# 8. World nuclear forces

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## I. Introduction

At the start of 2010 eight nuclear weapon states possessed more than 7500 operational nuclear weapons (see table 8.1). Almost 2000 of these are kept in 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 22 000 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. 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

[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, January 2010

All figures are approximate.

| Country[a] | Year of first nuclear test | Deployed warheads[b] | Other warheads[c] | Total |
|---|---|---|---|---|
| United States | 1945 | 2 468 | ~7 100[d] | ~9 600 |
| Russia | 1949 | 4 630 | 7 300[e] | ~12 000 |
| United Kingdom | 1952 | 160 | 65 | 225 |
| France | 1960 | 300 | – | 300 |
| China | 1964 | .. | 200[f] | 240 |
| India | 1974 | .. | 60–80[g] | 60–80 |
| Pakistan | 1998 | .. | 70–90[g] | 70–90 |
| Israel | .. | .. | 80[g] | 80 |
| **Total** | | **~7 560** | **~14 900** | **~22 600** |

[a] North Korea conducted nuclear test explosions in 2006 and 2009, but there is no public information to verify that it has operational nuclear weapons.

[b] 'Deployed' means on missiles or bases with operational forces.

[c] These are warheads in reserve, awaiting dismantlement or that require some preparation (e.g. assembly or loading on launchers) before they become fully operationally available.

[d] This figure includes 2600 in reserve in the US Department of Defense stockpile (for a total stockpile of *c.* 5100 warheads). A further 3500–4500 are scheduled to be dismantled by 2022.

[e] This figure includes warheads in reserve or awaiting dismantlement.

[f] China's warheads are not thought to be deployed on launchers.

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

nuclear arsenals, respectively. The nuclear capabilities of the Democratic People's Republic of Korea (DPRK, or North Korea) are discussed in section X. Brief conclusions are given in section XI.

Appendix 8A contains tables of global stocks of fissile materials—highly enriched uranium (HEU) and separated plutonium, the raw material for nuclear weapons. Appendix 8B gives details of nuclear explosions since 1945, with details of the May 2009 explosion in North Korea, which took the total number of explosions to 2054.

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 2010 the USA maintained an estimated arsenal of approximately 2468 operational nuclear warheads, consisting of roughly 1968 strategic and 500 non-strategic warheads (see table 8.2). In addition to this operational arsenal, approximately 2600 warheads are held in reserve, for a total stockpile of approximately 5100 warheads. Several thousand more retired warheads are awaiting dismantlement.

This force level is a slight change compared with the estimate presented in *SIPRI Yearbook 2009*.[3] The change reflects the limited additional 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 go below the limit of 2200 operationally deployed strategic warheads three-and-a-half-years before the deadline set under SORT.[4]

The 2010 START Treaty, signed by US President Barack Obama and Russian President Dmitry Medvedev on 8 April 2010, will set a force level of 700 deployed strategic delivery vehicles and 1550 for their associated warheads to be reached seven years after ratification.[5] This represents a modest reduction in the level of 1700–2200 operationally deployed strategic warheads set by SORT and 1600 strategic delivery vehicles set by the 1991 START treaty.

The Nuclear Posture Review (NPR) published in April 2010 will set the US nuclear posture for the next 5–10 years.[6] Previous US Government proposals—as formulated in the 2001 NPR[7]—to build a new nuclear weapon 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.[8] The shift limits 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.

A study completed in 2009 by the JASON panel of the Mitre Corporation rejects claims that it was necessary to build replacement warheads because of difficulties with certifying the reliability of existing warheads.[9] Even so, a

[3] Kile, S. N., Fedchenko, V. and Kristensen, H. M., 'World nuclear forces', *SIPRI Yearbook 2009*.

[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] For a summary and other details of the New START Treaty see annex A in this volume.

[6] US Department of Defense (DOD), *Nuclear Posture Review Report* (DOD: Washington, DC, Apr. 2010).

[7] US Department of Defense, 'Special briefing on the Nuclear Posture Review', Transcript, 9 Jan. 2002, <http://www.defense.gov/transcripts/transcript.aspx?transcriptid=1108>. See also Kristensen, H. M. and Handler, J., 'World nuclear forces', *SIPRI Yearbook 2002*, pp. 527–28.

[8] 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. 77 644–56.

[9] JASON Program Office, *Life Extension Program (LEP), Executive Summary*, Mitre Corporation, 9 Sep. 2009. The JASON panel is a group of independent scientists that advises the US Government on matters of science and technology.

**Table 8.2.** US nuclear forces, January 2010

| Type | Designation | No. deployed | Year first deployed | Range (km)[a] | Warheads x yield | No. of warheads |
|---|---|---|---|---|---|---|
| **Strategic forces** | | | | | | **1 968** |
| *Bombers*[b] | | *113/60* | | | | *316* |
| B-52H | Stratofortress | 93/44 | 1961 | 16 000 | ALCM 5–150 kt | 216[c] |
| B-2 | Spirit | 20/16 | 1994 | 11 000 | B61-7, -11, B83-1 bombs | 100[d] |
| *ICBMs* | | *450* | | | | *500* |
| LGM-30G | Minuteman III | | | | | |
| | Mk-12[e] | (0) | 1970 | 13 000 | 1–3 x 170 kt | (0)[e] |
| | Mk-12A | 250 | 1979 | 13 000 | 1–3 x 335 kt | 250 |
| | Mk-21 SERV | 200 | 2006 | 13 000 | 1 x 300 kt | 250 |
| *SSBNs/SLBMs* | | *228* | | | | *1 152* |
| UGM-133A | Trident II (D5)[f] | | | | | |
| | Mk-4 | .. | 1992 | >7 400 | 4 x 100 kt | 568 |
| | Mk-4A | .. | 2008 | >7 400 | 4 x 100 kt | 200 |
| | 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 | | .. | 1984 | 2 500 | 1 x 5–150 kt | (100)[h] |
| **Total** | | | | | | **2 468**[i] |

.. = not available or 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 an estimated 216 are deployed on two bases. Under the 2010 New START Treaty, each nuclear bomber is attributed only 1 weapon.

[d] Operational gravity bombs are only included for the B-2A bomber. The B-52H can also deliver bombs, but its nuclear mission is thought to be focused on ALCM since the bomber is not capable of penetrating modern air defence systems.

[e] The Department of Defense missed the Sep. 2009 deadline for fully retiring the W62 warhead (which is loaded in the Mk-12 re-entry vehicle), although all have probably been removed from operational missiles.

[f] Although D5 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 being retired.

[i] Including the additional *c.* 2600 warheads in reserve, the total stockpile is *c.* 5100 warheads. There are another 3500–4500 additional warheads awaiting dismantlement and a further *c.* 14 000 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–July 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.

debate is expected in 2010 on how much life extension programmes can change the designs of existing warheads.

In parallel with efforts to reduce the nuclear stockpile, the US Department of Defense (DOD) has revised 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. An updated strategic war plan—OPLAN (Operations Plan) 8010-08 Strategic Deterrence and Global Strike—was put into effect in December 2008, with an update published in February 2009. It focuses on Russia and China but also includes a series of strike options against four other adversaries. The plan is predominantly nuclear but also includes conventional strike options.[10]

To exercise OPLAN 8010, the US Strategic Command (STRATCOM) conducted the Global Thunder 09 nuclear exercise in September 2009 to test the readiness of ballistic missiles and long-range bombers. Shortly after the exercise, Russia requested an 'open display' of B-2 bombers at Whiteman Air Force Base (AFB), Missouri, and an ICBM re-entry vehicle on-site inspection at Warren AFB, Wyoming, in accordance with START.[11] These were the last Russian inspections in the USA under the treaty before it expired on 5 December 2009.

In an effort to increase the readiness and proficiency of its nuclear mission, the US Air Force (USAF) reorganized its nuclear command structure. The Air Force Global Strike Command (AFGSC) was formally activated at Barksdale AFB, Louisiana, on 7 August 2009. The new command took control of the USAF's ICBMs on 1 December 2009 and of its long-range bombers on 1 February 2010; this consolidated all strategic USAF wings

[10] Kristensen, H. M., 'Obama and the nuclear war plan', Federation of American Scientists (FAS) Strategic Security Blog, Feb. 2010, <http://www.fas.org/blog/ssp/2010/02/warplan.php>; and Kristensen, H. M., Norris, R. S. and Oelich, I., *From Counterforce to Minimal Deterrence* (Federation of American Scientists/Natural Resources Defense Council: Washington, DC, Apr. 2009). See also Kile, Fedchenko and Kristensen (note 3), p. 349.

[11] Knee, D., 'Russians make history as START draws to end', *Air Force Print News Today*, 15 Sep. 2009, <http://www.warren.af.mil/news/story.asp?id=123181490>.

under one command.[12] When fully operational, AFGSC will consist of more than 23 000 people. In addition, the standardization and training of nuclear inspection teams have been changed to improve the quality of the 10–14 nuclear surety inspections that are performed across the major commands each year.[13]

### Strategic bombers

The US Air Force has 20 B-2 and 93 B-52H bombers, of which 16 and 44, respectively, are thought to have nuclear missions. The USAF is studying options for a new nuclear-capable long-range strike aircraft to begin replacing the current bomber force from 2018.[14]

Approximately 316 nuclear warheads are estimated to be deployed with the bombers, including the aircraft-delivered B61-7, B61-11 (on the B-2 only) and B83-1 gravity bombs and the W80-1 warhead carried on air-launched cruise missiles (ALCMs, on the B-52H only). Most of USAF ALCMs and bombs have been withdrawn from service due to the accelerated implementation of the 2004 Nuclear Weapons Stockpile Plan and to meet the SORT limit.

