture known as Continuous At Sea Deterrence, one British SSBN is on patrol at all times.[59] The second and third SSBNs can be put to sea rapidly, while 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.

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 being upgraded with the US-produced Mk4A Arming, Fusing and Firing (AF&F) system in order to improve the accuracy of the D-5 missile and increase its ability to attack a wider range of targets.[60] It is believed that a number of the 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.[61] The reduced force-loading option is the result of a decision by the Ministry of Defence (MOD) to give a 'sub-strategic' role to the Trident fleet. The MOD's 1998 Strategic Defence Review states that the credibility of deterrence as a means of demonstrating resolve or conveying

[59] British Ministry of Defence and British Foreign and Commonwealth Office, *The Future of the United Kingdom's Nuclear Deterrent*, Cm 6994 (Stationary Office: London, Dec. 2006), p. 27.

[60] Taylor-Norton, R., 'Trident upgrade under way, MOD admits', *The Guardian*, 14 Mar. 2007.

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

a political message 'depends on retaining an option for a limited strike that would not automatically lead to a full scale nuclear exchange'.[62]

There has been a controversy in the UK about the future of the country's strategic nuclear deterrent after the four Vanguard SSBNs reach the end of their service lives from 2024.[63] In a 2006 White Paper the British Government recommended renewing the Trident system by replacing the existing submarines with a new class of SSBNs and equipping them with the modified Trident II D5LE SLBM being developed by the USA, thereby keeping the system in service until the early 2040s.[64] Opponents of the plan, which was approved by the House of Commons in 2007, have criticized the procurement costs of the new submarines and associated infrastructure. This was estimated in the 2006 White Paper to be £15–20 billion ($28.5–38 billion), at 2006 prices, for the planned four-boat fleet. There have also continued to be questions about the rationale for the UK keeping a nuclear force. In a letter published in January 2009, three former senior British military officers stated that the British nuclear deterrent was 'virtually irrelevant' an 'cannot be seen as independent of the United States in any meaningful sense' since it relies on the USA 'for the provision and regular servicing of the D5 missiles'.[65]

The modified Trident programme is currently in a two-year concept phase, due to finish in September 2009, focused on establishing the principal design parameters of the new submarine as well as on settling a number of key programme management and budget issues.[66] Following this, the main design phase will continue until 2014, with the subsequent construction phase scheduled to last until 2022. The new submarine will enter into service in 2024 after testing and acceptance trials. In November 2008 the National Audit Office issued a report warning that the MOD had a 'challenging timetable to meet if continuous at sea deterrence is to be maintained' and had 'little scope for incorporating time contingency in the overall programme to deal with slippage' in key areas.[67] The MOD acknow-

[62] British Ministry of Defence (MOD), *The Strategic Defence Review: Modern Forces for the Modern World*, Cm 3999 (MOD: London, July 1998), para. 63. An addendum in 2002 extended the role of nuclear weapons to include deterring 'leaders of states of concern and terrorist organisations'. British Ministry of Defence, *The Strategic Defence Review: A New Chapter*, Cm 5566, vol. 1 (Stationary Office: London, July 2002), para. 21.

[63] The lead ship of the class, HMS *Vanguard*, entered service in 1994. The original 25-year service life has been extended to 30 years.

[64] British Ministry of Defence and British Foreign and Commonwealth Office (note 59).

[65] Lord Bramall (Field Marshal), Lord Ramsbotham (Gen.) and Beach, H. (Gen.), 'UK does not need a nuclear deterrent', Letter, *The Times*, 16 Jan. 2009.

[66] British National Audit Office, *Ministry of Defence: The United Kingdom's Future Nuclear Deterrent Capability*, Report by the Comptroller and Auditor General, HC 1115 Session 2007–2008 (Stationary Office: London, 5 Nov. 2008).

[67] British National Audit Office (note 66), p. 5. The report notes that the MOD and its industrial partners faced budget uncertainties and critical 'skills gaps, including programme management, submarine construction expertise and nuclear-related experience'.

Table 8.5. French nuclear forces, January 2009

Type	No. deployed	Year first deployed	Range (km)[a]	Warheads x yield	Warheads in stockpile
Land-based aircraft					
Mirage 2000N	60	1988	2 750	1 x 300 kt ASMP	50
Rafale F3	–	(2009)	2 000	1 x ? kt ASMP-A	–
Carrier-based aircraft					
Super Étendard	24	1978	650	1 x 300 kt ASMP	10
Rafale MK3	–	(2010)	2 000	1 x ? kt ASMP-A	–
Submarine-launched ballistic missiles					
M45	48	1996	6 000[b]	4–6 x 100 kt	240
M51	–	(2010)	6 000	4–6 x 100 kt	–
Total					**300**[c]

ASMP = Air–Sol Moyenne Portée (medium-range air to surface missile); ASMP-A = ASMP-Améliorée (improved ASMP).

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

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

[c] The warhead stockpile will be reduced to fewer than 300 warheads in near future. France does not have a reserve but may have a small inventory of spare warheads.

Sources: Sarkozy, N., French President, Speech on defence and national security, Porte de Versailles, 17 June 2008, <http://www.defense.gouv.fr/livre_blanc/>; French Ministry of Defence website, various policy papers, press releases and force profiles; French National Assembly, various defence bills; Norris, R. S. et al., *Nuclear Weapons Databook*, vol. 5, *British, French, and Chinese Nuclear Weapons* (Westview: Boulder, CO, 1994), p. 10; *Air Actualités*, various issues; *Aviation Week & Space Technology*, various issues; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

ledged that it was studying a further life-extension of the Vanguard SSBNs in case the new submarine's entry into service is delayed.[68]

The British Government has said that it will defer a decision on whether to refurbish or replace the nuclear warheads carried on the D-5 SLBM until after the next election, probably in 2010. However, according to press reports, MOD officials privately told defence industry groups in 2008 that a decision had already been taken to replace the existing stockpile of nuclear warheads, at an estimated cost of more than £3 billion ($5.5 million).[69] The MOD has launched a long-term investment programme aimed at sustaining key skills and facilities at the AWE.[70]

[68] Barrie, D., 'U.K. ponders further vanguard extension', *Aviation Week & Space Technology*, 21 Nov. 2008.

[69] Taylor, M., 'Britain plans to spend £3bn on new nuclear warheads', *The Guardian*, 25 July 2008.

