Appendix 6A. Tables of nuclear forces

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All the nuclear weapon states have nuclear weapon modernization and maintenance programmes under way and appear committed to retain nuclear weapons for the foreseeable future.

During 2000, Russia and the United States continued to reduce their deployed strategic nuclear delivery vehicles within the framework of the 1991 Treaty on the Reduction and Limitation of Strategic Offensive Arms (START I Treaty), and the Russian Federal Assembly (parliament) ratified the 1993 Treaty on Further Reductions and Limitations of Strategic Offensive Arms (START II Treaty). However, within the START constraints, in the near future US modernization plans call for the deployment of new Trident II missiles on older Trident SSBNs, while Russia is modernizing its strategic forces by deploying new ICBMs and additional strategic bombers and is slowly constructing a new generation of SSBNs. Moreover, both countries continue to maintain large stockpiles of strategic and non-strategic (or tactical) nuclear weapons and to underscore their importance for their security policies. Tables 6A.1 and 6A.2 show the composition of the US and Russian operational strategic nuclear forces and present estimates of their non-strategic nuclear weapon holdings. The size of Russia's inventory of non-strategic nuclear weapons is believed to considerably exceed that of the USA but is difficult to estimate on the basis of public information.

The nuclear arsenals of the three other nuclear weapon states, as defined in the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT)—the United Kingdom, France and China—are considerably smaller than those of Russia and the USA but these countries remain committed to their nuclear arsenals as well; data on their delivery vehicles and nuclear warhead stockpiles are presented in tables 6A.3, 6A.4 and 6A.5, respectively. China's strategic modernization plan has received much attention, but whether its efforts aim at deploying a much larger strategic force or a more modern force comparable in size with its current deployments is not clear. Meanwhile, France is currently engaged in developing and deploying a new generation of SSBNs, SLBMs and air-launched weapons.

It is particularly difficult to obtain public information about the nuclear arsenals of the three de facto nuclear weapon states—India, Pakistan and Israel. Tables 6A.6, 6A.7 and 6A.8, respectively, present estimates of the size of their nuclear weapon stockpiles and provide information about their potential nuclear weapon delivery means.

The figures contained in the tables are estimates based on publicly available information and the authors' best estimates but contain some uncertainties, as reflected in the notes.

A list of the acronyms in this text and the tables and notes appears at the end of this appendix; other acronyms are defined at the first mention in the notes for each table.

Table 6A.1. US nuclear forces, January 2001[a]

Type	Designation	No. deployed	Year first deployed	Range (km)[b]	Warheads x yield	Warheads
Strategic forces						
Bombers[c]						
B-52H[d]	Stratofortress	94/56	1961	16 000	ALCM 5–150 kt[e]	400
					ACM 5–150 kt[f]	400
B-2[g]	Spirit	21/16	1994	11 000	Bombs[h]	950
Subtotal		*115/72*				*1 750*
ICBMs						
LGM-30G[i]	Minuteman III					
	Mk-12[j]	200	1970	13 000	3 x 170 kt	600
	Mk-12A	300	1979	13 000	3 x 335 kt	900
LGM-118A[k]	MX/Peacekeeper	50	1986	11 000	10 x 300 kt	500
Subtotal		*550*				*2 000*
SSBNs/SLBMs[l]						
UGM-96A[m]	Trident I (C-4)	192	1979	7 400	8 x 100 kt[n]	1 536
UGM-133A[o]	Trident II (D-5)					
	Mk-4[p]	192	1992	> 7 400	8 x 100 kt	1 536
	Mk-5	48	1990	> 7 400	8 x 475 kt[q]	384
Subtotal		*432*				*3 456*
Strategic subtotal						*7 206*
Non-strategic forces						
Tomahawk SLCM[r]		325[s]	1984	2 500	1 x 5–150 kt	320
B61-3, -4, -10 bombs[t]		n.a.	1979	n.a.	0.3–170 kt	1 350
Subtotal						*1 670*
Total						**8 876**[u]

[a] The 'enduring nuclear stockpile', as the Pentagon describes its post-cold war arsenal of nuclear weapons, consists of 14 different warhead versions of 8 basic designs: the B61-3, B61-4, B61-7, B61-10, B61-11, W62, W76, W78, W80-0, W80-1, B83-0, B83-1, W87 and W88. Another warhead, the W84, which previously armed the GLCM destroyed under the 1987 Treaty on the Elimination of Intermediate-Range and Shorter-Range Missiles (INF Treaty), is maintained in the inactive stockpile. The multi-megaton B53 bomb has been phased out. Production of new pits (plutonium cores) for the W88 warhead began in 1999 at the Los Alamos National Laboratory, and a significant portion of the stockpile is scheduled to undergo refurbishment and modernization over the next decade. The majority of this work will be on the B61 (all designs, including bombs currently deployed in 7 NATO countries), W76 and W80 warheads. Production of refurbished W76 and W80 warheads is scheduled to start in FYs 2008 and 2006, respectively.

All the remaining warheads in the US arsenal are so-called boosted designs, using tritium to increase the yield of the warhead. Because tritium decays, periodic replenishment of each operational warhead is necessary. Production of tritium ceased in 1988, and reserves from past production and retired warheads have been used to fill the tritium reservoirs. Although tritium supplies are expected to last at least until 2011 under a START II force level and even longer under START III levels, the US Department of Energy (DOE) announced in late 1999 that tritium production would resume at the Watts Bar and Sequoyah nuclear power plants of the Tennessee Valley Authority (TVA). Unlike the military production reactors that produced tritium for nuclear weapons during the cold war, the TVA reactors are considered civilian.

However, the DOE has disclosed that the TVA has previously been involved with the US military nuclear programme.

The reliability of the stockpile is managed under the Stockpile Stewardship Program (SSP), a joint DOE–Department of Defense (DOD) programme designed to test the performance and safety of each weapon system through a series of experiments and inspections. Each year, the Commander-in-Chief of the US Strategic Command (STRATCOM) certifies to the President whether the arsenal is capable of performing the tasks in the nuclear war plans and identifies possible deficiencies. Reliability certification was previously accomplished through underground testing of selected nuclear warheads at the Nevada Test Site (NTS), but after the Clinton Administration initiated a moratorium on underground nuclear testing in 1992 and signed the Comprehensive Nuclear Test-Ban Treaty (CTBT) in 1996, a new underground testing programme was started at NTS in 1997 to simulate the behaviour of nuclear weapons by subjecting small amounts of plutonium to powerful chemical explosions. The first of these so-called subcritical tests, which use too little plutonium to develop a sustained nuclear chain reaction but nonetheless provide data for development of computer simulations of nuclear explosions, was conducted at the U1A complex on 2 July 1997, followed by a second test on 18 Sep. 1997. Three more tests were conducted in 1998, and 2 in 1999 under the code names Oboe 1 and Oboe 2. In 2000 5 subcritical nuclear tests, the largest number yet in a single year, were conducted under this programme: Oboe 3 on 3 Feb., Thoroughbred on 22 Mar., Oboe 4 on 6 Apr., Oboe 5 on 18 Aug. and Oboe 6 on 14 Dec. The SSP also involves advanced computer processing facilities and powerful lasers to verify the performance of nuclear weapons through simulated nuclear explosions in the laboratory. These new capabilities have so far resulted in the introduction of the B61-11, the life extension of the W87, the certification of new neutron generators for the W76 warhead and the successful completion of a 3-D computer simulation of a thermonuclear explosion.

[b] Range for aircraft indicates combat radius, without in-flight refuelling.

[c] US bombers are not maintained on day-to-day alert. Unlike ICBMs and SSBNs, the bomber fleet was ordered by President George Bush to stand down in 1991. Bombers continue to exercise their nuclear mission, however, and can be returned to alert status within a few days if so ordered.

The B-1B is not included in the table because it has been converted to a conventional-only platform. The aircraft was officially removed from the SIOP on 1 Oct. 1997. Nonetheless, in compliance with the Secretary of Defense's Defense Planning Guidance for 1999–2002, the Air Force maintains a Nuclear Rerole Plan to restore a nuclear war-fighting capability for the B-1B within 6 months should the need arise. Under this plan, B-1B aircraft no longer undergo nuclear surety inspections to certify the crew's ability to handle nuclear weapons safely and proficiently and cannot participate in nuclear exercises. Instead, their nuclear surety and hardness against electromagnetic pulse (EMP) and blast effects from nearby nuclear detonations are maintained through the Conventional Mission Upgrade Program (CMUP) and the ability to employ B61 and B83 nuclear gravity weapons is retained. Spare bombs for 'reroled' B-1Bs are maintained in the STRATCOM's Active Reserve Stockpile. The START II Treaty, under which the B-1B is not accountable, allows for a one-time nuclear 'rerole' of the conventional B-1B fleet, in which case each aircraft would be credited with a 16-warhead 'weapons load'. Of the original 100 B-1Bs, 93 remain in service with the Air Combat Command and Air National Guard at Dyess AFB in Texas, Ellsworth AFB in South Dakota, Mount Home AFB in Indiana, McConnell AFB in Kansas and Robins AFB in Georgia. The B-1B is scheduled to remain in service until 2038.

[d] B-52Hs can carry up to 20 ALCMs/ACMs each. Because the US bomber force is shrinking, only about 400 ALCMs and 400 ACMs are deployed, with several hundred other ALCMs in reserve. The Nuclear Posture Review (NPR) released on 22 Sep. 1994 recommended eventually retaining 66 B-52Hs, but the Air Force decided on the higher number. The B-52Hs have been consolidated at 2 bases: the 2nd Bomb Wing at Barksdale AFB, Louisiana; and the 5th Bomb Wing at Minot AFB, North Dakota.