### Land-based ballistic missiles

The US ICBM force is changing significantly as part of the implementation of SORT. Approximately 500 warheads were deployed on 450 ICBMs as of January 2010, a reduction of 50 warheads compared with 2009. All W62 warheads have probably been removed from operational missiles, although the DOD missed its September 2009 deadline for retiring the weapon completely. As the 170-kiloton W62 is removed from the missiles, the modern 300-kt W87/Mk-21 security enhanced re-entry vehicle (SERV) is being installed. The increased power of the W87 warhead broadens the range of targets of the Minuteman III ICBM force. All missiles will carry only one warhead each, but several hundred additional warheads will be kept in storage for future upload if necessary.

The multi-year $7 billion upgrade of the Minuteman III force is nearly complete. The service life of the Minuteman III missile has been extended to 2030, delaying plans to deploy a replacement ICBM in 2018. Develop-

[12] US Air Force, Air Force Global Strike Command, 'Air Force Global Strike Command officials assume B-52, B-2 mission', News release, 1 Feb. 2010, <http://www.afgsc.af.mil/news/story.asp?id=123188329>.

[13] US Air Force Inspection Agency, 'Air Force officials establish core team for nuclear surety inspections', 31 Aug. 2009, <http://www.af.mil/news/story.asp?id=123159500>.

[14] US Department of Defense, 'Aircraft investment plan, fiscal years (FY) 2011–2040', Submitted with the FY 2011 budget, Feb. 2010, <http://www.militarytimes.com/static/projects/pages/30yearaviation.pdf>.

ment work on a follow-on missile continues, to replace the Minuteman III in 2030–40.

There were two Minuteman III flight tests in 2009, compared to four in 2008. A missile taken from Minot AFB, North Dakota, was launched from Vandenberg AFB, California, on 29 June. The three unarmed W78/Mk-12A re-entry vehicles landed near Kwajalein Atoll, Marshall Islands, approximately 6740 kilometres away.[15] On 23 August a Minuteman III, probably taken from Malmstrom AFB, Montana, was test-launched with a single re-entry vehicle to the same range.[16]

In addition to test launches, the ICBM wings conducted several nuclear exercises during 2009. In June, 11 national agencies and 1300 personnel conducted Nuclear Weapons Accident/Incident Exercise 2009 at Warren AFB in a simulated terrorist attack against the base. This was the largest and most complex exercise ever conducted at an ICBM base.[17]

### Ballistic missile submarines

On 27 March 2009 the USS *Alaska* nuclear-powered ballistic missile submarine (SSBN) arrived at Kings Bay Naval Submarine Base, Georgia, after completing a 26-month refuelling overhaul at Norfolk Naval Shipyard, Virginia. The submarine was previously based at Bangor Naval Submarine Base, Washington. The transfer to the Atlantic Ocean increases the number of SSBNs based at Kings Bay from five to six. The remaining eight SSBNs are based at Kitsap Naval Base near Bangor, Washington. Similarly to the USAF command reorganization, the US Navy decided in 2009 to split command of its Trident submarine groups into two, one overseeing Submarine Group 10 at Kings Bay and the other overseeing Submarine Group 9 at Kitsap. Submarine Group 10 will be further subdivided, with one commodore for the SSBNs of Submarine Squadron 20 and another for the nuclear-powered cruise missile submarines (SSGNs) of Submarine Squadron 16.[18]

All 14 US Navy Ohio Class SSBNs carry Trident II (D5) missiles. Twelve operational SSBNs carry a total of 288 D5 SLBMs, which are estimated to carry an average of 4 warheads each, for a total of about 1152 warheads. (Two additional SSBNs are undergoing overhaul at any given time, and

[15] US Air Force, Vandenberg Air Force Base, 'Vandenberg successfully launches Minuteman III', News release, 29 June 2009, <http://www.vandenberg.af.mil/news/story.asp?id=123156457>.

[16] US Air Force, Vandenberg Air Force Base, 'Vandenberg launches Minuteman III', News release, 23 Aug. 2009, <http://www.vandenberg.af.mil/news/story.asp?id=123164556>.

[17] US Air Force, Warren Air Force Base, 'Warren hosts national-level exercise', News release, 26 June 2009, <http://www.warren.af.mil/news/story.asp?id=123156188>.

[18] US Navy, Submarine Group 10 Public Affairs, 'Navy's only combined submarine squadron splits to enhance warfighting readiness', 30 Mar. 2009, <http://www.navy.mil/search/display.asp?story_id=43845>.

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, more than 60 per cent of US SSBN patrols now take place in the Pacific (compared to an average of only 15 per cent during the 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.

The rate of production of the D5LE SLBM, a modified version of the D5, which began in 2008, doubled to 24 missiles in 2009. A total of 108 missiles will be purchased by 2012, at a cost of more than $4 billion.[19] The first D5LE will be deployed in 2010. The modified D5 will arm the Ohio Class SSBNs for the rest of their service lives, which have been extended from 30 to 44 years.

The oldest SSBN is scheduled to retire in 2027 followed by the next boat in 2030, reducing the SSBN force to 12. To offset subsequent retirements, the US Navy plans to begin construction of the first of a new SSBN class in 2019, the second in 2022, and one each year in 2024–33.[20] The first SSBN(X), as the new class is currently called, is scheduled to become operational in 2029. It is likely to carry fewer missiles than the current Ohio Class—probably 16—to permit more boats under future arms control agreements and provide greater operational flexibility. The new SSBN programme is projected to cost at least $80 billion.[21]

Delivery of the W76-1/Mk-4A warhead, a modernized version of the existing W76/Mk-4, began in 2008. The W76-1/Mk-4A 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] D5 missile' and bring more targets, including hard targets, within range.[22] The first warhead was delivered to the US Navy in late October 2008, and entered the stockpile in late-February 2009. Production of approximately 2000 W76-1 warheads is planned up to 2017, four years earlier than previously planned.[23]

During 2009, US SSBNs test-launched four D5 missiles: one from the USS *Alabama* in the Pacific on 13 February; two from the USS *West Virginia* in the Atlantic on 3–4 September; and one from the USS *Alaska* in the

[19] US Department of the Navy, *Fiscal Year (FY) 2010 Budget Estimates, Justification of Estimates: Weapons Procurement (P-1)* (Department of the Navy: Washington, DC, May 2009), pp. 1–5.

[20] O'Rourke, R., *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, Congressional Research Service (CRS) Report for Congress RL32665 (US Congress, CRS: Washington, DC, 22 Dec. 2009), pp. 7, 11.

[21] O'Rourke (note 20), p. 29.

[22] US Department of Energy (DOE), 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.

[23] Norris, R. S. and Kristensen, H. M., 'Nuclear notebook: U.S. nuclear forces, 2010', *Bulletin of the Atomic Scientists*, vol. 66, no. 3 (May/June 2010).

Atlantic on 19 December, marking the 130th consecutive successful flight test of the D5 since 1989.

### Non-strategic nuclear weapons[24]

As of January 2010 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 missile, 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.[25] 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 have not been deployed since 1992, and will be retired in the near future.[26]

### Nuclear warhead stockpile management and modernization

The total US stockpile of roughly 5100 warheads is organized in two overall categories: active and inactive warheads. The deployed category includes 2468 intact warheads (with all the components) that are deployed on operational delivery systems. The approximately 2600 non-deployed warheads are either (*a*) active in the 'responsive force' that can be deployed on operational delivery systems in a relatively short time, or (*b*) inactive in long-term storage with their limited-life components (e.g. tritium) removed. In addition, 3500–4500 other warheads are awaiting dismantlement.

The USA keeps nearly 5000 pits (cores) in storage at the Pantex Plant as a strategic reserve. Another 9000 pits held at Pantex make up most of the

[24] The sizes of the Russian and US inventories of non-strategic nuclear weapons are not limited by any legally binding arms control agreement, including the 2010 New START Treaty.

[25] All B61 bombs were apparently withdrawn from Ramstein Air Base, Germany, in 2005 and RAF Lakenheath, 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>.

[26] Norris and Kristensen (note 23).

43 tonnes of weapon-grade plutonium previously declared in excess of military needs since 1993.[27] 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 2010 Russia had an estimated 4500 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. Russia's new National Security Strategy, approved in May 2009, states that it will maintain parity with the USA in the area of offensive strategic weapons in the most cost-effective way.[28] 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.[29] As explained by a Russian missile designer, '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.[30] In light of these criteria, Russia has prioritized the development and deployment of a road-mobile ICBM with multiple independently-targetable re-entry vehicles (MIRVs) and a new type of SLBM.

### 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 (Engels and Ryazan), with 13 Tu-160, 16 Tu-95MS16 and 7 Tu-95MS6 aircraft; and the 326th Heavy Bomber Division (Ukrainka), with 15 Tu-95MS16 and 25 Tu-95MS6 aircraft. The 37th Air Army also comprises four divisions of Tu-22M3

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

[28] [National Security Strategy of the Russian Federation for the period until 2020], Presidential Decree no. 537, 12 May 2009, <http://www.scrf.gov.ru/documents/99.html> (in Russian).