[70] Reid, J., Secretary of State for Defence, Oral answers, House of Commons, *Hansard*, column C60WS, 19 July 2005.

V. French nuclear forces

France's nuclear forces consist of four SSBNs and 84 aircraft, carrying a total of about 300 warheads (see table 8.5). In June 2008 French President Nicolas Sarkozy presented a White Paper on defence and national security, which includes important new information concerning French nuclear forces.[71] The White Paper underscores that France will continue to rely on the 'principle of strict sufficiency' (corresponding to the 'minimum deterrence' policy) as a guarantor of its security, and that the 'operational credibility' of the deterrent relies on 'permanent submarine patrols and airborne capability'. Following the strict sufficiency policy, France announced the reduction of the airborne component of its nuclear forces by one third starting in 2008.[72]

In order to maintain the 'technical credibility' of its nuclear weapons in the absence of nuclear testing and facilities producing weapons-grade material, in 1996 France started a nuclear weapon simulation programme, employing the Laser Mégajoule (LMJ, megajoule laser), weapons radiography and supercomputers. The White Paper states that France will continue to sustain its nuclear weapon complex, in particular the relevant research and development capabilities.

In 2008 France's sea-based strategic force consisted of a fleet of three operational SSBNs of the Triomphant Class. The older L'Inflexible Class SSBN was decommissioned in January 2008.[73] The fourth Triomphant Class SSBN, *Le Terrible,* will enter into service in 2010. It was launched on 21 March 2008 and began sea trials in early 2009.[74]

All operational French SSBNs are armed with 16 Aérospatiale M45 missiles, which carry up to six TN-75 warheads each.[75] In 2010–15 the SSBNs will be retrofitted with the longer-range M51.1 SLBM, a three-stage solid-propellant missile armed with up to six TN-75 warheads. The M51.1 is estimated to have a maximum range of 6000–8000 km.[76] As of January 2009

[71] French Government, *Défense et sécurité nationale: Le livre blanc* [Defence and national security: the White Paper] (Odile Jacob: Paris, June 2008). English translation: French Government, *The French White Paper on Defence and National Security* (Odile Jacob: New York, 2008), pp.161–63.

[72] French Government (note 71), p. 112; and Sarkozy, N., French President, 'Presentation of SSBM "Le Terrible"', Speech, 21 Mar. 2008, <https://pastel.diplomatie.gouv.fr/editorial/actual/ael2/bulletin.gb.asp?liste=20080331.gb.html>.

[73] 'Avec la retraite de L'Inflexible, une page se tourne' [With the withdrawal of L'Inflexible, a page turns], *Ouest France*, 17 Jan. 2008.

[74] Barreira, V. and Scott, R., 'DCNS unveils France's last Le Triomphant-class submarine', *Jane's Missiles & Rockets*, vol. 12, no. 5 (May 2008); and 'Sorti du port militaire, le Terrible est prêt à commencer les essais en mer' [Leaving the military port, the Terrible is ready to begin sea trials], *Ouest France*, 26 Jan. 2009.

[75] Norris, R. S. and Kristensen, H. M., 'Nuclear notebook: French nuclear forces, 2008', *Bulletin of the Atomic Scientists*, vol. 64, no. 4 (July/Aug. 2008).

[76] Lennox (note 26), p. 46; and 'France's nuclear-powered Le Vigilant prepares for patrol', *Jane's Missiles & Rockets*, vol. 9, no. 2 (Feb. 2005).

the M51.1 missile had been successfully flight-tested three times. After launches in 2006 and 2007, on 13 November 2008 an unarmed M51.1 missile was fired from a submerged launch platform at the Landes Missile Launch Test Centre at Biscarosse, Aquitaine. The first underwater launch is planned for 2010.[77]

In 2008 the air component of the French nuclear forces consisted of approximately 60 Mirage 2000N aircraft, equipping three squadrons; and about 24 Super Étendard aircraft deployed on the aircraft carrier *Charles de Gaulle*. The number of Mirage 2000N aircraft having a nuclear role will be reduced following the July 2008 statements of Nicolas Sarkozy. Both types of aircraft carry the Air–Sol Moyenne Portée (ASMP, medium-range air to surface missile) cruise missile. A total of 90 ASMP missiles were produced, along with 80 TN81 300-kt warheads for them.[78] A follow-on cruise missile, the ASMP-Améliorée (improved ASMP), is expected to enter service in 2009 as a replacement for the ASMP.[79]

VI. Chinese nuclear forces

China is estimated to have an arsenal of approximately 186 operational nuclear weapons for delivery mainly by ballistic missiles and aircraft (see table 8.6). Additional warheads may be in reserve, giving a total stockpile of about 240 warheads.[80] The Chinese Foreign Ministry stated in 2004 that China possessed 'the smallest nuclear arsenal' among the nuclear weapon states, but China is now thought to have more nuclear weapons than France and the United Kingdom.[81]

In January 2009 the Chinese Government released the latest of its biennial Defence White Papers. It reiterates China's commitment to the policy of no-first-use of nuclear weapons what the Chinese military strategy 'calls for the building of a lean and effective deterrent force and the flexible use of different means of deterrence'.[82]

[77] EADS Astrium, 'Successful first submarine launch of M51', Press release, 14 Nov. 2008, <http://www.astrium.eads.net/en/press-center/press-releases/2008/successful-first-submarine-launch-of-m51>.

[78] Fiszer, M. and Gruszczynski,, J., 'French MoD to develop nuclear missile', *Journal of Electronic Defense*, vol. 26, no. 12 (Dec. 2003).

[79] Norris, R. S., and Kristensen, H. M., 'Nuclear notebook: nuclear cruise missiles', *Bulletin of the Atomic Scientists*, vol. 63, no. 6 (Nov./Dec. 2007), p. 61.

[80] US Department of Defense (DOD), *Military Power of the People's Republic of China 2009*, Annual Report to Congress (DOD: Washington, DC, 25 Mar. 2009), p. 66; and US National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat Through 2015*, Unclassified summary of a National Intelligence Estimate (Director of Central Intelligence: Dec. 2001), pp. 3, 8.

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

[82] Chinese State Council, *China's National Defense in 2008* (Information Office of the State Council of the People's Republic of China: Beijing, Jan. 2009).