Table 6A.1 *contd*

The first figure in the *No. deployed* column is the total number of B-52Hs in the inventory, including those for training, test and backup. The second figure is the 'primary aircraft inventory', i.e., the number of operational aircraft available for nuclear and conventional missions. The B-52H is scheduled to remain in operation until 2044. In addition to front-line Air Force personnel, nuclear certification of full-time personnel from the Air Force Reserve in support of the nuclear war plans was approved by the Pentagon in late 1997.

[e] ALCMs (AGM-86B) are equipped with the W80-1 warhead. Although only *c.* 400 ALCMs are deployed, hundreds of others are held in reserve. Between 1982 and 1986 a total of 1739 ALCMs were produced by Boeing for the US Air Force. The Air Force states that there are a total of 1142 ALCMs in the inventory. This is a reduction of 251 missiles compared with the 1393 reported for Mar. 1997 and reflects an ongoing conversion of nuclear ALCMs to conventional cruise missiles (CALCMs or AGM-86Cs). Conversion of nuclear ALCMs to conventional CALCMs first began in June 1986. In 1999 the US Air Force ordered the conversion of another 322 ALCMs to conventional cruise missiles, as CALCM Block I (140 missiles) and Block IA (132 missiles) configurations. The remaining 50 ALCMs will be equipped with near-precision penetrator warheads for the new AGM-86D version. The ALCM inventory is expected to continue to decline and Air Force planning includes an ALCM force of 760 missiles in FYs 1999–2003. In addition to these active missiles, 200 ALCMs are kept in long-term storage. Full reconstitution of stored missiles will take *c.* 6 months. A life-extension programme is under way to extend the service of ALCMs until at least 2030.

[f] The Advanced Cruise Missile (ACM, or AGM-129A) is equipped with the W80-1 warhead. Originally, as many as 1461 ACMs were planned but the Pentagon announced in Jan. 1992 that production would stop at 640 missiles. A programme is under way to extend the service of the ACM until 2030.

[g] The first B-2 bomber was delivered to the 509th Bombardment Wing at Whiteman AFB, Missouri, on 17 Dec. 1993. The wing has 2 squadrons: the 393rd squadron was declared operational on 1 Apr. 1997; and the 325th was activated on 8 Jan. 1998. By the end of 1995, 8 more B-2s had arrived at Whiteman AFB: 5 were delivered in 1996, 4 in 1997, 2 in 1998 and 1 in 1999. All 6 aircraft from the test programme have been modified to full operational capability to bring the total number to 21.

The first figure in the *No. deployed* column is the total number of B-2s delivered to Whiteman AFB; the second figure is an approximate number of those available for nuclear and conventional missions. The B-2 is scheduled to be replaced in about 2040 and a follow-on bomber programme was begun in 1998.

[h] The B-2 is configured to carry various combinations of nuclear and conventional munitions. The nuclear weapons include the B61-7, B61-11 and B83 bombs. The B-2 is designated as the 'only' carrier of the new B61-11 earth-penetrating nuclear bomb introduced in Nov. 1997. Each B-2 can be armed with a load of either B61 or B83 bombs, but not a mix. When the B61-11 was first produced, each aircraft would initially have been forced to load with one or the other B61 version, but in late 1995 STRATCOM issued a new requirement for mixed loads of B61-7 and B61-11 bombs. The first 16 aircraft were produced as Block 10 versions, able to carry the B83 nuclear bomb (and the Mk 84 conventional bomb). These were followed by 3 production Block 20 versions, able to carry the B61-7 nuclear bomb. The last 2 aircraft were production Block 30 versions, able to carry both types of nuclear bomb and an assortment of conventional bombs, munitions and missiles. Earlier Block 10 and 20 aircraft are being upgraded to Block 30 standards. Originally scheduled to be completed in 2000, the upgrade will stretch to 2002 as a result of work being added. At completion there will be 21 Block 30 B-2s.

[i] The 500 Minuteman IIIs are located at 3 bases. Currently, there are 200 Minuteman IIIs deployed at Malmstrom AFB, Montana, divided in 4 missile squadrons (10th, 12th, 490th and 564th) of 50 missiles each as part of the 341st Space Wing. There are 150 Minuteman IIIs at Minot AFB, North Dakota, in 3 missile squadrons (740th, 741st and 742nd) as part of the

91st Space Wing. The 150 Minuteman IIIs at F.E. Warren AFB, Wyoming, in 3 missile squadrons (319th, 320th and 321st) and the 1 missile squadron of 50 MX ICBMs (400th), are part of the 90th Space Wing. In addition to the 500 operational Minuteman III missiles, there are 107 missiles for spares, operational testing and evaluation, and ageing and surveillance. US silo destruction has been completed in accordance with the START I Treaty at Ellsworth AFB, South Dakota, and Whiteman AFB—2 bases that once deployed Minuteman II ICBMs. Destruction of the 150 silos that once housed the Minuteman IIIs and the 15 missile alert facilities (with their underground launch control centres, LCCs) at Grand Forks AFB, North Dakota**,** began in 1999. The entire process is scheduled to be completed by 1 Dec. 2001.

To comply with the ban on MIRVs when the START II Treaty enters into force, the number of warheads on each of the 500 Minuteman III missiles will have to be reduced from 3 to 1, and the MX missile will be retired. Some Minuteman missiles have already been downloaded to carry only 1 re-entry vehicle. Currently, 300 Minuteman III missiles have the higher-yield W78 warhead and 200 have the W62 warhead. While several de-MIRVing options are possible, the Air Force has begun to place the Mark 21/W87 warhead on some Minuteman missiles at F.E. Warren AFB. Up to 500 W87s will be removed from the 50 MX missiles when they are retired.

Modernization of the Minuteman missiles continues under a $5 billion 4-part programme intended to improve the accuracy of the missiles and extend the service life to beyond 2020. The missile alert facilities (i.e., the LCCs) have been updated with Rapid Execution and Combat Targeting (REACT) consoles. The second part is the Guidance Replacement Program (GRP), which at a cost of $1.9 billion replaces the old NS-20 guidance system with the new NS-50. The GRP was initiated in Aug. 1993, low-rate initial production commenced in Mar. 1998, and full-rate production commenced in Dec. 1999. The Air Force signed a $171 million contract with TRW, Inc., a private contractor, in Nov. 2000 for the delivery of 80 NS-50 missile guidance sets by Dec. 2001. A total of 8 annual contracts (total value $1.3 billion) are planned through 2008 for a total of 652 NS-50 guidance sets. The new guidance system has been expected to increase the accuracy of the Minuteman III to nearly that of the current MX—a CEP of 100 metres—but the Pentagon has indicated that the GRP 'does not provide accuracy update to state of the art'. *Defense Week* subsequently reported that the NS-50 system had not been tested sufficiently to verify the expected accuracy, and the Air Force was only able to assert that the available data 'does not indicate that the NS-50 electronics upgrade has degraded the Minuteman III accuracy'. The IOC of the NS-50 guidance set was achieved in Aug. 2000, when the first 10 sets installed on operational Minuteman III missiles at Malmstrom AFB exceeded the 720-hour on-alert requirement, corresponding to some 30 days. The third part of the modernization programme is the Propulsion Replacement Program (PRP), which involves replacing the motors of the first, second and third solid-fuel stages of the Minuteman missile; incorporating the latest solid-propellant and bonding technologies; and replacing obsolete or environmentally unsafe materials and components. A total of 9 missiles are scheduled to undergo propulsion replacement in FY 2001, followed by 33, 86 and 96 in the subsequent 3 years. The fourth part is the Propulsion System Rocket Engine Life Extension Program, which refurbishes the post-boost, liquid propulsion stage of the Minuteman III.

Overall management of maintenance and readiness of US ICBMs was consolidated with TRW in Dec. 1997 as a cost-saving measure. The TRW's total contract to modernize and sustain the ICBM force amounts to $6.3 billion.

The first experimental launch of a combined GRP/PRP Minuteman III missile took place on 13 Nov. 1999 from Vandenberg AFB, California, to the Kwajalein Missile Range in the Pacific Ocean. Normally, 3 test launches are conducted each year, but 4 took place in 2000: on 24 May, 9 June, 25 Sep. and 28 Sep. The 9 June launch involved a missile equipped with 3 unarmed re-entry vehicles, which travelled *c.* 4200 miles (6720 km) in about 30 minutes before hitting a predetermined target at the Kwajalein Missile Range. The 28 Sep. test involved the launch of 2 missiles. The Air Force is exploring plans to replace the Minuteman III around 2020.

Table 6A.1 *contd*

[j] The Mk-12 carries the W62. This warhead is not part of the DOE's service life extension programme and would be scheduled for retirement because of its inferior safety features. A 1998 Pentagon study, however, predicted that arms control issues may force the DOE to keep the W62 in the stockpile anyway.

[k] The MX missile carries the W87 warhead. All MX missiles currently operational at F.E. Warren AFB are scheduled to be deactivated under the START II Treaty by 2007. The first 16 missiles are slated for deactivation in FY 2001, and 2 missiles had been destroyed by early Jan. 2001. Russia and the USA disagree on how much of the MX must be destroyed under START II. The USA regards an MX as destroyed if the top stage is destroyed and reserves the right to use the rest of the missile as a launch vehicle for 'satellites or other things'. Russia considers the missile destroyed when the whole missile has been destroyed. Despite the planned deactivation, flight testing of MX missiles continues under the Force Development and Evaluation Program with 1 missile randomly selected from the operational missiles transferred and launched from Vandenberg AFB on 8 Mar. 2000. MX missiles are thought to carry 10 warheads each, but test launches normally involve only 6 re-entry vehicles. A life extension programme is under way for the W87 to extend the warhead's service life to 40 years.