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

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

bombers.[31] In 2009 Russia continued to conduct regular strategic bomber patrols and announced that it had begun development of a new stealth strategic bomber, expected to enter service in 2025–30.[32]

## 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 31st Missile Army (two divisions, based in Orenburg) and the 33rd Guards Missile Army (four divisions, based in Omsk).[33] 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.[34]

As of January 2010, Russia had on combat duty approximately 50 RS-20V Voevoda heavy ICBMs.[35] This is a silo-based, two-stage, liquid-propellant ICBM, which entered into service in 1988–92.[36] An older version, the RS-20B, was reportedly retired from service in 2009.[37] Instead of dismantlement, the SRF sometimes refurbishes RS-20Bs as Dnepr space launch vehicles (SLVs). On 30 July 2009 a Dnepr SLV put six commercial satellites into orbit.[38] At the end of 2009 the SRF extended the service life of the RS-20V to 23 years. This followed the successful launch on 24 December of an RS-20V from Dombarovsky missile base, Orenburg Region, to Kamchatka Peninsula.[39] Russia is reportedly planning to develop a new liquid-propellant heavy ICBM by 2016 as a future replacement for the RS-20V.[40]

As of January 2010 Russia had approximately 60 RS-18 missiles deployed.[41] The RS-18 is a silo-based, two-stage, liquid-propellant ICBM carrying up to six warheads, which entered into service in 1980.[42] Its ser-

[31] US Department of State, 'Russian Federation MOU data', July 2009, pp. 61–62; and 'Strategic aviation', Russian Strategic Nuclear Forces Blog, 5 Jan. 2010, <http://russianforces.org/aviation/>.

[32] 'Russia could double number of bombers on strategic patrols—general', RIA Novosti, 22 Dec. 2009, <http://en.rian.ru/russia/20091222/157325197.html>; and 'Russia to develop new strategic bomber by 2017', RIA Novosti, 23 Dec. 2009, <http://en.rian.ru/russia/20091223/157335991.html>.

[33] US Department of State (note 31).

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

[35] Norris, R. S. and Kristensen, H. M., 'Nuclear notebook: Russian nuclear forces, 2010', *Bulletin of the Atomic Scientists*, vol. 66, no. 1 (Jan./Feb. 2010), p. 76.

[36] Lennox, D. (ed.), *Jane's Strategic Weapon Systems*, no. 51 (Jane's Information Group: Coulsdon, July 2009), pp. 160–62.

[37] [In 2009 SRF conducted three successful ICBM launches—General Shvaichenko], ARMS-TASS, 16 Dec. 2009, <http://armsshow.itar-tass.com/?page=article&aid=79161&cid=44>.

[38] Russian Ministry of Defence, [Launch of the RS-20B missile], 30 July 2009, <http://www.mil.ru/848/1045/1275/rvsn/19220/index.shtml?id=65401>.

[39] 'Russia test-fires Voyevoda ICBM', RIA Novosti, 24 Dec. 2009, <http://en.rian.ru/russia/20091224/157339099.html>.

[40] 'Russia says destroyed 9 ICBMs in 2009 under START 1 arms pact', RIA Novosti, 16 Dec. 2009, <http://en.rian.ru/russia/20091216/157256398.html>.

[41] Norris and Kristensen (note 35), p. 76.

[42] Lennox, ed. (note 36), pp. 159–60.

**Table 8.3.** Russian nuclear forces, January 2010

| Type/Russian designation (NATO designation) | No. deployed | Year first deployed | Range (km)[a] | Warhead loading | No. of warheads |
|---|---|---|---|---|---|
| **Strategic offensive forces** | | | | | **2 510** |
| *Bombers* | *76* | | | | *844* |
| 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) | 13 | 1987 | 10 500–13 200 | 12 x AS-15B ALCMs or AS-16 SRAMs, bombs | 156 |
| *ICBMs* | *331* | | | | *1 090* |
| RS-20V Voevoda (SS-18 Satan) | ~50 | 1992 | 11 000–15 000 | 10 x 500–800 kt | ~500 |
| RS-18 (SS-19 Stiletto) | ~60 | 1980 | 10 000 | 6 x 400 kt | ~360 |
| RS-12M Topol (SS-25 Sickle) | ~150 | 1985 | 10 500 | 1 x 800 kt | ~150 |
| RS-12M2 Topol-M (SS-27) | 50 | 1997 | 10 500 | 1 x 800 kt | 50 |
| RS-12M1 Topol-M (SS-27) | 18 | 2006 | 10 500 | 1 x (800 kt) | 18 |
| RS-24 (SS-27 Mod 2) | (3) | (2010–11) | 10 500 | 4 x (400 kt) | (12) |
| *SLBMs* | *160* | | | | *576* |
| RSM-50 Volna (SS-N-18 M1 Stingray) | 64 | 1978 | 6 500 | 3 x 50 kt | 192 |
| RSM-54 Sineva (SS-N-23 Skiff) | 96 | 1986/2007 | 9 000 | 4 x 100 kt | 384 |
| RSM-56 Bulava (SS-NX-30) | 0 | (2010–11) | >8 050 | 6 x (100 kt) | 0 |
| **Strategic defensive forces** | | | | | |
| *ABMs*[b] | *~2150* | | | | *~700* |
| 53T6 (SH-08 Gazelle) | 68 | 1986 | .. | 1 x 10 kt | 68 |
| S-300 (SA-10/20 Grumble) | 1900 | 1980 | .. | low kt | ~600 |
| S-400 Triumf (SA-21 Growler) | ~200 | 2007 | .. | .. | .. |
| **Non-strategic forces** | | | | | |
| *Land-based non-strategic bombers*[c] | *524* | | | | *~650* |
| 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* | | | | *~240* |
| 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 | |
| *SLCMs* SS-N-9, SS-N-12, SS-N-19, SS-N-21, SS-N-22 | | | | | *~280* |
| *ASW and SAM weapons* SS-N-15/16, SA-N-1/3/6, depth bombs, torpedoes[c] | | | | | *~250* |
| **Total defensive and non-strategic** | | | | | **~2 120** |
| **Total** | | | | | **~4 630**[d] |

. . = not available or not applicable; ( ) = uncertain figure; ABM = anti-ballistic missiles; ALCM = air-launched cruise missile; ASM = air-to-surface missile; ASW = Anti-submarine warfare; ICBM = intercontinental ballistic missile; kt = kiloton; NATO = North Atlantic Treaty Organization; SAM = surface-to-air missile; SLBM = submarine-launched ballistic missile; SLCM = sea-launched cruise missile; SRAM = short-range attack missile; 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] The 51T6 (SH-11 Gorgon) is no longer operational. The S-300P (SA-10 Grumble), S-300V (SA-12A Gladiator, SA-12B Giant) and S-400 may have some capability against some ballistic missiles. Only a third of 1900 deployed S-300s are counted as having nuclear capability.

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

[d] An additional *c.* 7300 warheads are estimated to be in reserve or awaiting dismantlement for a total stockpile of *c.* 12 000 warheads.

*Sources*: US Department of State, START I Treaty Memoranda of Understanding, 1990–July 2009; US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, June 2009); 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); *Jane's Strategic Weapon Systems*, no. 51 (Jane's Information Group: Coulsdon, July 2009); *Proceedings*, US Naval Institute, various issues; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

life was extended to 31 years as a result of test launches conducted in 2007 and 2008.[43]

Russia has approximately 150 RS-12M Topol ICBMs deployed in eight missile divisions.[44] The RS-12M is a road-mobile, three-stage, solid-propellant ICBM with a single warhead, which entered into service beginning in 1985.[45] It is expected to remain in service until 2019, following the completion of a service life extension programme.[46] As part of this programme, in 2009 there were successful test launches of the missile on 10 April from Plesetsk and on 10 December from Kapustin Yar.[47]

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

[44] Norris and Kristensen (note 35), p. 76.

[45] Lennnox (note 36), pp. 155–57.

[46] Isby, D. C., 'Mobile Topol-M production ends', *Jane's Missiles and Rockets*, vol. 13, no. 6 (June 2009), p. 6.

[47] Russian Ministry of Defence, [The successful test launch of the ICBM was conducted from the Kapustin Yar test range], 10 Dec. 2009, <http://www.mil.ru/848/1045/1275/rvsn/19220/index.shtml?id=69395>.

The RS-12M2/1 Topol-M missile is widely expected to become the backbone of the SRF once older missile types have been retired from service. It is a three-stage, solid-propellant ICBM that has been developed in both road-mobile (RS-12M1) and silo-based (RS-12M2) versions.[48] As of January 2010 Russia was believed to have 18 RS-12M1 and 50 RS-12M2 missiles in service.[49] The SRF has announced plans to introduce 10 more RS-12M2 and 9 more RS-12M1 missiles in 2010.[50]

Russia has developed and begun testing a missile designated as the RS-24, which is a RS-12M2/1 missile modified to carry three MIRVs.[51] Adding the MIRV capability to the existing single-warhead version of the missile was prohibited by the START Treaty. Statements made in 2009 by Russian military officials indicated that the missile would enter into service immediately after START's expiry, on 5 December 2009, and that the production of RS-12M1 might be abandoned in favour of the RS-24.[52] As of January 2010, however, the deployment of the RS-24 missile had not been announced by the military. Instead, more test launches were planned for 2010, and introduction of the missile into service was postponed until 2011.[53]

## Ballistic missile submarines and sea-launched ballistic missiles

As of January 2010 the Russian Navy operated 12 SSBNs in its Northern and Pacific fleets. Of these, five are Delta III Class (Project 667BDR Kalmar) submarines, deployed with the Pacific Fleet.[54] Six Delta IV Class (Project 667BDRM Delfin) submarines are deployed with the Northern Fleet. Five of these have undergone a service-life extension overhaul which included the installation of the new modification of the RSM-54 Sineva missile. The K-18 *Karelia* returned to service in January 2010. The sixth Delta IV submarine—the K-407 *Novomoskovsk*—is expected to return to the fleet in 2010 after such an overhaul.[55] Russia also keeps in service one

[48] Lennnox (note 36), pp. 158–59.