The White Paper explains that the Second Artillery Corps (SAC), the division of the People's Liberation Army that controls China's strategic missiles, has three levels of combat readiness. First, in peacetime, Chinese nuclear missiles 'are not aimed at any country'. This statement might refer to the fact that Chinese nuclear warheads are not 'mated with' their missiles under normal circumstances.[83] Second, under a threat of nuclear attack, the SAC 'will go into a state of alert, and get ready for a nuclear counterattack to deter the enemy'. This description is interpreted as combat deployment and aiming of strategic missiles. Finally, if China comes under a nuclear attack, the SAC will launch a counterattack 'either independently or together with the nuclear forces of [the Navy and the Air Force]'.[84]

As of early 2009 China had four types of deployed ICBMs: the solid-fuel mobile DF-31 and DF-31A; the silo-based, liquid fuel DF-5A; and the smaller liquid-fuel DF-4.[85] China deploys one type of medium-range ballistic missile (MRBM)—the solid-fuel, road-mobile DF-21—and one type of intermediate-range ballistic missile (IRBM)—the liquid-fuel DF-3A.[86] The DF-21 and DF-31 will probably replace the DF-3A and the DF-4. Satellite imagery analysis published in 2008 suggests that the first unit of the SAC to be equipped with the DF-31 may be stationed near Nanyang, Henan, approximately 850 km south east of Beijing.[87]

China operates a single Type 092 (Xia Class) SSBN armed with 12 intermediate-range solid-fuel, single-warhead JL-1 SLBMs. The submarine has never conducted a deterrent patrol and is not thought to be fully operational.[88] China is developing the Type 094 (Jin Class) SSBN, which will carry 12 JL-2 SLBMs with a range of more than 7200 km. The first unit is now in service and may reach 'initial operational capability' with the JL-2 in 2009–10.[89] As of 2008 four Jin Class SSBNs were reportedly in various stages of construction, but only three have been identified on commercial

[83] See e.g. Kristensen, H. M., 'China Defense White Paper describes nuclear escalation', FAS Strategic Security Blog, Federation of American Scientists, 23 Jan. 2008, <http://www.fas.org/blog/ssp/2009/01/chinapaper.php>;

[84] Chinese State Council (note 82), chapter VII.

[85] US Department of Defense (note 80), pp. 3, 5, 23, 24–27, 30, 56.

[86] 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, H. M., Norris, R. S. and McKinzie, M. G., *Chinese Nuclear Forces and U.S. Nuclear War Planning* (Federation of American Scientists/Natural Resources Defense Council: Washington, DC, Nov. 2006), p. 218.

[87] Richardson, D., 'Six possible launch sites for China's DF-31 mobile ICBM tracked down to Nanyang', *Jane's Missiles & Rockets*, vol. 12, no. 6 (June 2008).

[88] Kristensen, Norris and McKinzie (note 86), pp. 77–80.

[89] Kristensen, H. M., 'New Chinese SSBN deploys to Hainan Island', FAS Strategic Security Blog, Federation of American Scientists, 24 Apr. 2008, <http://www.fas.org/blog/ssp/2008/04/new-chinese-ssbn-deploys-to-hainan-island-naval-base.php>; and US Department of Defense (note 80), p. 3.

Table 8.6. Chinese nuclear forces, January 2009

Type/Chinese designation (US designation)	No. deployed	Year first deployed	Range (km)[a]	Warheads x yield	No. of warheads
Strategic weapons					**(186)**
Land-based missiles[b]	*134*				*134*
DF-3A (CSS-2)	17	1971	3 100[c]	1 x 3.3 Mt	17
DF-4 (CSS-3)	17	1980	5 500	1 x 3.3 Mt	17
DF-5A (CSS-4)	20	1981	13 000	1 x 4–5 Mt	20
DF-21 (CSS-5)	60	1991	2 100[c]	1 x 200–300 kt	60
DF-31 (CSS-X-10)	~10	2007	>7 200	1 x ?	10
DF-31A (?)	~10	(2008–10)	>11 200	1 x ?	10
SLBMs	*(12)*				*12*
JL-1 (CSS-N-3)	(12)	1986	>1 770	1 x 200–300 kt	(12)
JL-2 (CSS-NX-5)	(36)	(2009–10)	>7 200	1 x ?	(36)
Aircraft[d]	*>20*				*(40)*
H-6 (B-6)	20	1965	3 100	1 x bomb	(20)
Attack (?)	?	1972–?	?	1 x bomb	(20)
Non-strategic weapons[e]					
Cruise missiles (DH-10)	150–350	2007	>1500	1 x ?	?[f]
Short-range ballistic missiles (DF-15 and DF-11)					?
Total					**(186)**[g]

( ) = uncertain figure; SLBM = submarine-launched ballistic missile.

[a] Aircraft range is for illustrative purposes only; actual mission range will vary.

[b] China defines missile ranges as: short-range, <1000 km; medium-range, 1000–3000 km; long-range, 3000–8000 km; and intercontinental range, >8000 km.

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

[d] Figures for aircraft are for nuclear-configured versions only.

[e] The existence of tactical warheads is uncertain, although the testing series in the 1990s reportedly included tactical warhead designs.

[f] The DH-10 is thought to be conventional but may also have a nuclear capability. The weapon apparently is employable from H-6 bombers and ground-based launchers.

[g] Additional warheads are thought to be in storage to arm future DF-31, DF-31A, and JL-2 missiles. The total stockpile is believed to comprise *c*. 240 warheads.

Sources: US Department of Defense (DOD), Office of the Secretary of Defense, *Military Power of the People's Republic of China*, various years; US Air Force, National Air and Space Intelligence Center (NASIC), various documents; US Central Intelligence Agency, various documents; US DOD, Office of the Secretary of Defense, 'Proliferation: threat and response', Washington, DC, Jan. 2001, <http://www.defenselink.mil/pubs/ptr20010110.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), <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, CO, 1994); 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; Google Earth; and Authors' estimates.

satellite images.[90] The US intelligence community estimates that China might be building 'up to five JIN-class SSBNs'.[91]

VII. Indian nuclear forces

The conservative estimate presented here is that India has an arsenal of about 60–70 operational nuclear weapons. The figure is based on calculations of India's inventory of weapon-grade plutonium as well as the number of operational nuclear-capable weapon systems.[92] Most published estimates of the number of Indian nuclear weapons are based on calculations of the total amount of weapon-grade plutonium that India has produced. Numerous media and government reports suggest that India has not manufactured as many nuclear weapons as it otherwise could owing to material constraints. It is not publicly known whether India has produced highly enriched uranium (HEU) for weapon purposes, in particular for thermonuclear devices.