[l] Eighteen Ohio Class submarines constitute the current SSBN fleet. The Ohio Class SSBNs home-ported at Bangor, Washington, carry the Trident I (C-4) SLBM, while submarines operating in the Atlantic and Mediterranean carry the Trident II (D-5). The SLBMs and their associated warheads are stored at 2 locations: the Strategic Weapons Facility Atlantic (SWFLANT) near Kings Bay, Georgia, handles the Trident II (D-5) and its warheads, while the Strategic Weapons Facility Pacific (SWFPAC) near Bangor, Washington, handles the Trident I (C-4) and its warheads.

The 1994 NPR recommended completing construction of 18 Ohio Class SSBNs and then retiring the 4 oldest Trident I SSBNs. By 2006 all the remaining SSBNs will carry the longer-range and more accurate Trident II (D-5) missile, which means that the Trident I (C-4) missile will be retired and 4 of the 8 SSBNs home-ported at Bangor will be modernized to carry the Trident II (D-5). To upgrade the Bangor base to support the Trident II, a 10-year, $5 billion programme was begun in 2000. The 4 SSBNs to be modernized are the *Alaska* (SSBN-732) and *Nevada* (SSBN-733) (in 2000 and 2001) followed by the *Henry M. Jackson* (SSBN-730) and *Alabama* (SSBN-731) (in 2004 and 2005). The *Alaska* entered the Puget Sound Naval Shipyard for overhaul and conversion in Apr. 2000. To balance the future SSBN fleet between the Atlantic and Pacific, 3 submarines will be moved from Kings Bay to Bangor beginning in 2002, creating a 7-submarine force on each coast.

The 4 older submarines (*Ohio, Michigan, Florida* and *Georgia*) will be retired as SSBNs, 2 each in 2002 and 2003. Their future roles have not been disclosed. While they could be decommissioned or scrapped, the *Ohio* and *Michigan* recently underwent costly refuelling overhauls so it is possible that these 2 or all 4 ex-SSBNs could be converted to carry SLCMs for land-attack missions or used for special operations forces (SOF). A 1999 study determined that converting 22 of the 24 launch tubes to carry up to 154 SLCMs presented no significant technical problem but would cost at least $2.5 billion over 3 years. Treaty limitations (conventional SLCM-equipped SSBNs would still be included in the total number of US launch platforms under current START II counting rules) and a sizeable inventory of SLCMs already deployed on numerous SSNs and surface ships may prevent this plan from going forward. START I contained an Agreed Statement allowing for 2 US special-purpose Poseidon submarines. If the Navy wanted to replace those 2 Poseidons with 2 Trident submarines, this would have to be agreed in a future treaty.

As during the cold war, each SSBN is assigned 2 crews to maximize the time it can spend at sea. Currently, the SSBN force operates on a 112-day cycle that consists of a 77-day patrol followed by a 35-day refit period. In 2000, at any given time, 9 or 10 US SSBNs will be on patrol, a rate equal to that at the height of the cold war. Roughly one-half the SSBNs on patrol

(2 or 3 in each of the Atlantic and Pacific oceans) will be on 'hard' alert, i.e., within range of their targets. The remaining patrolling SSBNs are in transit to or from their launch-point areas and could be shifted to hard alert within a matter of hours or days. Although the START treaties attribute 8 warheads per Trident missile, missiles deployed on an SSBN at sea may carry fewer warheads and the submarine may therefore carry less than its maximum complement of 192 warheads. Loading fewer warheads on a missile will significantly extend its range. Some SLBMs may have 5 or 6 warheads while others have 7 or 8. It is the SIOP and other strike plans that ultimately determine how an SSBN will be loaded, where the SLBMs will be launched from, and at which targets the warheads are aimed. In Sep. 1999 *The New York Times* reported that the Navy had begun adding the W88 to Pacific Fleet SSBNs 'so in the next few years the W88 is likely to be aimed at China'. China was brought back under SIOP planning in 1998 after being removed in 1982 following the normalization of Sino-US relations. As a result, STRATCOM has designed the Chinese Integrated Strategic Operations Plan (CHISOP), a hypothetical Chinese nuclear war plan which it uses each year to 'wargame' US and Chinese nuclear forces against each other.

The Navy's SLBM Warhead Protection Program (SWPP) maintains the capability to develop replacement nuclear warheads for both the W88/Mk-5 and W76/Mk-4. One design is described as 'near-term' and the other as 'long-term'.

[m] The Trident I (C-4) was designed for a 10-year service life but is now planned to remain in operation until 2006. A total of 570 missiles were produced between 1976 and 1986, and 217 missiles have been launched in 113 different flight test events. Each event has involved firing 1–4 missiles. Of the 217 attempted launches, 180 were successful, while the remaining 38 either failed or did not launch for various reasons. The highest consecutive number of successful launches ever achieved by the Trident I (C-4) system is 45, accomplished between June 1984 and Aug. 1987. Since then, it has never achieved more than 12 consecutive launch successes. Until the early 1990s, Trident I (C-4) flight tests were carried out in both the Atlantic and Pacific oceans, but since 29 July 1993, when the last C4 test was conducted at the Pacific Test Range, all SLBM flight tests have been conducted at the Atlantic Test Range off the coast of Florida.

[n] The W76 warheads from the Trident I (C-4) missiles have been backfitted on Trident II submarines home-ported at Kings Bay and are supplemented by 400 W88 warheads, the number of warheads built before production ceased in 1989. The W76 completed a multi-year dual-revalidation programme in 2000 and is the most abundant nuclear warhead in the US operational arsenal.

[o] The US Navy continues to purchase Trident II (D-5) SLBMs. A $541 million contract was awarded to Lockheed Martin in Oct. 2000 for the production of 12 missiles between 2001 and 2003. By end-Dec. 1999 the Navy had purchased 372 Trident II missiles but, since the NPR called for backfitting 4 Trident I-equipped SSBNs with Trident IIs, the total number of D5 missiles to be procured will increase from 390 to 453, at an extra cost of $2.2 billion. Twenty-eight additional missiles were purchased for the research and development programme. The total cost of the programme is now $27.183 billion, or $60 million per missile. Some have questioned the need to continue to buy more missiles if the future force under a START III accord is going to be fewer than 14 SSBNs. A force of 10 submarines, e.g., requires 347 missiles and would result in significant savings.

Three Trident II (D-5) missiles were test launched in 2000. Since Jan. 1987 the Navy has conducted 112 flight tests of Trident II (D-5) missiles in 79 different events. Each event may launch from 1 to 4 missiles. Compared to the performance of the Trident I (C-4), the D5 programme has been extraordinarily successful. Of the 112 missiles launched, only 5 failed or did not work, and since Dec. 1989 the programme has accomplished an impressive record of 90 consecutive successful launches, making the Trident II the most reliable strategic nuclear missile ever. Nonetheless, flight testing continues and, because the current store of test missile kits will be depleted by 2004, the Navy signed a contract with Lockheed Martin in Dec. 2000 to support the testing programme beyond 2004.

Table 6A.1 *contd*

As a result of the extension of the service life of the Ohio Class submarines from 30 to 42 years, the SSBN fleet will outlive the current Trident II (D-5), which is scheduled to begin retiring in 2019. The Navy has therefore begun a programme to extend the service life of the D5. The upgraded missile, which is not considered a new missile but a 'variant' of the existing D5, is called the Trident II (D-5A). Funding is expected to begin in 2005, purchase of engines is planned for 2010–12, and the Navy wants production to start in 2015. Approximately 300 Trident II (D-5A) missiles are planned, enough to arm 10 submarines.

[p] The Mk-4 carries the W76 warhead. Since its construction began in 1976, Lockheed Martin's Missile and Space Operations has manufactured over 5000 Mk-4 re-entry body assembly kits for the US and British navies. In order to ensure that the W76/Mk-4 re-entry body can support SSBN operations until 2040, a service life extension programme is planned to run until 2020.

[q] The Mk-5 carries the W88, the most powerful warhead in the US arsenal. Production of the W88 was halted in 1989, after 384 warheads, when the Rocky Flats Plant was closed, and President Bush announced in Feb. 1992 that no more W88s would be built. In 1999, however, small-scale production of plutonium cores (pits) for the W88 resumed at the TA55 facility at Los Alamos National Laboratory. A total of 4 'development pits' had been manufactured by Feb. 2000. This production is not believed to aim at increasing the number of W88 warheads in the arsenal—although TA55 makes this a possibility if necessary—but to replenish W88 pits destroyed in reliability experiments. The current plan is for the TA55 facility to have a capacity to produce 20 pits a year in 2007 and eventually to have a capacity to produce 50 pits a year. First full-scale pit production for the W88 is scheduled for 2001, with certification into the operational stockpile to take place in 2004. After pit production for the W88 has been completed, the next production will involve pits for the W87 warhead.