[49] [In 2009 the second missile regiment equipped with mobile complexes 'Topol-M' will enter into service], ARMS-TASS, 17 Sep. 2009, <http://armstass.su/?page=article&aid=75694&cid=25>.

[50] [The number of 'Topol-M' ICBM regiments in service with the SRF will increase from 7 to 9 in 2010], PRIME-TASS, 10 Jan. 2010, <http://www.prime-tass.ru/news/0/{5840C86B-6F2C-40A4-9888-F6243989E262}.uif>.

[51] 'RS-24 makes third successful flight', *Jane's Missiles and Rockets*, vol. 13, no. 1 (Jan. 2009), p. 3; and Nikolskii, A., [SRF wants to obtain the replacement for the 'Satan'], *Vedomosti*, 9 Dec. 2009, <http://www.vedomosti.ru/newsline/news/2009/12/09/903154>.

[52] Isby, D. C., 'Russia's MIRV RS-24s set for deployment during December', *Jane's Missiles and Rockets*, vol. 13, no. 12 (Dec. 2009), p. 10; and Isby (note 46).

[53] Nikolskii, A., [Three-headed missile is almost ready], *Vedomosti*, 15 Jan. 2009.

[54] Korotchenko, S., [Russia begins from here], *Voenno-Promyshlennyi Kur'er*, 22–28 Oct. 2008; and Saunders, S. (ed.), *Jane's Fighting Ships 2009–2010*, 112th edn (Jane's Information Group: Coulsdon, 2009), p. 652.

[55] [Northern Fleet's nuclear submarine 'Karelia' successfully concluded sea trials after modernization in Severodvinsk], ITAR-TASS, 18 Dec. 2009, <http://armstass.su/?page=article&aid=

Project 941 Akula (Typhoon Class) submarine for use as a test platform for the RSM-56 Bulava missile.

Russia is building three SSBNs of a new class, the Project 955 Borei. The lead boat in the class, the *Yurii Dolgorukii*, conducted a number of sea trials in 2009.[56] The second and third submarines, the *Aleksandr Nevskii* and the *Vladimir Monomakh*, have been under construction at the Sevmash shipyard since March 2004 and March 2006, respectively. Russia also plans to lay down the fourth SSBN of this class, the *Svyatitel Nikolai*, in 2010. The Project 955 SSBNs are designed to be armed with RSM-56 Bulava missiles.[57]

The troubled development of the Bulava, a three-stage, solid-propellant SLBM, received considerable attention from media and high-level officials in Russia in 2009. Once fitted on the Project 955 SSBNs, the Bulava is supposed to form the backbone of the future Russian naval deterrent force. During 2009 Bulava missiles were launched by the TK-208 *Dmitrii Donskoi* on 15 July and 9 December. Both attempts were high-profile failures.[58] This brought the total number of test flights of the Bulava to 12, with an additional 2 pop-up tests (i.e. tests of the mechanism which ejects the missile from the submarine). Only 2 of these are reported to have been completely successful.[59] The repeated failures are a major setback, not only for the Bulava development programme, but also for the plans to bring Project 955 submarines into service. The nuclear warheads to be carried by the Bulava reportedly were 'prepared [a] long time ago'.[60]

In 2009 Russia successfully conducted five underwater test launches of currently deployed types of SLBM. The K-443 *Svyatoi Georgii Pobedonosets* and K-44 *Ryazan'* conducted submerged launches of RSM-50 SLBMs on 6 and 7 October, respectively, from the Sea of Okhotsk to the Chizha test range in Arkhangelsk region.[61] On 13 July the K-84 *Yekaterinburg* launched an RSM-54 Sineva SLBM from a location near Franz Josef Land along a depressed trajectory to the Kura test site in Kamchatka. On 14 July the

79264&cid=25>; [Nuclear submarine 'Karelia' rejoined the Navy], *Izvestia*, 22 Jan. 2010; Saunders, ed. (note 54); and Isby, D. C., 'Russia announces construction of two new missile submarines', *Jane's Missiles and Rockets*, vol. 13, no. 6 (June 2009), p. 12.

[56] [SSBN 'Yuri Dolgoruky' has successfully completed the next stage of production tests], ARMS-TASS, 17 Nov. 2009, <http://armstass.su/?page=article&aid=77844&cid=25>.

[57] [Delay in construction of the 'Borei' submarine is not connected to the 'Bulava' trials], *Kommersant*, 21 Dec. 2009.

[58] [Yuri Solomonov could not carry 'Bulava'], *Kommersant*, 23 July 2009; and McKee, M., 'Strange "Norway spiral" was an out of control missile', *New Scientist*, 10 Dec. 2009.

[59] 'Bulava missile test history', Russian Strategic Nuclear Forces blog, 9 Dec. 2009, <http://russian
forces.org/navy/slbms/bulava.shtml>.

[60] 'Bulava nuclear warhead ready long ago—Defense Ministry representative', ITAR-TASS, 8 Dec. 2009, Translation from Russian, World News Connection.

[61] Isby, D. C., 'Bulava tests face further delay', *Jane's Missiles and Rockets*, vol. 13, no. 12 (Dec. 2009), p. 7. The RSM-50 entered service in 1978 and is deployed on Delta III Class submarines. It has 2 liquid-fuelled stages and carries 3 warheads. Lennox, ed. (note 36), pp. 149–50.

K-117 *Bryansk* launched another Sineva from the North Pole region towards the Chizha test range.[62] On 1 November the K-117 *Bryansk* again launched a Sineva from the Barents Sea to Kura.[63]

### Non-strategic nuclear weapons

Since the end of the cold war, Russia has significantly reduced its inventory of non-strategic nuclear weapons in implementation of two non-legally binding unilateral initiatives on non-strategic nuclear weapons, undertaken in 1991–92 together with parallel initiatives by the USA.[64] 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.[65] On the basis of the number of available delivery platforms, it is estimated that Russia has approximately 2000 operational warheads for delivery by air-defence missiles, tactical aircraft and naval cruise missiles, depth bombs and torpedoes.[66] In addition, Russia is believed to have up to several thousand non-strategic warheads held in reserve or awaiting dismantlement.

## IV. British nuclear forces

The United Kingdom's nuclear deterrent consists exclusively of a sea-based component: Vanguard Class Trident SSBNs, Trident II (D5) SLBMs and associated warheads, and support infrastructure. In March 2009 the British Prime Minister, Gordon Brown, confirmed that the UK's inventory of 'operationally available warheads' had been reduced to fewer than 160.[67] These weapons are available for use by a fleet of four Trident SSBNs (see table 8.4). The UK leases the D5 SLBMs from the US Navy. Under a system of 'mingled asset ownership', the missiles to be loaded onto British submarines are randomly selected from the stockpile at the US Navy's Trident facility in Kings Bay, Georgia. The submarines then go to the Royal Naval Armaments Depot at Coulport, Scotland, where the missiles are fitted with

[62] Makeev Design Bureau, [Director General's note], *Konstruktor*, no. 7 (July 2009), p. 2. The Sineva (the Blue) SLBM was first test launched in 1983. On the upgraded Sineva version see Kile, S. N., Fedchenko, V. and Kristensen, H. M., 'World nuclear forces, 2008', *SIPRI Yearbook 2008*, pp. 378–79.

[63] Litovkin, D., ['Dolphin' hit a 'peg'], *Izvestia*, 2 Nov. 2009.

[64] See Fieldhouse, R., 'Nuclear weapon developments and unilateral reduction initiatives', *SIPRI Yearbook 1992*, pp. 72–73, 89–92.

[65] 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.

[66] Warheads for ships and submarines are stored on land in depots and can be deployed if necessary. See also Kile, Fedchenko and Kristensen (note 62), pp. 380–81.

[67] Brown, G., Speech on nuclear energy and non-proliferation, International Nuclear Fuel Cycle Conference, Lancaster House, London, 17 Mar. 2009, <http://www.number10.gov.uk/Page18631>.

nuclear warheads designed and manufactured at the Atomic Weapons Establishment (AWE), Aldermaston, England. The Trident fleet is based at Faslane, Scotland. On 26 May 2009, HMS *Victorious* successfully test-launched a D5 missile off the Atlantic coast of Florida as part of a demonstration and shakedown operation following a refuelling overhaul.[68]

Each SSBN is equipped with 16 D5 missiles carrying up to 48 warheads. The warhead is similar to the US W76 warhead and has an explosive yield of about 100 kt. It is believed that a number of the D5 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.[69] The reduced force-loading option is the result of a decision by the Ministry of Defence (MOD) in 1998 to give a 'sub-strategic', or limited-strike, role to the Trident fleet aimed at enhancing the credibility of the deterrent.[70] In 2002 the role of nuclear weapons was extended to include deterring 'leaders of states of concern and terrorist organisations'.[71]

In a posture known as Continuous at Sea Deterrence (CASD), one British SSBN is on patrol at all times.[72] The second and third SSBNs can be put to sea rapidly, but the British inventory does not include enough missiles 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 its missiles de-targeted and a 'notice to fire' measured in days.