India's nuclear doctrine, which was published as a draft document in 1999, is 'based on the principle of a minimum credible deterrent and no-first-use'.[93] However, India published additional guidelines in January 2003 stating that it would use nuclear weapons to deter or retaliate against the use of chemical or biological weapons.[94] There has been no official statement specifying the size of the arsenal required for 'minimum credible deterrence' but, according to the Indian MOD, it involves 'a mix of land-based, maritime and air capabilities'.[95]

Strike aircraft

At present, aircraft constitute the most mature component of India's nuclear strike capabilities (see table 8.7).[96] 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 addition to the Mirage 2000H, some of the IAF's four

[90] Saunders, S. (ed.), *Jane's Fighting Ships 2008–2009*, 111th edn (Jane's Information Group: Coulsdon, 2008), p. 120.

[91] US Department of Defense (note 80), p. 48.

[92] On India's stocks of fissile materials see appendix 8A.

[93] Indian Ministry of Defence (MOD), *Annual Report 2004–05* (MOD: New Delhi, 2005), p. 14; and Indian Ministry of External Affairs, 'Draft report of National Security Advisory Board on Indian nuclear doctrine', 17 Aug. 1999, <http://meaindia.nic.in/disarmament/dm17Aug99.htm>.

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

[95] Indian Ministry of Defence (note 93), p. 15.

[96] Norris, R. S. and Kristensen, H. M., 'Nuclear notebook: India's nuclear forces', *Bulletin of the Atomic Scientists*, vol. 64, no. 5 (Nov./Dec. 2008).

Table 8.7. Indian nuclear forces, January 2009

Type	Range (km)[a]	Payload (kg)	Status
Land-based ballistic missiles[b]			
Prithvi I (P-I)	150	800	Entered service in 1994; widely believed to have a nuclear delivery role; fewer than 50 launchers deployed; most recent test flight on 9 May 2007
Agni I[c]	>700	1 000	First and second Army operational test in Oct. 2007 and Mar. 2008, respectively; deployed with the Army's 334 Missile Group
Agni II	>2 000	1 000	Last test-launched 29 Oct. 2004; inducted into Army but operational status uncertain
Agni III	>3 000	1 500	Under development; test-launched 3 times, most recently 7 May 2008; induction expected in 2010–11
Sea-based ballistic missiles			
Dhanush	350	1 000	Last test-launched on 30 Mar. 2007; induction underway
K-15[d]	700	500–600	Test-launched from submerged pontoon on 26 Feb. 2008
Aircraft			
Mirage 2000H Vajra	1 850	6 300	Has reportedly been certified for delivery of nuclear gravity bombs
Jaguar IS Shamsher	1 400	4 760	Some of 4 squadrons may have nuclear delivery role

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

[b] India has also begun developing a subsonic cruise missile with a range of 1000 km, known as the Nirbhay ('Fearless'), which may have a nuclear capability.

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

[d] According to unconfirmed Indian media reports, a land-based version of the K-15, known as the Shourya, was test-launched for the first time on 12 Nov. 2008.

Sources: Indian Ministry of Defence, annual reports and press releases; International Institute for Strategic Studies (IISS), *The Military Balance 2006–2007* (Routledge: London, 2007); US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NAIC: Wright-Patterson Air Force Base, Ohio, Mar. 2006); 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, <https://www.cia.gov/library/reports/archived-reports-1/>; US National Intelligence Council, 'Foreign missile developments and the ballistic missile threat through 2015' (unclassified summary), Dec. 2001, <http://www.dni.gov/nic/special_missilethreat2001.html>; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

squadrons of Jaguar IS Shamsher ('Sword') fighter-bombers may have a nuclear delivery role.[97] Other aircraft in the Indian Air Force's inventory which are potentially suitable for a nuclear role are the MiG-27 (Bahadur) and the Su-30MKI. The Su-30MKI has an in-flight refuelling capability with the IL-78 aerial tanker.

Land-based missiles

The Prithvi ('Earth') was India's sole operational ballistic missile for many years. A number of Prithvi I missiles are widely believed to have been modified to deliver nuclear warheads, although this has not been officially confirmed. The Prithvi I (SS-150) is a single-stage, road-mobile, liquid-fuel ballistic missile capable of delivering a 1000-kg warhead to a maximum range of 150 km.[98] The missile was first flight-tested in 1988 and inducted into service by the Indian Army in 1994. It is currently deployed with the Army's 333, 444 and 555 missile groups. There are two newer versions of the Prithvi missile. The Prithvi II (SS-250) entered into service with the IAF in 2004 and with the Army in 2006. On 23 May 2008 the Army test-fired for the first time a 350-km extended range Prithvi II in a 'post-induction training launch' from the Integrated Test Range (ITR) at Chandipur-on-Sea, Orissa.[99] The Prithvi III (SS-350) is a solid-fuel missile which has improved range, accuracy and handling characteristics. Neither the Prithvi II nor the Prithvi III are believed to be assigned a nuclear weapon delivery role.

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. On 4 February 2008, three days after Pakistan test-launched an IRBM, the Indian Government reportedly announced that the Agni I and the Agni II were operationally deployed with the Strategic Forces Command's 334 and 335 missile groups, respectively.[100] On 23 March 2008 army personnel from the Strategic Forces Command carried out the fifth successful test flight of an Agni I missile and the second from a mobile road launcher.[101] The Agni II was most recently test-

[97] Norris and Kristensen (note 96).

[98] According to Indian press reports, the range of the Prithvi I is being extended to 250 km. Mallikarjun, Y., 'Nuclear-capable Prithvi-II test-fired successfully', *The Hindu*, 24 May 2008.

[99] Mallikarjun (note 98); and Indian Ministry of Defence (MOD), 'Army test fires Prithvi-II, achieves near perfect accuracy', Press release, 23 May 2008, <http://pib.nic.in/release/release.asp?relid=39106&kwd>.

[100] Bermudez, J. S., 'Pakistan carries out successful Ghauri launch', *Jane's Defence Weekly*, 13 Feb. 2008; and 'Raising of two Agni missile groups cleared', *The Hindu*, 24 Sep. 2003.