[r] As part of an overall consolidation of nuclear weapon facilities, all the US Navy's TLAM/N missiles (with W80-0 warheads) have been removed from their previous storage locations at Naval Air Station (NAS) North Island in San Diego, California, and Naval Weapon Station (NWS) Yorktown, Virginia, and are now stored at the Strategic Weapons Facilities alongside strategic weapons for the SSBNs. NWS Yorktown was decertified in Aug. 1997 after its complement of TLAM/Ns was shipped south to SWFLANT, which was first certified to receive the missiles in Apr. 1997. NAS North Island's nuclear certification expired in Apr. 1998 after all its TLAM/Ns had been airlifted to the SWFPAC. As a result of this change, it is now thought that no nuclear weapons are stored in California or Virginia, 2 of the most 'nuclearized states' in the USA during the cold war.

As a result of the 1994 NPR, surface vessels are no longer equipped to carry nuclear-armed Tomahawk missiles. The option was retained, however, to redeploy them on attack submarines, although all the TLAM/Ns are thought to be stored on land under normal circumstances. Moreover, while most US attack submarines were credited with some nuclear capability during the cold war, today most do not have a nuclear mission. In the Pacific Fleet, e.g., less than one-half of the 25 front-line attack submarines regularly undergo nuclear certification. The reduced nuclear requirement is further illustrated by the fact that SSNs that pass inspection are subsequently de-certified to save resources for more important non-nuclear responsibilities. However, TLAM/Ns can be redeployed in only 30 days if the order is given. To ensure training and force integration, TLAM/N operations are now included in STRATCOM's annual 'Global Guardian' nuclear exercises.

[s] Although the number of US non-strategic nuclear weapons has declined dramatically compared with the cold war period, a Pentagon study concluded in 1998 that the level of US tactical weapons will not be significantly reduced given Russia's much larger inventory of tactical nuclear weapons and its declared dependence on them.

[t] An ample supply of B61 tactical nuclear bombs exists for various US and European NATO aircraft. Aircraft for NATO allied air forces include F-16s and Tornado fighter bombers. The USA is the only nuclear weapon state that currently deploys nuclear weapons outside its own

territory. It is estimated that *c*. 150 bombs are deployed at 10 airbases in 7 European NATO nations. The airbases include: Kleine Brogel, Belgium; Buechel AB, Germany; Ramstein AB, Germany; Spangdahlem AB, Germany; Araxos, Greece (a press report from Jan. 2001 that the bombs at Araxos have been removed has not been confirmed); Aviano, Italy; Ghedi-Torre, Italy; Volkel, Netherlands; Incirlik, Turkey; and RAF Lakenheath, UK. The Weapons Storage and Security System (WS3) used to store the nuclear bombs at these locations was installed between 1990 and 1998. Current programming calls for modernizing the WS3 before 2005 to maintain the system through the autumn of 2018. A service life extension of the B61 began in 1999.

In the USA, significant numbers of B61s are stored at AFBs in Nevada and New Mexico. US aircraft include the F-15E Strike Eagle, F-16A/B/C/D Fighting Falcon and F-117A Nighthawk. Although the F-117A is considered nuclear-capable, it is maintained at a lower level of nuclear readiness than the other aircraft. Air Combat Command recommended denuclearizing the F-117A in 1992 to free resources for training and onboard computer capacity, but the Air Staff intervened and decided to maintain the platform in a nuclear-capable configuration. All the F-15, F-16 and F-117A aircraft will be replaced by the F-22 and Joint Strike Fighter (JSF) over the next decade or so. The F-22 does not have a nuclear capability, but the Air Force's longer-range plan is for some of the JSF fleet to be nuclear-capable.

In response to Presidential Decision Directive-60, signed by President Bill Clinton in Nov. 1997, the nuclear readiness posture of dual-capable aircraft (DCA) based in the USA was reduced. The lowered posture was implemented through Change 3 to the Nuclear Supplement (Annex C) of the Joint Strategic Capabilities Plan in Apr. 1998. Nonetheless, the entire DCA force was maintained for worldwide deployment 'in any theater', and fighter-bombers are now routinely included in STRATCOM's annual 'Global Guardian' nuclear exercises.

[u] In addition to this active stockpile, an inactive stockpile was created in early 1990 to provide a reserve of extra warheads (a hedge) for reconstitution (e.g., upload) of part of the operational force in case Russia returns to a more hostile regime or China dramatically increases its nuclear arsenal. The inactive stockpile incorporates all those warheads that are not assigned to operational delivery platforms and not awaiting final disassembly at the Pantex facility in Texas. Also stored in the inactive stockpile are warheads used for replacing warheads that have been destroyed in various tests or removed because of reliability problems. As arms control agreements have reduced the size of the active stockpile, the inactive stockpile has grown significantly as part of the total stockpile. Before START I, about 5% of the total stockpile was in the 'inactive' category. Present plans for the START II stockpile could increase that to at least a 1 : 1 ratio with the active stockpile. The inactive stockpile is not counted in current arms control agreements, and the trend is that deployed strategic warheads are a shrinking fraction of the reconstitutable warheads. 'Most weapons' removed from active status under START I, e.g., have been placed in the inactive stockpile to meet the 'lead and hedge' requirements contained in the 1994 NPR. Similarly, if START II is implemented with 3500 'accountable' warheads, the total stockpile will include an additional 5000 warheads in the inactive stockpile and *c*. 1000 operational non-strategic warheads also not accountable under the START regime.

Sources: START I Treaty MOU, Sep. 1990, 5 Dec. 1994, 1 July 1995, 1 Jan. 1996, 1 July 1996, 1 Jan. 1997, 1 July 1997, 1 July 1998, 1 Jan. 1999, 1 July 1999, 1 Jan. 2000, 1 July 2000; Cohen, W., Secretary of Defense, *Annual Report to the President and the Congress* (US Department of Defense: Washington, DC, Jan. 2001), pp. 89–99, D-1; International Institute for Strategic Studies, *The Military Balance 2000/2001* (Oxford University Press: Oxford, 2000); US Senate Committee on Foreign Relations, START II Treaty, Executive Report 104-10, 15 Dec. 1995; US Navy, personal communication; US Department of Defense, various documents obtained under the Freedom of Information Act; Natural Resources Defense Council, 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

Table 6A.2. Russian nuclear forces, January 2001

Type	NATO designation	No. deployed	Year first deployed	Range (km)[a]	Warheads x yield	Warheads
Strategic offensive forces						
Bombers						
Tu-95MS6[b]	Bear-H6	29	1984	6 500–10 500	6 x AS-15A ALCMs, bombs	174
Tu-95MS16	Bear-H16	34	1984	6 500–10 500	16 x AS-15A ALCMs, bombs	544
Tu-160[c]	Blackjack	15	1987	10 500–13 200	12 x AS-15B ALCMs or AS-16 SRAMs, bombs	180
Subtotal		*78*				*898*
ICBMs[d]						
SS-18[e]	Satan	168	1979	11 000–15 000	10 x 500–750 kt	1 680
SS-19[f]	Stiletto	150	1980	10 000	6 x 500–750 kt	900
SS-24 M1[g]	Scalpel	36	1987	10 000	10 x 550 kt	360
SS-25[h]	Sickle	360	1985	10 500	1 x 550 kt	360
SS-27[i]	n.a.	24	1997	10 500	1 x 550 kt	24
Subtotal		*738*				*3 324*
SLBMs[j]						
SS-N-18 M1	Stingray	112	1978	6 500	3 x 500 kt	336
SS-N-20	Sturgeon	60	1983	8 300	10 x 200 kt	600
SS-N-23	Skiff	112	1986	9 000	4 x 100 kt	448
Subtotal		*284*				*1 384*
Total strategic offensive						**5 606**[k]
Strategic defensive forces						
SAMs						
SA-5B Gammon, SA-10 Grumble		1 200				**1 200**
Non-strategic forces[l]						
Land-based non-strategic						
Bombers and fighters:						
Tu-22M Backfire		105			AS-4 ASM,	
Su-24 Fencer		280			AS-16 SRAM, bombs	
Subtotal		*385*				*1 540*
Naval non-strategic[m]						
Attack aircraft:						
Tu-22M Backfire		45			AS-4 ASM, bombs	
Su-24 Fencer		50				
Subtotal		*95*				*190*
SLCMs						
SS-N-9, SS-N-12, SS-N-19, SS-N-21, SS-N-22						320
ASW weapons						
SS-N-15, SS-N-16, torpedoes		n.a.				340
Total defensive and non-strategic						**3 590**
Total						**9 196**

[a] Range for aircraft indicates operational range at maximum and standard payloads.

[b] Strategic bombers are part of the Russian Air Force's 37th Air Army. According to the 30 Jan. 2001 START I Treaty MOU, Bear bombers are deployed at the following airbases: Bear-H16—21 at Ukrainka AB (79th Heavy Guard Bomber Regiment) and 13 at Engels AB (121st Heavy Bomber Regiment); Bear H-6—24 at Ukrainka and 5 at Engels. In late Apr. 2000, Tu-95 and Tu-160 bombers flew non-stop from Engels AB down to the Black Sea and then up to the White Sea to launch cruise missiles at the northern Kanin Nos test range. In mid-Aug. Tu-95s from Ukrainka flew to north-western Russia to fire cruise missiles as part of the Northern Fleet exercises (the same in which the *Kursk* submarine sank). The bombers landed in Belarus before returning to Ukrainka. In early Dec. 7 Tu-95MS bombers (2 from Engels and 5 from Ukrainka) were deployed at 3 Arctic staging bases to conduct exercises.