The four Vanguard Class SSBNs will reach the end of their service lives from 2024.[73] In a plan approved by the British Parliament in 2007, the Royal Navy will renew the Trident system by replacing the existing submarines with a new class of SSBNs and equipping them with the modified D5LE SLBM being developed by the USA. The new submarine will enter into service in 2024 after testing and acceptance trials.[74] The scheduled in-

[68] Lockheed Martin, 'Lockheed Martin-built Trident II D5 missile achieves 127 successful test flights', Press release, 30 July 2009, <http://www.lockheedmartin.com/news/press_releases/2009/0730ssuk-trident.html>.

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

[70] British Ministry of Defence (MOD), *The Strategic Defence Review: Modern Forces for the Modern World*, Cm 3999 (MOD: London, July 1998), para. 63.

[71] British Ministry of Defence, *The Strategic Defence Review: A New Chapter*, Cm 5566, vol. 1 (The Stationery Office: London, July 2002), para. 21.

[72] British Ministry of Defence and British Foreign and Commonwealth Office, *The Future of the United Kingdom's Nuclear Deterrent*, Cm 6994 (The Stationary Office: London, Dec. 2006), p. 27. See also Simpson, J. and Nielsen, J., 'The United Kingdom', eds H. Born, B. Gill and H. Hänggi, SIPRI, *Governing the Bomb: Civilian Control and Democratic Accountability of Nuclear Weapons* (Oxford University Press: Oxford, 2010)

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

[74] The MOD has been studying a further life-extension of the Vanguard SSBNs in case the new submarine's entry into service is delayed. Barrie, D., 'U.K. ponders further vanguard extension', *Aviation Week and Space Technology*, 21 Nov. 2008.

**Table 8.4.** British nuclear forces, January 2010

| Type | Designation | No. deployed | Year first deployed | Range (km)[a] | Warheads x yield | Warheads in stockpile |
|---|---|---|---|---|---|---|
| *Submarine-launched ballistic missiles* | | | | | | |
| D5 | Trident II | 160 | 1994 | >7 400 | 1–3 x 100 kt | 225[b] |

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

[b] Up to 160 warheads are operationally available, including *c*. 144 to arm 48 missiles on 3 of 4 SSBNs. The total stockpile consists of no more than 225 warheads. 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.

service date means that the British and US timetables for building a new generation of submarines and missiles to go on them are not in alignment. The US Navy has decided to extend the life of its existing D5 missiles to 2042, nearly two decades after the new generation of British submarines is scheduled to enter service. MOD officials have emphasized that design of the submarines' missile compartment has to be coordinated from the outset with the US Navy to ensure that it will be compatible with the design of the D5's successor.[75]

In 2009 the British Government appeared to back away from the idea of a 'like-for-like' replacement for the Vanguard Class submarines. In March 2009 Brown indicated that the new submarines would have 12 missile tubes rather than the 16 of the existing submarines.[76] In a 23 September 2009 speech to the UN General Assembly, Brown said that the UK was considering building only three Trident replacement submarines, rather than the planned four.[77] However, Brown gave no indication that the UK planned to reduce its stockpile of nuclear warheads, although he kept open the option of doing so 'consistent with [the UK's] national deterrence and with the progress of multilateral discussions'.[78] The option of reducing the SSBN force to three submarines had been included in a 2006 white paper on the future of the UK's strategic deterrent.[79] However, concerns had been raised about whether the smaller fleet could reliably sustain the CASD pos-

[75] Richardson, D., 'UK planning for Trident replacement takes shape', *Jane's Missiles and Rockets*, vol. 13, no. 5 (May 2009), p. 9.

[76] Brown (note 67).

[77] Brown, G., Speech to UN General Assembly, New York, 23 Sep. 2009, <http://www.un.org/ga/64/generaldebate/GB.shtml>.

[78] Brown (note 67).

[79] British Ministry of Defence and British Foreign and Commonwealth Office (note 72), p. 26.

ture. The concerns were raised again following a February 2009 collision between HMS *Vanguard* and the French SSBN *Le Triomphant* in the Bay of Biscay. Both submarines were forced to return to port for repairs.[80] Brown's statement at the UN came against the background of renewed political opposition during 2009 to the estimated procurement costs of the new submarines and associated infrastructure. In 2006 the cost of the planned four-boat fleet was estimated to be £15–20 billion ($28.5–38 billion).[81] A decision to reduce the new fleet to three submarines would save an estimated £3 billion ($5.7 billion).[82]

The British Government has yet to formally announce whether the nuclear warheads carried on the D5 SLBM will be refurbished or replaced. However, some press reports in 2008 indicated that a decision had already been taken to replace the existing stockpile of warheads, at an estimated total cost of more than £3 billion ($5.5 million).[83] The MOD has launched a long-term investment programme aimed at sustaining key skills and facilities at the AWE.[84]

## V. French nuclear forces

France's nuclear forces consist of aircraft and SSBNs, carrying a total of about 300 warheads (see table 8.5). A 2008 white paper on defence and national security includes important clarifications concerning French nuclear forces. France will continue to rely on the 'principle of strict sufficiency' (corresponding to a 'minimum deterrence' policy) as a guarantor of its security, and the 'operational credibility' of the deterrent relies on 'permanent submarine patrols and airborne capability'.[85] France will also continue to sustain its nuclear weapon complex, including the research and development capabilities. In order to maintain the 'technical credibility' of its nuclear weapons in the absence of nuclear testing and facilities producing weapon-grade material, in 1996 France started a nuclear weapon simulation programme, employing the Laser Mégajoule (LMJ, megajoule laser), radiography and supercomputers.[86]

[80] 'France and UK admit to nuclear submarine collision in Atlantic', *Jane's Missiles and Rockets*, vol. 13, no. 4 (Apr. 2009), p. 16.

[81] British Ministry of Defence and British Foreign and Commonwealth Office (note 72), p. 26.

[82] Wintour, P. and Norton-Taylor, R., 'Brown offers to cut Trident nuclear submarines by a quarter', *The Guardian*, 23 Sep. 2009.

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

[84] Reid, J., Secretary of State for Defence, 'Atomic Weapons Establishment', Written ministerial statement, House of Commons, *Hansard*, 19 July 2005, column C59WS.

[85] 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.

[86] French Government (note 85), p. 163.

**Table 8.5.** French nuclear forces, January 2010

| 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<br>1 x . . kt ASMP-A | 50 |
| Rafale F3 | – | (2010) | 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] |

. . = not available or not applicable; ( ) = uncertain figure; 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 the 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 and Space Technology*, various issues; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

In 2009 France's sea-based strategic force consisted of a fleet of three operational Triomphant Class SSBNs—*Le Triomphant*, *Le Téméraire* and *Le Vigilant*. A fourth Triomphant Class SSBN, *Le Terrible,* is scheduled to enter service in July 2010.[87] All operational French SSBNs are armed with 16 Aérospatiale M45 missiles, which each carry up to six TN-75 warheads.[88] In 2010–15 the SSBNs will be gradually equipped 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.[89] The M51.1 missile had been successfully flight-tested in

[87] Saunders, ed. (note 54), p. 246.

[88] 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).

[89] Lennox, ed. (note 36), p. 46; and 'France's nuclear-powered *Le Vigilant* prepares for patrol', *Jane's Missiles and Rockets*, vol. 9, no. 2 (Feb. 2005).

2006, 2007 and 2008 from a submerged launch platform.[90] On 27 January 2010 the missile was launched for the first time 'in real conditions' from the SSBN *Le Terrible*. The launch was reported as being successful.[91] France is developing another version of the M51 missile, the M51.2, which is designed to carry the new Tête Nucléaire Océanique (TNO, Oceanic Nuclear Warhead) and will supplant the M51.1 after 2015.[92]

In 2009 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 decrease following President Sarkozy's announcement in 2008 that France would reduce the airborne component of its nuclear forces by one-third.[93] 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 use with them.[94]

The phasing-out of ASMPs will begin in 2011. A follow-on cruise missile, the ASMP-Améliorée (improved ASMP), completed 'operational evaluation firings' in March 2009 and was formally announced as operational on 1 October. As of January 2010, it was in service on the Mirage 2000N fighters of the 3/4 Limousin Fighter Squadron at Istres, and was due to become operational on the Dassault Rafale F3 in 2010. The missile's Tête Nucléaire Aeroportée (TNA, Airborne Nuclear Warhead) is the 'new medium-energy thermonuclear charge', the yield of which is not publicly known.[95]

## VI. Chinese nuclear forces

China is estimated to have an arsenal of approximately 200 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. The existence of tactical warheads is uncertain, although the testing series in the 1990s reportedly included tactical warhead designs. There are no credible reports indicating that the size of the Chinese nuclear stockpile has changed significantly in recent years.

[90] Kile, Fedchenko and Kristensen (note 3), pp. 363–64.

[91] 'French ballistic missile test called a success', Global Security Newswire, 27 Jan. 2010, <http://www.globalsecuritynewswire.org/gsn/nw_20100127_8630.php>.