[101] Bedi, R., 'India records fifth successful Agni 1 firing', *Jane's Missiles & Rockets*, vol. 12, no. 5 (May 2008), p. 16.

launched in October 2004, before its formal induction by the Army, and there are doubts about whether it is fully operational.

On 7 May 2008 the Indian Defence Research and Development Organisation (DRDO) conducted the third test flight of the intermediate-range Agni III. The missile, which was equipped with a new ring laser gyroscope inertial navigation system, was launched from a fixed platform at the ITR on Wheeler Island in the Bay of Bengal. It delivered a dummy warhead to the target area approximately 3000 km from the launch site.[102] Although DRDO officials subsequently declared the Agni III to be ready for induction, this is not expected to occur until 2010–11.[103] The test marked the second successful test flight of the Agni III after the first launch failed in 2006.[104] The two-stage, solid-fuel missile is expected to be able to deliver a 1500-kg payload to a range in excess of 3000 km.

In 2008 design work was under way for a three-stage Agni V IRBM that will have a range of 5000 km.[105] The new missile is based on the Agni III design and will use approximately 60 per cent of the latter's subsystems.[106] The first test flight of the new missile, which will use a canister-launch system, is scheduled for 2010. There have been unconfirmed media reports that the Indian Government decided not to proceed with the development of a full-fledged ICBM because of concern about negative international reactions.[107]

On 12 November 2008 the DRDO conducted the first test flight of a missile known as the Shourya ('Silent'), with a range of 600–700 km. The mis–sile, which will be silo-based, was cold-launched using a gas booster from an underground canister launcher at the ITR at Balasore, Orissa. Indian press reports indicate that the missile is a land-based version of the K-15 missile (see below), although this has not been officially confirmed.[108] According to the MOD, it is designed for 'simplicity of operation and maintenance' and 'can be easily handled, transported and stored within the

[102] Indian Ministry of Defence, 'Third launch of Agni-3 successful', Press release, 7 May 2008, <http://pib.nic.in/release/release.asp?relid=38568&kwd>; and Pandit, R., 'Agni-III test-fired, can reach Beijing, Shanghai', *Times of India*, 8 May 2008, <http://timesofindia.indiatimes.com/India/Agni-III_test-fired_can_reach_Beijing_Shanghai/articleshow/3019821.cms>.

[103] Pandit (note 102); and 'Agni-III ready for induction, can reach China', Rediff News, 7 May 2008, <http://www.rediff.com/news/2008/may/07agni.htm>.

[104] 'India demonstrates Agni 3 with "textbook precision"', *Jane's Missiles & Rockets*, vol. 11, no. 6 (June 2007), p. 2.

[105] The new missile was previously referred to as the Agni IV (or as the Agni III* in earlier reports) but the DRDO has decided to skip over this designation. Pandit, R., 'Going ballistic: India looks to join elite missile club', *Times of India*, 13 May 2008.

[106] Mallikarjum, Y., 'Agni-V design completed; to be test-fired in 2010', *The Hindu*, 27 Nov. 2008; and Somasekhar, M., 'DRDO to make missiles lighter, cost-effective, *The Hindu Business Line*, 25 Sep. 2008.

[107] Joseph, J., 'Govt allots Rs2,500 cr for Agni-V', *DNA* (Mumbai), 16 June 2008; and 'Thinking cap', *DNA* (Mumbai), 18 June 2007.

[108] Subramanian, T. S., 'Shourya test-fired successfully', *The Hindu*, 13 Nov. 2008.

canister for longer shelf life'.[109] It is not publicly known whether the Shourya is nuclear-capable.

The DRDO's Advanced Systems Laboratory at Hyderabad, Andhra Pradesh, has begun development of a subsonic cruise missile with a range of 1000 km, known as the Nirbhay ('Fearless').[110] Indian defence officials have not indicated whether the missile, which is reportedly similar to the US Tomahawk and the Pakistani Babur cruise missiles, will be nuclear capable.

Sea-launched missiles

India continues to develop two systems that will comprise the naval leg of its planned triad of nuclear forces. The first is the Dhanush ('Bow'), a modified Prithvi II missile launched from a stabilization platform mounted on surface ships. According to the Indian MOD, the Dhanush will be capable of carrying both conventional and nuclear warheads.[111] The system's operational utility may be limited by its relatively short maximum range: 350 km. The MOD stated in 2006 that the 'process of weaponisation' of two Indian Navy ships with the Dhanush system was in progress.[112]

The DRDO has tested components of an underwater missile launch system and is developing a two-stage ballistic missile that can be launched from a submerged submarine using a gas booster.[113] MOD statements have designated the missile as the K-15, although other sources refer to it as the Sagarika ('Oceanic') project.[114] On 26 February 2008 a K-15 was test-launched for the first time from a submerged pontoon near Visakhapatnam, Andhra Pradesh, on India's east coast. An MOD spokesperson said that the test 'was successful'. According to media reports the missile will have a range of 700 km, similar to that of the Agni I.[115] The K-15 is expected to be deployed on an indigenous nuclear-powered submarine, the Advanced Technology Vessel (ATV), which has been under development by India since the 1970s.[116]

[109] Indian Ministry of Defence, 'DRDO tests 600 kms range SSM missile SHOURYA', Press release, 12 Nov. 2008, <http://pib.nic.in/release/release.asp?relid=44764>.

[110] Dutta, S., 'Fearless Tomahawk-type missile on radar', *The Telegraph* (Calcutta), 20 July 2007.

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

[112] Indian Ministry of Defence (MOD), *Annual Report 2005–2006* (MOD: New Delhi, 2006), p. 88.

[113] Associated Press, 'India developing submarine launched ballistic missiles', *International Herald Tribune*, 11 Sep. 2007; and Unnithan, S., 'The secret undersea weapon', *India Today*, 17 Jan. 2008.

[114] The Indian MOD stated in 2006 that 'There is no missile project by name "Sagarika"'. Indian Ministry of Defence, 'Development and trials missiles', Press release, 2 Aug. 2006, <http://pib.nic.in/release/rel_print_page1.asp?relid=19395>.

[115] 'India successfully tests submarine-based missile', Reuters, 26 Feb. 2008, <http://in.reuters.com/article/topNews/idINIndia-32156820080226>; and Agence France-Presse, 'India test-fires sea-based nuclear-capable missile: ministry', *Space War*, 26 Feb. 2008.