[c] According to the 30 Jan. 2001 START I Treaty MOU, 15 Blackjacks are based at Engels AB. Ukraine sent 8 Tu-160s to Russia in late 1999 and early 2000 in exchange for partial payment of Ukrainian natural gas debts to Russia (the deal also included the transfer of 3 Tu-95MSs, included in the totals above, and some 575 cruise missiles). In addition, the Kazan Gorbunov production plant delivered 1 new construction Tu-160 to the Russian Air Force in May. These additions raised the number of deployed Tu-160s in the Russian Air Force from 6 to 15 in 2000. The Gorbunov plant may complete at least 1 more new Tu-160. The larger force led to the creation of a new unit for the Tu-160s, the 22nd Donbass Guard Heavy Bomber Aviation Division (Tu-160s had operated as part of the 121st Heavy Bomber Regiment). Plans exist to modernize the Blackjacks and to equip them with conventionally armed long-range cruise missiles.

[d] Deactivation and retirement of ICBMs and their launchers proceed through at least 4 stages: in the first stage, an ICBM is removed from alert status by electrical and mechanical procedures; second, warheads are removed from the missile; third, the missile is withdrawn from the silo; and fourth, to comply with START-specified elimination procedures, the silo is blown up and eventually filled in. The number of missiles and warheads will vary depending on which stage one chooses to feature.

[e] In the Sep. 1990 START I Treaty MOU, the Soviet Union declared 204 SS-18s in Russia (30 at Aleysk, 64 at Dombarovskiy, 46 at Kartaly and 64 at Uzhur). Thirty-six SS-18s have been removed from service in Russia (6 at Aleysk, 12 at Dombarovskiy and 18 at Uzhur), leaving 168. Under the START I Treaty, Russia is permitted to retain 154 SS-18s after Dec. 2001; thus at least another 14 should be removed from service in 2001. If the START II Treaty is fully implemented, all SS-18 missiles will be destroyed, but Russia may convert up to 90 SS-18 silos for deployment of single-warhead ICBMs. Two variants of the SS-18 are thought to be deployed—the RS-20B and the RS-20V. Although all SS-18s are counted with 10 warheads, the RS-20B variant can carry a single warhead, and a few may be deployed. The range of the fully loaded SS-18s is some 11 000 km. Single-warhead missiles have ranges of 15 000 km. Warheads on the RS-20B have yields of 500–550 kt, and on the RS-20V, 550–750 kt.

[f] In the Sep. 1990 START I Treaty MOU, the Soviet Union declared 130 SS-19s in Ukraine and 170 in Russia. A Nov. 1995 agreement included the sale of 32 SS-19s, once deployed in Ukraine, back to Russia. Some SS-19s in Russia are being withdrawn from service. Under START II Russia may keep up to 105 SS-19s downloaded to a single warhead.

[g] Thirty-six SS-24M1s are rail-based, with garrison deployments at Bershet, Kostroma and Krasnoyarsk. The 10 silo-based SS-24 M2s deployed at Tatishchevo were removed in 2000 to accommodate deployments of new SS-27 silo-based missiles.

[h] In Russia, the SS-25 is known as the Topol missile. By 27 Nov. 1996, the last SS-25 missiles left in Belarus after the breakup of the Soviet Union, and their warheads, had been shipped back to Russia. Some if not all of these missiles were redeployed in Russia. Deployments of new regiments of SS-25s ended by 1997 as Russia shifted to producing and deploying the follow-on to the SS-25—the Topol-M, or the SS-27 as it is designated by the US Government.

Table 6A.2 *contd*

[i] Flight testing of the SS-27 began on 20 Dec. 1994. Two silo-based SS-27s were put on 'trial service' in Dec. 1997 at the Tatishchevo missile base near Saratov in south-western Russia. One regiment of 10 missiles was declared operational in Dec. 1998 and a second regiment with another 10 missiles in Dec. 1999. A third regiment was activated in late Dec. 2000, but with only 4 missiles out of the planned 10 (and 1 of these may have not been fully operational) because of a cut in the anticipated funding for 2000, bringing the total to 24. The SS-27s are housed in former SS-19 and SS-24 silos at Tatishchevo. In 1998 the Strategic Rocket Forces had intended to deploy 20-30 SS-27s a year over the next 3 years and 30–40 a year for 3 years after that, but deployments have fallen far short of this schedule. The change in priority in Russian defence spending from nuclear to conventional forces discussed in 2000 suggests that higher deployment rates may not materialize; only some 60–80 may be deployed by the end of 2005. Six ICBM launches took place in 2000: on 9 Feb. the 10th and supposed final test launch of the SS-27 was conducted; on 26 Sep. the first training launch of a silo-based SS-27 from Plesetsk, and a SS-18 launch from Baikonur carrying commercial satellites, provided significant performance information (which allowed the Strategic Rocket Forces to extend the SS-18s service life to 24 years); on 27 Sep. the first launch of a mobile SS-27; on 11 Oct. a launch of a 16-year-old SS-25 (which indicated that the service life of SS-25 missiles could be extended by 1 year); and on 1 Nov. 1 SS-19 was fired to verify the ability to deploy a single warhead on a downloaded SS-19 as permitted by the START II Treaty. According to the Strategic Rocket Forces, mobile SS-27s are to be deployed by the end of 2002 or the beginning of 2003.

[j] The Sep. 1990 START I Treaty MOU listed 62 SSBNs. By the end of 2000 only some 17 are assessed to remain operational: 7 Delta IIIs, 7 Delta IVs and 3 Typhoons. All Yankee, Delta I and Delta II submarines have been withdrawn from operational service. Of the original 6 Typhoon submarines, 1 was being scrapped in 2000, another is non-operational, and a third may be out of service. Unless further funding is found or a replacement for the ageing SS-N-20 missiles is developed, most or all of the remaining Typhoons may be retired. Of the 14 Delta IIIs, 6 have been removed from service and 1 has been converted to a deep submergence rescue vehicle (DSRV) carrier. The 5 remaining Delta IIIs in the Pacific Fleet were to be retired in 2000, but in 1999 it was decided to extend their operations until 2005. In 1999, in order to keep the Delta IVs in service, it was decided to restart the SS-N-23 production line. Since this is proceeding slowly, steps are also being taken to extend the service life of the deployed SS-N-23s. Operational SSBNs in the Northern Fleet are based on the Kola Peninsula (at Nerpichnya and Yagelnaya) and in the Pacific Fleet at Rybachiy, 15 km south-west of Petropavlovsk on the Kamchatka Peninsula. Test launches of SLBMs in 2000 included: on 27 Mar. the Delta IV Class submarine *Karelia* fired 2 SS-N-23s, and on 27 Dec. the Delta IV Class submarine *Novomoskovsk* launched a SS-N-23. From 1991 to 1999 Russian SSBN patrols (along with nuclear-powered general-purpose submarine patrols) fell dramatically, as shown below.

Russian strategic (SSBN) and general-purpose (SSN/SSGN) submarine patrols per year, 1991–2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SSBNs	37	28	19	19	14	12	13	11	7	6
SSN/SSGNs	18	9	13	14	13	14	11	13	9	3
Total	*55*	*37*	*32*	*33*	*27*	*26*	*24*	*24*	*16*	*9*

Source: US Navy, Office of Naval Intelligence, Memos on 'Russian strategic and general purpose nuclear submarine patrols covering 1991–2000', released under the Freedom of Information Act to Center for Energy and Environmental Studies, Princeton University.

The keel of a new Borey Class SSBN was laid in Nov. 1996. Construction has been intermittent and was suspended altogether in 1998 while the submarine was redesigned to accommodate a new SLBM. The Russian Navy hopes to have it in commission by 2005, but it is not

certain if it will be finished by then. Despite the Russian Navy's interest in maintaining an SSBN fleet, the future of the Russian SSBN force remains very much in doubt.

[k] In 2000 President Putin's announcement that Russia is interested in negotiating a START III treaty with limits of 1500 or fewer strategic warheads and decisions that led to a shift of resources from nuclear to conventional forces underscored the likelihood that Russia's strategic forces will continue to decline.

[l] Assessing the composition and number of Russian non-strategic forces is very difficult. The estimates provided are derived from President Mikhail Gorbachev's (Oct. 1991) and President Boris Yeltsin's (Jan. 1992) announcements on planned non-strategic force reductions, and from various updates regarding dismantlements and platform number changes since then (e.g., the number of nuclear-capable ships in the Russian Navy has declined from *c.* 400 in 1990 to *c.* 140 in 2000). Most if not all the army, navy and air defence non-strategic nuclear weapons are thought to be consolidated at regional or central storage sites since the Gorbachev and Yeltsin initiatives were supposed to be completed in 2000 (since President Bush did not respond to President Gorbachev's offer to consolidate aircraft bombs in central storages, air force weapons may still be in front-line storages servicing tactical or medium-range bomber bases). All ground force nuclear weapons were supposed to have been eliminated by the end of 2000, but several thousand more tactical nuclear weapons may be being retained as spares or as a reserve for redeployment, or have been retired and are awaiting dismantlement.

[m] Under the Gorbachev and Yeltsin initiatives, non-strategic nuclear weapons were removed from ships and submarines and placed in regional or central storages. Any nuclear weapons deployed on naval aircraft or at front-line storages servicing naval airbases were also to be placed in regional or central storages.