[92] Lennox, ed. (note 36), p. 47.

[93] French Government (note 85), p. 112; and Sarkozy, N., French President, 'Presentation of SSBM "Le Terrible"', Speech, Cherbourg, 21 Mar. 2008, <https://pastel.diplomatie.gouv.fr/editorial/actual/ael2/bulletin.gb.asp?liste=20080331.gb.html>.

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

[95] Richardson, D., 'ASMP-A enters French Air Force service', *Jane's Missiles and Rockets*, vol. 13, no. 12 (Dec. 2009), p. 10.

**Table 8.6.** Chinese nuclear forces, January 2010

| Type/Chinese designation (US designation) | No. deployed | Year first deployed | Range (km)[a] | Warhead loading | No. of warheads |
|---|---|---|---|---|---|
| *Land-based missiles*[b] | *134* | | | | *134* |
| DF-3A (CSS-2) | 12 | 1971 | 3 100[c] | 1 x 3.3 Mt | 12 |
| DF-4 (CSS-3) | 12 | 1980 | 5 500 | 1 x 3.3 Mt | 12 |
| DF-5A (CSS-4) | 20 | 1981 | 13 000 | 1 x 4–5 Mt | 20 |
| DF-21 (CSS-5) | 60 | 1991 | 2 100[d] | 1 x 200–300 kt | 60 |
| DF-31 (CSS-10 Mod 1) | ~15 | 2006 | >7 200 | 1 x . . | 15 |
| DF-31A (CSS-10 Mod 2) | ~15 | 2007 | >11 200 | 1 x . . | 15 |
| *SLBMs* | *(36)* | | | | *(36)* |
| JL-1 (CSS-N-3) | (12) | 1986 | >1 770 | 1 x 200–300 kt | (12) |
| JL-2 (CSS-NX-14) | (24) | (2010) | >7 200 | 1 x . . | (24) |
| *Aircraft*[e] | *>20* | | | | *(40)* |
| H-6 (B-6) | 20 | 1965 | 3 100 | 1 x bomb | (20) |
| Attack (. .) | . . | 1972– . . | . . | 1 x bomb | (20) |
| *Cruise missiles* | *150–350* | | | | . . |
| DH-10 | 150–350 | 2007 | >1500 | 1 x . . | . .[f] |
| **Total** | | | | | **(~200)**[g] |

. . = not available or not applicable; ( ) = 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 may be greater than is normally reported.

[d] The DF-21A (CSS-5 Mod 2) variant is believed to have a range of up to 2500 km.

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

[f] The DH-10, which is also known by the Chinese designation CJ-10, may have a nuclear role. It is apparently 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.* 240–300 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* (DOD: Washington, DC, Jan. 2001); 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); 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.

At the same time, China has been changing the delivery systems for those warheads as part of its long-term modernization programme aimed at developing a more survivable force and more flexible nuclear deterrence

and retaliatory options.[96] According to a 2009 report by the US Air Force, China has 'the most active and diverse ballistic missile development program in the world' and its 'ballistic missile force is expanding in both size and types of missiles'.[97]

Chinese land-based ballistic missiles are operated by the Second Artillery Corps (SAC) of the People Liberation Army (PLA). According to the data published annually by the US Department of Defense, in 2009 China's nuclear-capable missile arsenal consisted of the ageing liquid-fuelled DF-3A (Dong Feng, or East Wind) intermediate-range ballistic missile and the more modern road-mobile, solid-fuelled DF-21 medium-range ballistic missile (MRBM), which was assigned 'regional deterrence missions'.[98] In addition, China had two operationally deployed types of ICBM: the silo-based, liquid-fuelled DF-5A missile and the smaller, liquid-fuelled DF-4. The SAC is deploying modern mobile ICBM systems that are intended to enhance the survivability of the Chinese missile force by enabling the weapons to operate over a larger area. This includes the DF-31, a solid-propellant, road-mobile missile that was first deployed in 2006, as well as a longer-range (in excess of 11 200 km) variant, the DF-31A.[99] According to the USAF report, the new deployments means that the number of Chinese 'ICBM nuclear warheads capable of reaching the United States could expand to well over 100 during the next 15 years'.[100] However, the Chinese Government has reaffirmed that its nuclear posture adheres to the principle of a 'lean and effective strategic force' and to China's long-standing policy of no first use of nuclear weapons.[101]

According to China's 2008 defence white paper, the PLA Navy is working to enhance its 'capability of nuclear counterattacks'.[102] China has had difficulty in developing a sea-based nuclear deterrent. It built a single Type 092 (Xia Class) SSBN armed with 12 intermediate-range solid-fuel, single-warhead JL-1 (Ju Long, or Great Wave) SLBMs. The submarine has never conducted a deterrent patrol and is not thought to be fully operational.

[96] For a description of China's nuclear doctrine, and its plans for changing the operational status of the nuclear forces at 3 different levels of crisis, see 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), chapter VII. See also Gill, B. and Medeiros, E. S., 'China', eds Born, Gill and Hänggi (note 72)

[97] US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, Mar. 2009), p. 3.

[98] US Department of Defense (DOD), *Military Power of the People's Republic of China 2009*, Report to Congress (DOD: Washington, DC, Mar. 2009), p. 24. Although China has its own system for defining missile ranges (see table 8.6), 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.

[99] US Department of Defense (note 98).

[100] US Air Force (note 97), p. 3.

[101] Chinese State Council (note 96), chapter VII.

[102] Chinese State Council (note 96), chapter V.

China is currently building and deploying the Type 094 (Jin Class) SSBN. As of 2009, four submarines were reportedly in various stages of construction and outfitting, and a fifth had been commissioned but was not in service.[103] There have been reports indicating that one of the submarines had been deployed to a new base near Yulin on Hainan Island in the South China Sea.[104]

Each Jin Class SSBN will carry 12 three-stage, solid-propellant SLBMs, the JL-2, which is a sea-based variant of the DF-31 ICBM. The JL-2 has an estimated range of 7200 km, which means that it will have a true intercontinental range. It is believed to be armed with a single nuclear warhead, although there has been speculation that China might develop and deploy MIRVs on the missile.[105] The US DOD assessed in 2009 that the JL-2 would achieve an initial operational capability in 2009–10.[106] The same DOD report noted that the PLA Navy has 'only limited capacity to communicate with submarines at sea' and 'no experience in managing a SSBN fleet that performs strategic patrols'.[107]

It is thought that China has a small stockpile of nuclear bombs for delivery by aircraft. Although the PLA Air Force is not believed to have units whose primary purpose is to deliver the bombs, a declassified 1993 US Government report assesses that 'some units may be tasked for nuclear delivery as a contingency mission'.[108] The most likely aircraft for nuclear missions is the ageing H-6 bomber and possibly a more modern fighter-bomber aircraft. China is also a developing an air-launched version of a land-attack cruise missile, the DH-10 (also designated CJ-10) that may be for delivery by the H-6 aircraft. It is uncertain whether China has assigned a nuclear role to air- or ground-launched cruise missiles.

## VII. Indian nuclear forces

The conservative estimate presented here is that India has an arsenal of 60–80 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.[109]

In August 2009 Dr K. Santhanam, one of the key scientists associated with the nuclear tests conducted by India in May 1998, claimed that the

[103] Saunders, ed. (note 54), p. 128.

[104] Kristensen, H. M., 'New Chinese SSBN deploys to Hainan Island', 24 Apr. 2008, <http://www.fas.org/blog/ssp/2008/04/new-chinese-ssbn-deploys-to-hainan-island-naval-base.php>.

[105] See e.g. Saunders, ed. (note 54).

[106] US Department of Defense (note 98), p. 48.

[107] US Department of Defense (note 98), p. 24.

[108] US National Security Council, 'Report to Congress on status of China, India and Pakistan nuclear and ballistic missile programs', [28 July 1993], obtained under the US Freedom of Information Act by the Federation of American Scientists, <http://fas.org/irp/threat/930728-wmd.htm>.

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

hydrogen bomb test had been a fizzle (i.e. an inefficient detonation releasing less explosive energy than could be expected from theoretical calculations).[110] The statement has influenced the domestic debate on the need to conduct more nuclear tests. This option has become an increasingly costly one because it would jeopardize India's nuclear cooperation deals with the United States and other countries.[111]

### Strike aircraft

At present, aircraft constitute the most mature component of India's nuclear strike capabilities (see table 8.7).[112] 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, Madhya Pradesh, in north-central India. In addition, it is believed that some of the IAF's four squadrons of Jaguar IS Shamsher (Sword) fighter-bombers may have a nuclear delivery role.[113] Other aircraft in the IAF's inventory that are potentially suitable for a nuclear role are the MiG-27 (Bahadur) and the Su-30MKI.

### Land-based missiles

The Prithvi (Earth) short-range ballistic missile (SRBM) 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-kilogram warhead to a maximum range of 150 km. The first test of the missile was in 1988 and it was subsequently inducted into service by the Indian Army in 1994. It is currently deployed with the army's 333, 444 and 555 missile groups. The Prithvi II and Prithvi III SRBMs are not believed to be assigned nuclear weapon delivery roles.

Indian defence sources indicate that the family of longer-range Agni (Fire) ballistic missiles, which are designed to provide a quick-reaction nuclear capability, has largely taken over the Prithvi's nuclear role.[114] The

[110] Parashar, S., 'Kalam certifies Pokharan II, Santhanam stands his ground', *Times of India*, 28 Aug. 2009.