[116] Raghuvanshi, R., 'India working on sea-based nuclear missiles', *Defense News*, 15 Oct. 2007; and Joseph, J., 'Sea trials of nuke submarine in 2 yrs', *DNA* (Mumbai), 4 Dec. 2007. The ATV is

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 military inventory of HEU and separated plutonium, the country could theoretically produce up to 100 nuclear weapons.[117] However, Pakistan is believed to have used only part of this inventory to manufacture warheads, and thus the actual number of warheads is likely to be lower than this maximum. Pakistani officials claim that the country has already produced more warheads than needed to satisfy its 'minimum deterrence requirement' but note that this requirement is subject to review 'according to situation'.[118]

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), Punjab. There is evidence that Pakistan is moving towards a plutonium-based arsenal.[119] The 50-megawatt thermal (MW(t)) Khushab I reactor, completed in 1998, is capable of producing about 10–12 kg of weapon-grade plutonium annually.[120] Pakistan is building two additional plutonium production reactors at the nuclear complex at Khushab, Punjab; commercial satellite images taken during 2008 indicated that the second reactor was nearing completion.[121] According to one estimate, the power of the new reactors will be approximately 100 MW(t). This will increase Pakistan's plutonium production capability several-fold, provided that the country has sufficient spent fuel-reprocessing capacity.[122] Plutonium separation takes place at the pilot- scale New Labs reprocessing plant at Rawalpindi, Punjab. A new chemical separation facility appears to be nearing completion at Chashma, Punjab.[123]

widely assumed to be a ballistic missile submarine, but some media reports have indicated that it is an attack submarine.

[117] Pakistan possesses *c.* 2.0 tonnes of HEU and *c.* 90 kg of separated plutonium. See appendix 8A.

[118] Ehsan ul-Haq (Gen.), Chairman of the Joint Chiefs of Staff Committee, Interview, *Today with Kamran Khan*, Karachi Geo News TV, 24 Nov. 2006, Translation from Urdu, World News Connection.

[119] Plutonium-based nuclear warheads would normally be lighter and more compact than those using HEU to achieve the same yield. Such warheads could either be fitted onto smaller missiles, possibly including cruise missiles, or give already deployed ballistic missiles longer ranges.

[120] 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 (IPFM: Princeton, NJ, Sep. 2006).

[121] Albright, D. and Brannan, P., 'Second Khushab plutonium production reactor nears completion', Institute for Science and International Security (ISIS) Report, 18 Sep. 2008, <http://www.isis-online.org/publications/southasia/>.

[122] Albright and Brannan (note 121).

[123] Albright, D. and Brannan, P., 'Chashma nuclear site in Pakistan with possible reprocessing plant', Institute for Science and International Security (ISIS) Report, 18 Jan. 2007, <http://www.isis-online.org/publications/southasia/>.

Strike aircraft

The aircraft of the Pakistani Air Force that is most likely to be used in the nuclear weapon delivery role is the US-produced F-16 (see table 8.8). Other aircraft, such as the French-produced Mirage V or the Chinese-produced A-5, could also be used.

Pakistan currently maintains 32 F-16A/B aircraft in service, deployed in three squadrons. As part of a $5.1 billion deal agreed in 2006, the USA delivered the final 4 of 14 refurbished F-16 aircraft to the Pakistani Air Force on 28 July 2008.[124] The deal also includes the purchase of 18 Block 52 F-16C/D aircraft, with an option for 18 more and the midlife update of the F-16s already in Pakistani service.[125]

Land-based missiles

Pakistan has begun deployment of two types of short-range ballistic missiles (SRBMs) which are believed to have nuclear delivery roles. The Ghaznavi (Hatf-3) is a single-stage, solid-propellant, road-mobile SRBM which was formally inducted into service in 2004. The Pakistani Army test-launched a Ghaznavi missile on 13 February 2008.[126] The other SRBM, the Shaheen I (Hatf-4), entered into service with the Pakistani Army in 2003. It was most recently test-launched on 25 January 2008 during a troop training exercise conducted by the Army Strategic Force Command (ASFC).[127]

Pakistan's only MRBM currently in service is the Ghauri I (Hatf-5), which is a road-mobile, liquid-propellant, single-warhead missile. Pakistani military officials said that it has a nuclear delivery role. In addition, Pakistan continues to develop the two-stage, road-mobile, solid-propellant Shaheen II (Hatf-6) MRBM. On 19 April 2008 the Pakistani military announced that a Shaheen II missile had been successfully test-launched to a range of 2000 km.[128] Another Shaheen II was test-launched on 21 April 2008 at the end of the first 'operational readiness' field training exercise with the missile.[129] The Shaheen II's range of 2000–2500 km means that it can reach targets across India. Pakistani officials have denied that the

[124] US Embassy in Pakistan, 'U.S. delivers four F-16 aircraft to Pakistan Air Force', Press release, 28 July 2008, <http://islamabad.usembassy.gov/pr-08072801.html>. The value of the deal was lowered to $3.1 billion when Pakistan reduced its order of new F-16s by half.

[125] Schanz, M. V., 'US and Pakistan hammer out new F-16 deal', *Air Force Magazine*, vol. 90, no. 12 (Dec. 2006); and Grevall, J., 'Pakistan agrees deal with US for F-16s', *Jane's Defense Weekly*, 11 Oct. 2006. The agreement stipulated that Pakistan would not equip the F-16s with systems to penetrate air defences and would seek advance US approval for any F-16 flights out of Pakistani airspace.

[126] 'Ghaznavi missile launched', *Dawn* (Karachi), 14 Feb. 2008.

[127] 'Pakistan tests ballistic missile', BBC News, 25 Jan. 2008, <http://news.bbc.co.uk/2/7208416.stm>.

[128] 'Pak successfully test fires Hataf-6 Shaheen-2 missile', *The Nation* (Lahore), 19 Apr. 2008.

[129] 'First training launch of Hatf VI', *Dawn* (Karachi), 22 Apr. 2008.