Sources: START I Treaty MOU, 1 Sep. 1990, 5 Dec. 1994, 1 July 1995, 1 Jan. 1996, 1 July 1996, 1 Jan. 1997, 1 July 1997, 1 Jan. 1998, 1 July 1998, 1 Jan. 1999, 1 July 1999, 1 Jan. 2000, 1 July 2000, 31 Jan. 2001; International Institute of Strategic Studies, *The Military Balance 2000/2001* (Oxford University Press: Oxford, 2000); *Strategic Nuclear Forces*, Volume 1 of *Russia's Arms and Technologies, the XXI Century Encyclopedia* (Arms and Technologies Publishing House: Moscow, 2000); *Jane's Fighting Ships, 2000–2001* (Jane's Information Group: Coulsdon, 2000)*; Combat Fleets of the World 2000–2001* (Naval Institute Press: Annapolis, Md., 2000); US Navy, Office of Naval Intelligence, Memos on 'Russian strategic and general purpose nuclear submarine patrols covering 1991–2000', released under the Freedom of Information Act to Center for Energy and Environmental Studies, Princeton University; Podvig, P. L. (ed.), *Strategicheskoye Yadernoye Vooruzhniye Rossii* [Russian strategic nuclear weapons] (IzdAT: Moscow, 1998); 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

Table 6A.3. British nuclear forces, January 2001[a]

Type	Designation	No. deployed	Year first deployed	Range (km)	Warheads x yield	Warheads in stockpile
SLBMs[b]						
D-5	Trident II	48	1994	> 7 400[c]	1–3 x 100 kt[d]	185[e]

[a] In July 1998 the Labour Government announced the results of the Strategic Defence Review (SDR). The decisions with regard to the British nuclear forces were:

1. Only 1 SSBN will be on patrol at any time, carrying a reduced load of 48 warheads—half the Conservative Government's announced ceiling of 96.

2. The submarine on patrol will be at a reduced alert state and will carry out a range of secondary tasks; its missiles will be detargeted, and after notice the SSBN will be capable of firing its missiles within several days rather than within several minutes, as during the cold war.

Table 6A.3 *contd*

3. There will be fewer than 200 operationally available warheads, a one-third reduction from the Conservative Government's plans.

4. The number of Trident II (D-5) missiles already purchased or ordered was reduced from 65 to 58.

As a result of these decisions the total explosive power of the operationally available weapons will be reduced by almost 70% compared to the force level planned under the Conservative Government. The explosive power of each Trident submarine will be one-third less than that carried on the Chevaline-armed Polaris submarines, the last of which was retired in 1996.

The Royal Air Force (RAF) operated 8 squadrons of dual-capable Tornado GR.1/1A aircraft. At the end of Mar. 1998, with the withdrawal of the last remaining WE-177 bombs from operational service, the nuclear role of the Tornado was terminated, bringing to an end a 4-decade-long history of RAF aircraft carrying nuclear weapons. By the end of Aug. 1998 the remaining WE-177 bombs had been dismantled. The *c*. 40 Tornadoes currently at RAF Bruggen in Germany will be reassigned to RAF Lossiemouth and RAF Marham in the UK by the end of 2001, and the base at Bruggen will be closed.

In 2000 the Ministry of Defence (MOD) awarded a contract for operation of the Atomic Weapons Establishment (AWE) to an industrial consortium consisting of Lockheed Martin, Serco Limited and British Nuclear Fuels. The 10-year contract is for £2.2 billion ($3.6 billion). On 1 Apr. 1999 the Chief of Defence Logistics assumed overall responsibility for the routine movement of nuclear weapons within the UK. Day-to-day duties are being transferred, in phases, from RAF personnel to the MOD Police, with support from AWE civilians and the Royal Marines. The process will occur gradually and be completed by 31 Mar. 2002.

[b] The first Trident submarine, the HMS *Vanguard*, went on its first patrol in Dec. 1994. The second submarine, *Victorious*, entered service in Dec. 1995. The third, *Vigilant*, was launched in Oct. 1995 and became operational in the autumn of 1998. The fourth and final submarine of the class, *Vengeance*, was launched on 19 Sep. 1998, commissioned on 27 Nov. 1999 and deployed on its first patrol in Feb. 2001. The Vanguard Class submarine has a total complement of 205 to provide a Ship's Company of 130 for a patrol. The current estimated cost of the programme is $18.8 billion.

Each Vanguard Class SSBN carries 16 US-produced Trident II (D-5) SLBMs. There are no specifically US or British Trident II missiles but a pool of SLBMs at the Strategic Weapons Facility Atlantic at the Kings Bay Submarine Base, Georgia. The UK has title to 58 SLBMs but does not actually own them. A missile that is deployed on a US SSBN may at a later date deploy on a British one, or vice versa. British SSBNs conduct their missile flight tests at the US Eastern Test Range off the coast of Florida. The *Vanguard* conducted 2 successful Demonstration and Shakedown Operations (DASO) in May and June 1994, launching 2 Trident II (D-5) missiles. The *Victorious* held DASOs in July and Aug. 1995, with 2 missiles fired. In Oct. 1997 the *Vigilant* launched 2 missiles during 2 DASOs, and on 21 Sep. 2000 the *Vengeance* launched a missile during a single DASO exercise.

Of the 4 SSBNs, 1 is normally on patrol at any given time; 2 more submarines are undergoing training in port or in local waters and could be deployed with relatively short warning. A fourth submarine is undergoing repair and maintenance and would require significantly longer preparation to be able to deploy. During transit to and from its patrol area, each SSBN is protected by 1 or 2 attack submarines (SSNs), but in the autumn of 2000 the Royal Navy briefly withdrew all its SSNs from service after the *Tireless* suffered a reactor malfunction. While the submarines were being checked for similar reactor problems, other ASW assets such as frigates, ASW helicopters and maritime patrol aircraft were used to sanitize SSBN

transit areas around the shallow waters of the Irish Sea. British SSBN patrols are thought to be coordinated with the operations of French SSBNs.

[c] The range can be extended by reducing the number of RVs. In its 'sub-strategic' configuration, e.g., a missile carrying a single warhead, it would have a range of more than 10 000 km.

[d] British SLBMs are thought to carry a variation of the US W76 warhead designed for the Trident I (C-4) and Trident II (D-5), enclosed in a US Mk-4 RV.

[e] Several factors enter into the calculation of the number of warheads that will be in the future British stockpile. It is assumed that the UK will produce only enough warheads for 3 boatloads of missiles, a practice it followed with the Polaris. As stated in the SDR, there will be 'fewer than 200 operationally available warheads' in the stockpile and no more than 48 warheads per SSBN. The government also stated that it will be the practice that normally only 1 SSBN will be on patrol, with the other 3 in various states of readiness.

A further consideration is the 'sub-strategic mission'. An MOD official described it as follows: 'A sub-strategic strike would be the limited and highly selective use of nuclear weapons in a manner that fell demonstrably short of a strategic strike, but with a sufficient level of violence to convince an aggressor who had already miscalculated our resolve and attacked us that he should halt his aggression and withdraw or face the prospect of a devastating strategic strike' (*RUSI Journal,* 1996). The sub-strategic mission has begun with the *Victorious* and 'will become fully robust when *Vigilant* enters service', according to the 1996 White Paper. The *Vigilant* achieved Operational Availability on 1 Feb. 1998. If this has remained the policy, then some Trident II SLBMs already have a single warhead and are assigned targets once covered by WE-177 gravity bombs. E.g., when the *Vigilant* is on patrol, 10, 12 or 14 of its SLBMs may carry up to 3 warheads per missile, while the other 2, 4 or 6 missiles may be armed with just 1 warhead. There is some flexibility in the choice of yield of the Trident warhead. (Choosing to only detonate the unboosted primary could produce a yield of 1 kt or less. Choosing to detonate the boosted primary could produce a yield of a few kilotons.) With these 2 missions an SSBN would have *c.* 36–44 warheads on board during its patrol.

The table assumes that the British stockpile for the SSBN fleet is *c*. 160 warheads. With an additional 15% for spares, the total stockpile is estimated to contain some 185 warheads. At any given time the sole SSBN on patrol will carry *c*. 40 warheads. The second and third SSBNs can be put to sea fairly rapidly, with similar loadings, while the fourth might take longer because of its cycle of overhaul and maintenance.

Sources: MOD, *Defence White Paper 1999*, Cm 4446 (Stationery Office: London, 1999); MOD press releases and Web site URL <http://www.mod.uk/policy/wp99/press.htm>; British Ministry of Defence (MOD), *Strategic Defence Review* (MOD: London, July 1998); MOD, *Statement on the Defence Estimates 1996,* Cm 3223 (Her Majesty's Stationery Office: London, 1996); Ormond, D., 'Nuclear deterrence in a changing world: the view from a UK perspective', *RUSI Journal*, June 1996, pp. 15–22; Norris, R. S. *et al., Nuclear Weapons Databook Vol. V: British, French, and Chinese Nuclear Weapons* (Westview: Boulder, Colo., 1994), p. 9; British House of Commons, *Parliamentary Debates (Hansard)*; 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

Table 6A.4. French nuclear forces, January 2001[a]

Type	No. deployed	Year first deployed	Range (km)[b]	Warheads x yield	Warheads in stockpile
Land-based aircraft[c]					
Mirage 2000N	60	1988	2 750	1 x 300 kt ASMP[d]	50[d]
Carrier-based aircraft[e]					
Super Étendard	24	1978	650	1 x 300 kt ASMP	10
SLBMs[f]					
M4A/B	16	1985	6 000	6 x 150 kt	96[g]
M45	32	1996	6 000	6 x 100 kt	192
Total					**348**

[a] In Feb. 1996 President Jacques Chirac announced several reforms for the French armed forces, including the nuclear forces, for the period 1997–2002. This involved a combination of withdrawing several systems and modernizing others. The most significant development concerned the decision not to replace the silo-based S3D IRBM and hence to eliminate land-based missiles as a component of the nuclear forces. All 18 missiles on the Plateau d'Albion were deactivated on 16 Sep. 1996; it took 2 years and cost $77.5 million to fully dismantle the silos and the complex. After the land-based missiles had been deactivated, Chirac stated during his visit to Moscow in Sep. 1997 that 'no part of the French nuclear deterrent force is any longer targeted'. Other recent actions include completion of the dismantlement of the South Pacific test facilities at Mururoa and Fangataufa. France ceased producing plutonium for weapons in 1992 and HEU in 1996. It has closed down and pledged to dismantle the Marcoule reprocessing plant and the Pierrelatte enrichment plant, actions it began in 1998. Funding for France's nuclear deterrent is expected to remain fairly steady in 2001, at FFr 15.8 billion ($2.3 billion), although future expenditure may drop.