[111] On these deals see Anthony, I. and Bauer, S., 'Controls on security-related international transfers', *SIPRI Yearbook 2009*, pp. 467–71.

[112] 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).

[113] Norris and Kristensen (note 112).

[114] 'Prithvi SRBM', Bharat Rakshak Missiles, 12 Oct. 2009, <http://www.bharat-rakshak.com/MISSILES/ballistic/prithvi.html>.

**Table 8.7.** Indian nuclear forces, January 2010

| Type | Range (km)[a] | Payload (kg) | Status |
|---|---|---|---|
| *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 |
| *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 15 Apr. 2009 |
| Agni I[c] | >700 | 1 000 | Most recent Indian Army operational test in Mar. 2008; deployed with the Indian Army's 334 Missile Group |
| Agni II | >2 000 | 1 000 | Army operational launches on 19 May and 23 Nov. 2009; both unsuccessful; operational status uncertain |
| Agni III | >3 000 | 1 500 | Under development; test-launched 3 times, most recently on 7 Feb. 2010; induction expected in 2010–11 |
| Agni IV | ~5 000 | . . | Under development; test launch expected in 2010 |
| *Sea-based ballistic missiles* | | | |
| Dhanush | 350 | 500 | Test-launched on 6 Mar. and 13 Dec. 2009; induction underway |
| K-15[d] | 700 | 500–600 | Under development; test-launched from submerged pontoon on 26 Feb. 2008 |

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

[b] India has also begun developing a subsonic cruise missile with a range of 1000 km, known as the Nirbhay (Fearless), which is rumoured to 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* (NASIC: Wright-Patterson Air Force Base, OH, Mar. 2009); 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.

Agni was developed by India's Defence Research and Development Organisation (DRDO) as part of its integrated missile development programme. The Agni I is a single-stage, solid-fuel missile that can deliver a 1000 kg warhead to a maximum distance of 700–800 km. It is currently in service with the Indian Army's 334 Missile Group. The two-stage Agni II can deliver a similar payload to a maximum range of 2000 km.[115] During 2009 flight-tests of the Agni II missile took place in May and November. The tests were described as being 'not fully successful' in achieving performance goals.[116]

The two-stage, solid-fuel Agni III missile is expected to be able to deliver a 1500-kg payload to a range 3000–3500 km. The rocket represents several important technological advances in India's missile programme: it makes use of a flex-nozzle control system for rocket guidance, specially developed composite propellants, and guidance and control systems with fault-tolerant avionics.[117] The Agni III was most recently flight-tested in February 2010. DRDO officials declared the test to have been successful and stated that the Agni III was ready for induction into the armed forces.[118]

### Sea-based 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) missile, a naval version of the Prithvi II that is under development by the DRDO.[119] The missile is launched from a stabilization platform mounted on surface ships and can reportedly carry a 500-kg warhead to a maximum range of 350 km.[120] It is designed to be able to hit both sea- and shore-based targets, but the system's operational utility may be limited by its relatively short range. A Dhanush missile was successfully tested in December 2009.[121]

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.[122] MOD statements have designated the missile as the K-15, although other Indian sources refer to it

[115] Chansoria, M., 'India's missile programme: augmenting firepower', *India Strategic*, Oct. 2009.

[116] Mallikarjun, Y., 'Agni-II test-fired', *The Hindu*, 20 May 2009; and 'Agni-II missile fails to clear night trial', *Times of India*, 24 Nov. 2009.

[117] Pant, H. V. and Gopalaswamy, B., 'Launch into the Ivy League', *Indian Express*, 1 May 2007.

[118] 'Agni 3 clears test, all set to be inducted into the armed forces', *Indian Express*, 8 Feb. 2010.

[119] Indian Ministry of Defence, 'Dhanush missile—test launch', Press release, 30 Mar. 2007, <http://pib.nic.in/release/release.asp?relid=26541>.

[120] '"Dhanush" missile successfully test-fired', *Times of India*, 14 Dec. 2009.

[121] Mallikarjun, Y. and Subramanian, T. S., 'Dhanush missile successfully test fired', *The Hindu*, 14 Dec. 2009.

[122] 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.

as the Sagarika (Oceanic) project.[123] The new nuclear-capable missile will reportedly be able to deliver a 500-kg payload to a distance of up to 700 km.[124]

The K-15 is expected to be deployed on an indigenously constructed nuclear-powered submarine, which is being built for the Indian Navy at Visakhapatnam, Andhra Pradesh, under the Advanced Technology Vessel (ATV) project.[125] The first of these, the INS *Arihant*, was launched on 26 July 2009. The submarine will undergo sea-trials for up to two years and will be equipped with an unknown number of K-15 missiles.[126]

## VIII. Pakistani nuclear forces[127]

Pakistan is estimated to possess 70–90 nuclear weapons that can be delivered by aircraft or ballistic missiles (see table 8.8). Its current nuclear arsenal is based on weapon designs using 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 considerable evidence that Pakistan is moving towards a plutonium-based arsenal. Plutonium-based 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 would give already deployed ballistic missiles longer ranges. The 50-megawatt-thermal Khushab I reactor, completed in 1998, is capable of producing about 10–12 kg of weapon-grade plutonium annually.[128] Pakistan is building two additional plutonium production reactors at the nuclear complex at Khushab, Punjab, one of which may have started operating in 2009.[129] These new reactors will increase Pakistan's plutonium-production

[123] In 2006 the Indian MOD stated 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>.

[124] Subramanian, T. S., '"Sagarika" missile test-fired successfully', *The Hindu*, 27 Feb. 2008.

[125] Unnithan, S., 'Indigenous N-submarine in two years: Navy chief', *India Today*, 3 Dec. 2007.

[126] Subramanian, T. S., 'Nuclear submarine Arihant to be fitted with K-15 ballistic missiles', *The Hindu*, 27 July 2009.

[127] Norris, R. S. and Kristensen, H. M., 'Nuclear notebook: Pakistani nuclear forces, 2009', *Bulletin of the Atomic Scientists*, vol. 65, no. 5 (Sep./Oct. 2009).

[128] 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). For Pakistan's current stocks of fissile materials see appendix 8A.

[129] Albright, D. and Brannan, P., 'Commercial satellite imagery suggests Pakistan is building a second much larger plutonium production reactor: is South Asia headed for a dramatic buildup in nuclear arsenals?', Institute for Science and International Security, 24 July 2006, <http://isis-online.org/isis-reports/category/pakistan/>; and Brannan, P., 'Steam emitted from second Khushan reactor cooling towers; Pakistan may have started operating second reactor', Imagery Brief, Institute for Science and International Security, 24 Mar. 2010, <http://isis-online.org/isis-reports/category/pakistan/>.

capability several-fold, provided that the country has sufficient capacity to reprocess spent fuel.[130]

International concerns about the custodial security of Pakistan's nuclear arsenal continued to grow in 2009.[131] There have been fears that nuclear weapons could be obtained by terrorists or misused by elements in the Pakistani Government. However, US officials have generally expressed confidence in the security of Pakistan's nuclear arsenal. It is widely believed that Pakistan's efforts to improve the security of its nuclear weapons have been ongoing and include some cooperation with the USA.[132]

### Strike aircraft

In its nuclear weapon delivery role, the Pakistani Air Force is most likely to use the US-produced F-16 fighter aircraft. Pakistan had originally planned to spend $5.1 billion on buying F-16 aircraft. The financial constraints that the 2005 Kashmir earthquake imposed on Pakistan reduced the number of new aircraft that it could purchase from 36 to 18, which lowered the total value of the deal to $3.1 billion ($1.4 billion for the 18 new aircraft; $641 million for associated munitions; and $891 million on 46 Mid-Life Update kits for Pakistan's existing F-16 fleet).[133] In addition, the USA has provided Pakistan with 14 F-16s designated as Excess Defense Articles.

### Land-based missiles

Pakistan has two land-based, short-range ballistic missiles that are believed to have nuclear delivery roles. The Ghaznavi (Hatf-3) is a single-stage, solid-propellant, road-mobile SRBM, which was inducted into service in 2004. The moat recent reported test flight of the Ghaznavi was in February 2008.[134] The Shaheen I (Hatf-4) entered into service with the Pakistani Army in 2003. It was most recently test-launched in January 2008 during a training exercise conducted by the Army Strategic Force Command.[135]

[130] Albright and Brannan (note 129).

[131] Ahmed, I., 'Pakistan's nuclear weapons: how safe are they?', Institute for South Asian Studies (ISAS) Brief, National University of Singapore, 18 Nov. 2009, <http://www.isasnus.org/publications.htm>.

[132] Kerr, P. and Nikitin, M. B., *Pakistan's Nuclear Weapons: Proliferation and Security Issues*, Congressional Research Service (CRS) Report for Congress RL34248 (US Congress, CRS: Washington, DC, 9 Dec. 2009).

[133] Camp, D., US Department of State, 'Defeating al-Qaeda's Air Force: Pakistan's F-16 program in the fight against terrorism', Statement before the US House of Representatives Foreign Affairs Subcommittee on South Asia, 16 Sep. 2008, <http://2001-2009.state.gov/p/sca/ci/af/2008/109757.htm>.

[134] 'Ghaznavi missile launched', *Dawn*, 14 Feb. 2008.