Table 8.8. Pakistani nuclear forces, January 2009

Type	Range (km)[a]	Payload (kg)	Status
Aircraft			
F-16A/B	1 600	4 500	32 aircraft, deployed in 3 squadrons; most likely aircraft to have a nuclear delivery role
Ballistic missiles			
Ghaznavi (Hatf-3)	~400	500	Entered service with Pakistani Army in 2004; fewer than 50 launchers deployed; last test-launched 13 Feb. 2008; believed to be a copy of M-11 missile acquired from China in 1990s
Shaheen I (Hatf-4)	>450[b]	750–1 000	Entered service with Pakistani Army in 2003; fewer than 50 launchers deployed; last test-launched 25 Jan. 2008
Shaheen II	2 000	~1 000?	First Army operational readiness launch on 19 Apr. 2008; second on 21 Apr. 2008[c]
Ghauri I (Hatf-5)	>1 200	700–1 000	Entered service with Pakistani Army in 2003; fewer than 50 launchers deployed; test-launched in 1 Feb. 2008
Cruise missiles			
Babur (Hatf-7)	700[d]	. .	Under development. Ground-launched version tested three times in 2007 (Mar., Jun. and Dec). Sea- and air-launched versions under development too
Ra'ad (Hatf-8)	350	. .	Under development; air-launched; first test-launch Aug. 2007; second 8 May 2008

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

[b] Some unofficial sources claim a range of 600–1500 km.

[c] The twin operational readiness tests suggest that the Shaheen II may be operational.

[d] Since 2006 the range of flight tests has increased from 500 to 700 km, and the goal is now 1000 km.

Sources: US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NAIC: Wright-Patterson Air Force Base, Ohio, Aug. 2003); 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, <https://www.cia.gov/library/reports/archived-reports-1/>; US National Intelligence Council, 'Foreign missile developments and the ballistic missile threat through 2015' (unclassified summary), Dec. 2001, <http://www.dni.gov/nic/special_missile threat2001.html>; International Institute for Strategic Studies, *The Military Balance 2006–2007* (Routledge: London, 2007); 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

country was seeking to develop longer-range ballistic missiles that could strike targets outside the region.[130]

Pakistan is continuing to develop its arsenal of cruise missiles. In December 2007 Pakistan conducted the fourth test flight since 2005 of a nuclear-capable cruise missile, designated the Babur (Hatf-7). Efforts are under way to increase the range of the subsonic cruise missile from 700 km to 1000 km.[131] Pakistan is developing an air-launched version of the Babur, which will reportedly be carried by F-16 and JF-17 aircraft.[132] It is also developing a sea-launched version, rumoured to be for deployment on the Agosta submarine.[133]

Pakistan is developing a nuclear-capable air-launched cruise missile, known as the Ra'ad (Hatf-8), which will have a range of 350 km. On 8 May 2008 Pakistan conducted the second test launch of the Ra'ad as part of a 'continuing process of validating the design parameters'.[134] The missile, which was previously test-fired in August 2007 from a Mirage fighter, was described by Pakistan's military press service as having 'special stealth capabilities'.[135]

IX. Israeli nuclear forces

Israel continues to maintain its long-standing policy of nuclear ambiguity, neither officially confirming nor denying that it possesses nuclear weapons. In 2006 the Israeli Prime Minister, Ehud Olmert, made a remark that was widely interpreted as tacitly acknowledging that Israel possesses a nuclear arsenal. Israeli officials quickly disavowed the remark and reiterated that Israel 'will not be the first country that introduces nuclear weapons to the Middle East'.[136]

The size of the Israeli nuclear weapon stockpile is unknown but it is widely believed to consist of roughly 100 plutonium warheads. According to one estimate, Israel possessed 0.6 tonnes of military plutonium as of December 2007;[137] this is the equivalent of 120 warheads, assuming that each contains 5 kg of plutonium. Only part of this plutonium may have been used to produce weapons. It is estimated here that Israel has approximately 80 intact nuclear warheads, of which 50 are re-entry vehicles for

[130] Ehsan ul Haq (note 118).

[131] President of the Islamic Republic of Pakistan, Office of the Press Secretary, 'Government has prepared comprehensive plan to equip armed forces: Musharraf', Press release, 30 May 2007.

[132] 'Pakistan successfully test-fires Hataf-VII missile', *PakTribune*, 26 July 2007.

[133] Hali, S., 'Second strike capability', *The Nation* (Islamabad), 16 Aug. 2006.

[134] Khan, I. A., 'Cruise missile fired from an aerial platform', *Dawn* (Karachi), 9 May 2008.

[135] Pakistani Inter Services Public Relations (ISPR), 'Pakistan test fires nuclear capable Hatf-VIII', Press release, 8 May 2008, <http://www.ispr.gov.pk/front/main.asp?o=t-press_release&date=2008/5/8>.

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

[137] See appendix 8A.

Table 8.9. Israeli nuclear forces, January 2009

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 on 27 June 2001
Jericho III	>4 000	1 000–1 300	Test-launched on 17 Jan. 2008
Submarines			
Dolphin			Rumoured to be equipped with nuclear-capable cruise missiles; denied by Israel

[a] Missile payloads may have to be reduced in order to achieve maximum range. Aircraft range is for illustrative purposes only; actual mission range will vary.

[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 operational.

Sources: Cohen, A., and Burr, W., 'Israel crosses the threshold', *Bulletin of the Atomic Scientists*, vol. 62, no. 3 (May/June 2006); Cohen, A., *Israel and the Bomb* (Columbia University Press: New York, 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, 2003); Fetter, S., 'Israeli ballistic missile capabilities', *Physics and Society*, vol. 19, no. 3 (July 1990)— for an updated analysis, see unpublished 'Ballistic missile primer', <http://www.publicpolicy.umd.edu/Fetter/publications.htm>; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and Authors' estimates.

delivery by ballistic missiles and the rest bombs for delivery by aircraft (see table 8.9). Many analysts believe that Israel has a recessed nuclear arsenal (i.e. one that requires some preparation before use). Israel may have produced tactical nuclear weapons, including artillery shells and atomic demolition munitions, but this has never been confirmed.

On 17 January 2008 Israel conducted a test launch of a multi-stage ballistic missile from the Palmahim Air Base.[138] Israeli radio identified the missile as a Jericho III. While not providing details of the type or purpose of the missile, the Israeli MOD stated that the experiment tested the missile's rocket propulsion system and was successful.[139] The Jericho III is a three-stage solid-propellant missile, with a maximum range in excess of

[138] 'Israel says carries out missile launching test', Reuters, 17 Jan. 2008, <http://www.reuters.com/article/worldNews/idUSL175785020080117>; and Richardson, D., 'Israel carries out two-stage ballistic missile launch', *Jane's Missiles & Rockets*, vol. 12, no. 3 (Mar. 2008).