[b] Range for aircraft assumes combat radius, without in-flight refuelling, and does not include the 300-km range of the Air-Sol Moyenne Portée (ASMP) air-to-surface missile.

[c] Three squadrons with 60 Mirage 2000Ns currently have nuclear roles. Two of these (*Dauphine* and *La Fayette*) are based at Luxeuil and the third (*Limousin*) at Istres. Since the 1991 Gulf War, in which France was unable to use the night-attack capability of the then nuclear-only Mirage 2000N, the aircraft has been given some conventional capability to increase its utility. However, in a speech in May 1994 President François Mitterrand identified the 'N' in Mirage 2000N as standing for nuclear ('Mirage 2000N, c'est-à-dire nucleaires') and Dassault, the producer of the aircraft, states on its Internet site that the 'primary assignment' of the Mirage 2000N remains the nuclear strike role.

The predecessor to Mirage 2000N, the Mirage IVP, was converted from its nuclear role in July 1996 and retired after 32 years of service. The Mirage IVP's ASMP missiles may have been reassigned to the Mirage 2000N. Five Mirage IVPs were retained for reconnaissance missions and are in the 1/91 Gascogne squadron at Mont-de-Marsan. The other aircraft were put into storage at Châteaudun.

The Mirage will eventually be replaced by the Rafale (B-301), which is planned to be the multi-purpose navy and air force fighter-bomber for the 21st century. Its roles include conventional ground attack, air defence, air superiority and nuclear delivery of the ASMP and/or ASMP-A. The navy version (Rafale M) will enter the inventory in 2001 to form Squadron 12F at Landivisiau and within a couple of years enter service onboard the *Charles de Gaulle* replacing the Super Étendard. The air force's Rafale D will attain a nuclear strike role in about 2005. The Air Force still plans to buy a total of 234 Rafales.

[d] The ASMP is equipped with a single TN-81 warhead. It is estimated that France has *c.* 60 operational ASMPs but additional missiles may be in inactive storage. There are con-

flicting reports about the inventory of missiles and warheads. A report from the French Senate stated in 1991 that France initially produced 80 warheads and 90 ASMP missiles. In May 1994, however, when 15 Mirage IVPs (plus 3 spares) still had nuclear roles and only 45 Mirage 2000Ns were operational, President François Mitterrand identified 60 ASMP missiles for use by both air force and navy aircraft. He did not disclose the number of warheads, however, and used slightly different language to describe the number of missiles assigned to the different types of aircraft. For the Mirage IVP, he gave a fixed number, saying 'we possess 15 missiles ('nous disposons de quinze missiles'). For the Mirage 2000N/Super Étendard aircraft, however, the number was less precise, namely, 'these forces possess 45 missiles' ('les forces disposent de quarante-cinq missiles'), indicating that the exact number may be dependent on the number of operational aircraft. Since then an additional 15 Mirage 2000Ns have become operational.

A longer-range ASMP (500 km as opposed to 300 km), sometimes called the 'ASMP Plus' (the official name is ASMP Amélioré, ASMP-A), is expected to enter service in 2007. The ASMP-A may be equipped with a modified warhead designated the TNA (tête nucléaire aeroportée) .

[e] France built 3 aircraft carriers, the first of which entered service in 1961 (*Clemenceau*) and the second in 1963 (*Foch*). Both were modified to handle the AN 52 nuclear gravity bomb with Super Étendard aircraft. The AN 52 was retired in July 1991. The *Foch* was modified in 1981 to 'handle and store' the ASMP, and *c.* 20 were allocated for 2 squadrons—*c.* 24 Super Étendard aircraft. The *Foch* is thought to have routinely carried nuclear weapons until it was decommissioned. The new 40 500-ton aircraft carrier *Charles de Gaulle*, which has a crew of 1850, can accommodate 35–40 aircraft. Until the first Rafale M squadron is introduced in 2002, the ship will carry a single squadron of Super Étendards (presumably therefore with *c.* 10 ASMPs). The Navy plans to purchase a total of 60 Rafale Ms, of which the first 16 will perform an air-to-air role. Missions for subsequent aircraft may include the ASMP and/or the ASMP Plus. The first 10 Rafale Ms are scheduled to be delivered in 2002, and *c*. 40 aircraft may be delivered as 2-seaters.

The *Charles de Gaulle* has been commissioned but its full operability remains hampered by technical problems. It was previously scheduled to become operational at the end of 1999 but suffered a propeller failure during sea trial in Nov. 2000, which has delayed its delivery until Apr. 2001, almost 5 years behind schedule. France has spent over FFr 20 billion ($2.8 billion) on the *Charles de Gaulle*, or over FFr 7 billion ($1 billion) more than its initial estimate of FFr 13 billion ($1.8 billion) in 1987. Another FFr 50 billion ($7.1 billion) has been spent on 60 Rafale Ms and 3 E2C Hawkeye aircraft. France is currently considering whether to include funding for a second carrier in its 2003–2008 defence spending plan. It is possible that the second carrier will be built with a non-nuclear propulsion system.

[f] France has in operation 4 SSBNs of 3 classes: 2 of the new Triomphant Class SSBNs, 1 L'Inflexible Class SSBN and 1 Redoubtable Class SSBN. The 2 Triomphant SSBNs each carry 16 M45 SLBMs with 6 of the new TN-75 warheads, which are thought to have been tested at the Mururoa test site in 1995. *Le Triomphant* (S616) was rolled out from its construction shed in Cherbourg on 13 July 1993 and became operational in Sep. 1996. The second SSBN, *Le Téméraire* (S617), which was commissioned in Dec. 1999, some 6 months behind schedule, successfully test launched an M45 missile in May 1999. The schedule for the third submarine, *Le Vigilant* (S618), has slipped and it will not be ready to launch until 2002 and commission in July 2004. FFr 1.9 billion ($256.5 million) was allocated for the fourth SSBN (S619) in Sep. 2000, which is scheduled to become operationally available in about 2008. The total cost of the Triomphant Class programme is estimated at FFr 96.3 billion ($13 billion).

Until recently, the 2 older SSBNs both carried 16 M4 SLBMs. Faced with the delay of the third Triomphant SSBN, however, France has begun refitting the *L'Inflexible* to carry the newer M45 SLBM. The refit is a necessary, albeit expensive, solution to match a reduced inventory of only 3 sets of SLBMs (2 M45 and 1 M4). Without this refit France would, in certain situations, only have been able to deploy 2 SSBNs as opposed to 3. The remaining M4-

Table 6A.4 *contd*

equipped SSBN, *Le Foudroyant*, was refitted to carry the M4 in 1993. This system is widely reported to be armed with TN-70 or TN-71 warheads, although the French Ministry of Defence Internet site now credits the M4 with only the TN-71.

President Chirac announced on 23 Feb. 1996 that a new SLBM, known as the M51, will replace the M45. The service entry date has been advanced to 2008 instead of 2010 to coincide with the commissioning of the fourth Triomphant Class SSBN, and the M51 is expected to have a range of 8000–10 000 km and carry up to 6 warheads each. The M51, which is a modified version of the cancelled M5, will eventually arm all 4 SSBNs. The M51 was initially planned to carry an entirely new type of warhead (TNO, tête nucléaire océanique), but the combination of costs, changing strategic requirements and the cessation of nuclear weapon testing means that the missile will instead be equipped with a more robust version of existing designs. A dispute over increased costs briefly brought M51 development to a halt in the autumn of 2000 and efforts to control costs may force changes to the specifications of the missile. The first flight test is scheduled for 2005.

[g] France is thought to already have transitioned to an operational inventory of 288 warheads for 2 sets of M45 SLBMs and 1 set of M4 SLBMs, enough to arm 3 of 4 SSBNs. A lower number of missiles than launch-tubes were also the case when there were 5 submarines in the fleet, at which point only 4 sets of M4 SLBMs were procured. Of the 4 submarines, 3 are maintained in the operational cycle, although only 1 or 2 are normally 'on station' in designated patrol areas at any given time, compared with 3 in the early 1990s.

The SSBN force is organized under the Oceanic Strategic Task Force (Force Océanique Stratégique, FOST) and homeported at the Île Longue base in Brest. The Navy has recently reorganized its submarine fleet and will in the future base all its submarines (including SSNs formerly at Toulon) at Brest. Under this reform the SSBN command centre at Houilles (Yvelines) will also be relocated to Brest, although communication facilities at Rosnay (Indre) will continue. Communication with SSBNs on patrol is also maintained with 4 C-160H Astarté communication relay aircraft.

French SSBNs are protected during their operations by nuclear attack submarines, maritime patrol aircraft (Atlantique 2), anti-submarine frigates and minesweepers. SSBN protection will also be an important mission for the planned Barracuda Class SSN. Like the SSBNs, French attack submarines each have 2 crews to optimize their operational availability. In late 2000 France also detected increased levels of radioactivity in the cooling water of its Rubis Amethyste Class SSN *Saphir*. The submarine was operating in the Mediterranean Sea when it was recalled to have its nuclear core replaced. It is unclear whether French SSBNs have similar reactor problems.