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

**Table 8.8.** Pakistani nuclear forces, January 2010

| 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 the Pakistani Army in 2004; fewer than 50 launchers deployed; most recent test launch on 13 Feb. 2008; believed to be a copy of the M-11 missile acquired from China in the 1990s |
| Shaheen I (Hatf-4) | >450[b] | 750–1 000 | Entered service with the Pakistani Army in 2003; fewer than 50 launchers deployed; most recent test launch on 25 Jan. 2008 |
| Shaheen II (Hatf-6) | 2 500 | (~1 000) | First 2 army operational readiness launch on 19 and 21 Apr. 2008; expected to become operational soon[c] |
| Ghauri I (Hatf-5) | >1 200 | 700–1 000 | Entered service with the Pakistani Army in 2003; fewer than 50 launchers deployed; test-launched on 1 Feb. 2008 |
| *Cruise missiles* | | | |
| Babur (Hatf-7) | 700[d] | . . | Under development; test-launched on 6 May 2009; sea- and air-launched versions also under development |
| Ra'ad (Hatf-8) | 350 | . . | Under development; air-launched; first 2 test launches on 25 Aug. 2007 and on 8 May 2008 |

. . = not available or not applicable; ( ) = uncertain figure.

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

[b] Some unofficial sources claim that the Shaheen I has a range of 600–1500 km.

[c] The 2 operational readiness tests suggest that the Shaheen II may be operational.

[d] Since 2006 the range of flight tests has increased from 500 km 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* (NASIC: Wright-Patterson Air Force Base, OH, Mar. 2009); 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; 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>; 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.

The Ghauri I (Hatf-5) is Pakistan's only medium-range ballistic missile. It is a road-mobile, liquid-fuelled, single-stage missile with a range of about 1200 km. The missile entered into service with the Pakistani Army in 2003 and was most recently test-launched in February 2008.[136] Pakistan continues to develop the two-stage, road-mobile, solid-propellant Shaheen II (Hatf-6) MRBM. It uses a two-stage, solid-propellant rocket motor and has a maximum range of 2500 km. It was first successfully tested on 9 March 2004 and the most recent tests of the missile were in April 2008.

Pakistan is continuing to develop its arsenal of cruise missiles. On 6 May 2009 it conducted the latest in a series of a flight tests of the nuclear-capable Babur (Hatf-7) cruise missile.[137] It is also reported to be developing air- and sea-launched versions of this missile.[138] The development of the Babur is believed to be a response to India's desire to acquire a missile defence system.[139] In addition, 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. The Ra'ad's first test was in August 2007, and it was tested for the second time in May 2008.[140]

## 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.[141] In 2009 this policy came under renewed international scrutiny when remarks made by officials in the new US Administration were interpreted as calling for Israel to join the NPT as a non-nuclear weapon state.[142]

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 650 kg of military plutonium as of January 2009;[143] this is the equivalent of 130 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 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). There has been speculation that Israel may have produced tactical nuclear weapons, including

[136] Ansari, U., 'Pakistan pushes to improve missile strike capability', *Defense News*, 17 Nov. 2008.
[137] Nasir, S. A., 'Babar missile test-fired last Wednesday', *The Nation* (Islamabad), 9 May 2009.
[138] 'Pakistan successfully test-fires Hataf-VII missile', *PakTribune*, 26 July 2007.
[139] 'Babur missile far superior to Indian Brahmos: Musharraf', *PakTribune*, 11 Aug. 2005.
[140] Khan, I. A., 'Cruise missile fired from aerial platform', *Dawn*, 9 May 2008.
[141] On the role of this policy in Israel's national security decision making see Cohen, A., 'Israel', eds Born, Gill and Hänggi (note 72).
[142] Lake, E., 'Secret U.S.–Israel nuclear accord in jeopardy', *Washington Times*, 6 May 2009.
[143] See appendix 8A this volume.

**Table 8.9.** Israeli nuclear forces, January 2010

| 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 |

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

[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 to 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 'A ballistic missile primer', <http://www.publicpolicy.umd.edu/Fetter/Publications>; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

artillery shells and atomic demolition munitions, but this has never been documented. There have also been unsubstantiated rumours in recent years that Israel may have developed a nuclear-capable sea-launched cruise missile (SLCM), based on the US-made Harpoon missile, for its fleet of three Type 800 Dolphin Class diesel-electric attack submarines purchased from Germany. Israel has denied these rumours.[144]

## 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 graphite-moderated research reactor at Yongbyon, and hence the number of warheads it may have produced, has been the

[144] Ben-David, A., 'Israel orders two more Dolphin subs', *Jane's Defense Weekly*, 30 Aug. 2006, p. 5; and Williams, D., 'Israeli sub sails Suez, signalling reach to Iran', Reuters, 3 July 2009, <http://www.reuters.com/article/idUSTRE5621XZ20090703>.

subject of controversy.[145] In addition, doubts persist about whether North Korea has the design and engineering skills needed to manufacture a fully functional operational nuclear weapon.[146] North Korea demonstrated a nuclear weapon capability by carrying out underground nuclear test explosions in October 2006 and May 2009.[147] In both cases the estimated yield of the test explosion was much lower than what the initial nuclear tests by nuclear weapon states have historically produced; this has led some experts to question if the detonation was fully successful.[148] According to the US intelligence community, the 2009 test 'was apparently more successful than the 2006 test'.[149]

On 26 June 2008 North Korea made a formal declaration of its nuclear programme. It declared that it held a stock of 30.8 kg of separated plutonium, but this did not include unextracted plutonium contained in irradiated fuel rods, material that remained in equipment at the Yongbyon facilities or was lost during reprocessing, and plutonium used in the October 2006 nuclear detonation.[150] North Korea reprocessed the rest of the fuel rods containing plutonium in 2009.[151] As of December 2009, North Korea's plutonium stockpile was estimated to be about 35 kg.[152] This would be sufficient to make seven nuclear weapons, assuming that each weapon uses 5 kg of plutonium.

Apart from its 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 for military purposes.[153] In 2009 North Korea issued a number of statements acknowledging that it had an enrichment programme under way for producing fuel for future

[145] 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 inspectors in 1990.

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

[147] See Fedchenko, V. and Ferm Hellgren, R., 'Nuclear explosions, 1945–2006', *SIPRI Yearbook 2007*; and appendix 8B.

[148] 'CIA says North Korea nuclear test a failure: report', Reuters, 28 Mar. 2007, <http://www.reuters.com/article/topNews/idUSSEO15521620070328>; and Park, J., 'The North Korean nuclear test: what the seismic data says', *Bulletin of the Atomic Scientists*, 26 May 2009.

[149] Blair, D. C., 'Annual threat assessment of the US Intelligence Community for the Senate Select Committee on Intelligence', Office of the Director of National Intelligence, 2 Feb. 2010, <http://www.dni.gov/testimonies/20100202_testimony.pdf>, p. 14.

[150] 'North Korea declares 31 kilogrammes of plutonium', Global Security Newswire, 24 Oct. 2008, <http://www.globalsecuritynewswire.org/gsn/ts_20081024_4542.php>; and Kile, S. N., 'Nuclear arms control and non-proliferation', *SIPRI Yearbook 2009*, pp. 397–402.

[151] See chapter 9 in this volume.

[152] See appendix 8A.

[153] 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 North Korea had a covert, production-scale uranium enrichment programme.

nuclear power reactors.[154] The US Director of National Intelligence reiterated in February 2010 that North Korea 'has pursued a uranium enrichment activity in the past, which we assess was for weapons'.[155]

## XI. Conclusions

In 2009 there was an overall decline in the number of operational nuclear weapons deployed by the five legally recognized and four de facto nuclear weapon states. The decline was due primarily to the withdrawal from deployment of warheads on strategic nuclear delivery vehicles by Russia and the United States—which together account for more than 90 per cent of the world's inventory of nuclear weapons—pursuant to meeting the warhead limit set by the 2002 SORT Treaty. However, many of the Russian and US warheads withdrawn from service have been placed in storage and could be redeployed on delivery vehicles, since neither the 1991 START Treaty nor SORT requires warheads to be verifiably dismantled.

Despite signs of a further resurgence of public interest in nuclear disarmament in 2009, all of the legally recognized nuclear 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.

[154] Korean Central News Agency (KCNA), 'DPRK Foreign Ministry vehemently refutes UNSC's "Presidential Statement"', 14 Apr. 2009, <http://www.kcna.co.jp/item/2009/200904/news14/20090414-23ee.html>; KCNA, 'UNSC urged to retract anti-DPRK steps', 29 Apr. 2009, <http://www.kcna.co.jp/item/2009/200904/news29/20090429-14ee.html>; KCNA, 'DPRK Foreign Ministry declares strong counter-measures against UNSC's "Resolution 1874"', 13 June 2009, <http://www.kcna.co.jp/item/2009/200906/news13/20090613-10ee.html>; and KCNA, 'DPRK Permanent Representative sends letter to president of UNSC', 4 Sep. 2009, <http://www.kcna.co.jp/item/2009/200909/news04/20090904-04ee.html>. For analysis of these statements see Pollack, J., 'Parsing enrichment in North Korea', Arms Control Wonk, 7 Sep. 2009, <http://www.armscontrolwonk.com/2456/parsing-uranium-enrichment-in-north-korea>.

[155] Blair (note 149), p. 14.