[139] Katz, Y., 'Israel test-fires long-range ballistic missile', *Jerusalem Post*, 17 Jan. 2008.

4000 km and an estimated payload of 1000–1300 kg. Some reports speculate that the missile may be able to carry MIRVed warheads.[140]

X. North Korea's military nuclear capabilities

North Korea is widely believed to have produced and separated enough plutonium to build a small number of nuclear warheads. However, the amount of plutonium that North Korea has separated from the spent fuel of its 5-megawatt electric MW(e) graphite-moderated research reactor at Yongbyon, and hence the number of warheads it may have produced, has been the subject of controversy.[141] In addition, doubts persist about whether North Korea has the design and engineering skills needed to manufacture an operational nuclear weapon.[142] North Korea demonstrated a nuclear weapon capability in October 2006 by carrying out an underground nuclear test explosion.[143] However, the unexpectedly low explosion yield led many experts to believe that it had been a fizzle (i.e. an inefficient detonation releasing less explosive energy than expected).[144]

On 26 June 2008, as part of the denuclearization deal reached at the Six-Party Talks, North Korea made a formal declaration of its nuclear programme.[145] The contents of the 60-page declaration were not made public. According to press reports, North Korea declared that it held a stock of 30.8 kg of separated plutonium.[146] This did not represent the total amount of plutonium produced by North Korea: it apparently did not include unextracted plutonium contained in irradiated fuel rods and material that remained in equipment at the Yongbyon facilities or was lost during reprocessing. Nor did it include the plutonium used in the October 2006 nuclear detonation. The declared plutonium inventory was less than the US Government's estimate but fell within the range of estimates by non-governmental experts.[147] Efforts to verify the accuracy and completeness of the North's declaration have been hampered by its refusal to allow inspect-

[140] Richardson (note 138).

[141] Among other uncertainties, it is unclear whether North Korea extracted plutonium from the spent fuel rods believed to have been removed from the reactor before the arrival of International Atomic Energy Agency (IAEA) inspectors in 1990.

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

[143] See Fedchenko, V. and Ferm Hellgren, R., 'Nuclear explosions, 1945–2006', *SIPRI Yearbook 2007: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2007).

[144] 'CIA says North Korea nuclear test a failure: report', Reuters, 28 Mar. 2007, <http://www.reuters.com/article/topNews/idUSSEO1552162007032 8>.

[145] On the deal reached at the Six-Party Talks see chapter 9, section III, in this volume.

[146] 'North Korea declares 31 kilogrammes of plutonium', *Global Security Newswire*, 24 Oct. 2008, <http://www.globalsecuritynewswire.org/gsn/ts_20081024_4542.php>.

[147] Albright, D., Brannan, P. and Shire, J., 'North Korea's plutonium declaration: a starting point for an initial verification process', Institute for Science and International Security (ISIS) Issue Brief, 10 Jan. 2008, <http://www.isis-online.org/publications/dprk/>.

ors to conduct sampling at its nuclear facilities or to use other forensics techniques to independently determine the amount of plutonium produced in the Yongbyon reactor.[148]

North Korea's declaration did not state whether it had produced nuclear weapons or how many. In January 2009 a senior US scholar said that North Korean officials had told him during a visit to Pyongyang that the country had already weaponized the 30.8 kg of plutonium declared in June 2008. If this is true, North Korea could have built five to six nuclear weapons, assuming that each weapon used 5 kg of plutonium.

Apart from the plutonium programme, North Korea has been suspected by the USA of pursuing an undeclared uranium enrichment programme aimed at producing HEU for use in nuclear weapons. In January 2009 there were renewed allegations by senior US officials that North Korea had an active programme for enriching uranium.[149] However, some analysts cautioned that the evidence behind the allegations was scientifically unpersuasive.[150]

North Korea deploys 500–600 road-mobile SRBMs of three types—Hwasong-5 (Scud B), Hwasong-6 (Scud Mod-C) and Hwasong-7 (Scud Mod-D)—and 50–200 road-mobile Nodong MRBMs.[151] It is also developing the longer-range Taepodong-1 and Taepodong-2 missiles. 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.[152]

XI. Conclusions

In 2008 there was an overall decline in the number of operational nuclear weapons deployed by five legally recognized and four de facto nuclear weapon states. The decline was due primarily to the rapid withdrawal from deployment of warheads on strategic nuclear delivery vehicles by Russia and the USA—which together account for more than 90 per cent of the world's inventory of nuclear weapons—in order to meet the warhead limit set by SORT. However, the reduction of the USA's nuclear stockpile

[148] Acton, J., 'Definitely, maybe: verifying North Korean denuclearisation', *Jane's Intelligence Review*, vol. 20, no. 8 (Aug. 2008).

[149] Kessler, G., 'White House voices concern on North Korea and uranium', *Washington Post*, 8 Jan. 2009. In 2007 US intelligence officials had backed away from earlier claims that the North had a covert, production-scale uranium enrichment programme.

[150] See e.g. Acton, J., 'More on NORK HEU', Arms Control Wonk, 14 Jan. 2009, <http://www.armscontrolwonk.com/2156/more-on-nork-heu>. The allegations were reportedly based on an analysis of enriched uranium traces that were discovered on smelted aluminium tubes and reactor documents provided by North Korea.

[151] Lennox (note 26), pp. 90–96; and Nuclear Threat Initiative, 'North Korea profile: missile capabilities', Dec. 2006, <http://www.nti.org/e_research/profiles/NK/Missile/62.html>.

[152] See e.g. Hecker, S. S., 'Report on North Korean nuclear program', Policy Forum Online 06-97A, Nautilus Institute, 15 Nov. 2006, <http://www.nautilus.org/fora/security/0697Hecker.html>.

occurred largely on paper and consisted of transferring ownership of warheads from the Department of Defense to the Department of Energy.

Despite signs of a further resurgence of public interest in nuclear disarmament in 2008, all of the legally-recognized weapon states appeared determined to retain their nuclear arsenals for the indefinite future and were either modernizing their nuclear forces or had announced plans to do so. Among the de facto nuclear weapon states, India and Pakistan continued to expand their nuclear strike capabilities, while Israel appeared to be waiting to see how Iran's nuclear programme developed. There remained considerable uncertainty about North Korea's nuclear weapon capabilities.