Sources: French Ministry of Defence, 'Activities of the naval forces', Fact Sheet, n.d. [2000], URL <http://www.defense.gouv.fr/marine/anglais/present/dim2000/e_missions2.htm>; French Ministry of Defence, 'Nuclear disarmament and non-proliferation', *Arms Control, Disarmament and Non-Proliferation: French Policy* (La Documentation française: Paris, 2000), chapter 3, pp. 36–56; Tertrais, B., International Institute for Strategic Studies, *Nuclear Policies in Europe,* Adelphi Paper 327 (Oxford University Press: New York, Mar. 1999), p. 16; International Institute for Strategic Studies, *The Military Balance 1999/2000* (Oxford University Press: Oxford, 1999), pp. 52–55; Address by M. Jacques Chirac, President of the Republic, at the École Militaire, Paris, 23 Feb. 1996; Assemblée Nationale, *Projet de loi relatif à la programmation militaire pour les années 1997 à 2002,* no. 2766 (20 May 1996), section 2.3.4, Evolution de l'équipement des forces armées (1996–2002), p. 45; Intervention de Monsieur François Mitterrand sur la Politique Française de Dissuasion [Statement by Mr François Mitterrand on French deterrent policy], Palais de l'Elysée, 5 May 1994, pp. 4–5; Norris, R. S. *et al.*, *Nuclear Weapons Databook, Vol. V: British, French, and Chinese Nuclear Weapons* (Westview: Boulder, Colo., 1994), p. 10; *Air Actualités*, various issues; 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

Table 6A.5. Chinese nuclear forces, January 2001[a]

Type	NATO designation	No. deployed	Year first deployed	Range (km)[b]	Warheads x yield	Warheads in stockpile
Aircraft[c]						
H-6	B-6	120	1965	3 100	1–3 bombs	120
Q-5	A-5	30	1970	400	1 x bomb	30
Land-based missiles[d]						
DF-3A[e]	CSS-2	40	1971	2 800	1 x 3.3 Mt	40
DF-4	CSS-3	20	1980	5 500	1 x 3.3 Mt	20
DF-5A[f]	CSS-4	20	1981	13 000	1 x 4–5 Mt	20
DF-21A[g]	CSS-5	48	1985–86	1 800	1 x 200–300 kt	48
SLBMs[h]						
Julang I	CSS-N-3	12	1986	1 700	1 x 200–300 kt	12
Non-strategic weapons[i]						
Artillery/ADMs, Short-range missiles					Low kt	120
Total						**~ 410**

[a] The Pentagon stated in 2000 that China does not seem to have aspirations for a large strategic force. Although modernizations are under way, 'their strategic force is really quite small'. A 1999 estimate by the US intelligence community concludes that by 2015 China will probably have added 'a few tens' of more survivable land- and sea-based mobile missiles with smaller warheads and 'tens of missiles' will be targeted against the USA. Rumours that China has deployed nuclear weapons in Tibet have not been confirmed.

[b] Range for aircraft indicates combat radius, without in-flight refuelling.

[c] All figures for bomber aircraft are for nuclear-configured versions only. Hundreds of aircraft are also deployed in non-nuclear versions. The table assumes 150 bombs for the bomber force, with yields estimated between 10 kt and 3 Mt.

The Chinese bomber force is antiquated, based on Chinese-produced versions of 1950s-vintage Soviet aircraft. With the retirement of the H-5, a copy of the Soviet Il-28 Beagle medium-range bomber, the main bomber is the H-6. This aircraft is based on the Soviet Tu-16 Badger medium-range bomber, which entered service with Soviet forces in 1955. China began producing the H-6 in the 1960s. It was used to drop weapons in 2 nuclear tests, a fission bomb in May 1965 and a multi-megaton bomb in June 1967. For more than a decade China has been developing a supersonic fighter-bomber, the H-7 (or FB-7), at the Xian Aircraft Company. The aircraft is not believed to have a nuclear mission.

Modernization of the Chinese bomber force occurs partly through purchase of aircraft from abroad. China purchased 40 Su-30 multi-role aircraft from Russia in 1999 at a price of $2 billion. As of Oct. 2000 the aircraft had not been delivered. China also ordered 22 Su-27s in 1995, at about $710 million. This group is based at Suixi, in Guangdong Province. Another 24 Su-27SK and 2 Su-27UBK fighters were purchased in the early 1990s at a cost of $1 billion. These aircraft are currently with the 3rd Air Division at Wuhu airfield, 250 km west of Shanghai, and participated in the 'Strait 96' exercise in the Taiwan Strait in Mar. 1996. Under a separate agreement Russia sold production rights to China to assemble and produce Su-27s in China at the Shenyang plant, with Russian engineers ensuring quality control. The initial 2 aircraft first flew in Dec. 1998. The People's Liberation Army Air Force (PLAAF) has a requirement for 200 Su-27s, which will take until at least 2015 to acquire under existing schedules. The Su-27 has an air-to-ground capability, but there is no evidence at this time that the PLAAF is modifying it for a nuclear role. It is not believed to have an in-flight refuelling capability.

Table 6A.5 *contd*

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

In addition to the missiles listed in the table, the DF-31 is believed to be in the final stages of development. A 1999 report that DF-31 had been deployed in southern China has not been confirmed. The DF-31 is a 3-stage, solid-propellant, mobile ICBM with a range of *c*. 8000 km and has a CEP of 0.3–0.5 km. The DF-31 has been flight tested 3 times, the latest on 4 Nov. 2000 with several decoy warheads. The flight path was much shorter than the missile's estimated range of 8000 km. The second test took place in the spring of 2000. The first flight test was conducted from Wuzhai, 400 km south-west of Beijing, on 2 Aug. 1999; a dummy warhead and several decoys were used, according to one report. It is predicted that garrison deployment of the DF-31 will take place between 2005 and 2010 and that the missile will be targeted primarily against Russia and Asia. One report also states that the DF-31 underwent tests in Oct. 1997 that simulated launching the missile from submarine tubes. A variant of the missile is believed to be under development to arm the new Type 094 Class SSBN. There were media reports of a simulated test of the DF-41 in 1999, but this missile is thought to have been cancelled. Instead, the test may have involved a new road-mobile, solid-propellant ICBM currently in development, which the CIA has said is likely to be tested 'within the next several years' and targeted primarily against the USA.

The nuclear capability of the 600-km range M-9 (CSS-6) and the 300-km range M-11 (CSS-7) is unconfirmed. The Taiwanese Defence Minister has specifically referred to the M-9 and M-11 as nuclear-capable. One regiment-size M-9 unit is deployed in south-eastern China and may soon be augmented by an additional unit. An improved M-11 Mod 2 was displayed in a military parade on 1 Oct. 1999 in Beijing. There is also a 150-km range road-mobile CSS-8 with a solid-fuel first stage and a liquid-fuel second stage. Taiwanese officials report that the number of M-type missiles in China's 3 southern provinces has risen from 30–50 to 160–200 since 1997.

Allegations of Chinese theft of US nuclear warhead designs have fuelled speculation that China may soon deploy missile systems with multiple warheads. China has had the technical capability to develop MRV payloads for 20 years. An MRV system releases 2 or more RVs along the missile's linear flight path to a single target, landing in a relatively confined area at about the same time. The more sophisticated and flexible MIRV system can manoeuvre multiple RVs to several different release points to provide targeting flexibility against several independent targets over a much wider area and over a longer time span. If China needed an MRV capability in the near term, according to the CIA, one option might be to use a DF-31-type RV to develop and deploy a simple MRV or MIRV capability on the DF-5 in a few years. Multiple warheads on the DF-31, however, would probably require a new, smaller warhead, and a future mobile MIRVed missile would be many years away. Many expect that US deployment of an advanced missile defence system will stimulate Chinese efforts to deploy a multiple-warhead system in an attempt to ensure the continued effectiveness of its nuclear deterrent.

[e] The DF-3/CSS-2 missile has been deployed for more than 25 years and is being gradually retired. The DF-3 is deployed in Dalong, Datong, Dengshahe, Ching-yu, K'un-ming, Lianxiwang, Tonghua and Yidu. The 2-stage, liquid-fuelled missile is deployed in a silo and transportable mode.

[f] The liquid-fuelled DF-5/CSS-4 is deployed in a silo. The number of missiles varies among reports. A US Defense Department report from June 2000 said that China has built 18 DF-5 silos, while a July 2000 news report suggested a total force of 24. The US National Air Intelligence Center stated that as of 1998 the deployed DF-5 force consisted of 'fewer than 25' missiles. A CIA report leaked to *The Washington Times* shortly before President Clinton's visit to China in June 1998 assessed that 13 of the missiles were targeted at the USA. A senior administration official subsequently said that China does not keep its nuclear warheads mounted on top of its missiles but keeps them in storage separate from the missiles. The DF-5

is deployed in Hsuan-hua, Lo-ning and Shuangjiang.

[g] The DF-21/CSS-5 is a 2-stage solid-propellant missile carried in a canister on a TEL. The improved Mod 2 version is not yet deployed. The DF-21 are deployed in Ching-yu, Chuxiong, Datong, Liangkengwang and Tonghua.

[h] China has had great difficulty in developing SSBNs and SLBMs. It has only 1 operational Xia Class (Project 092) SSBN. The single existing submarine, which participated in a naval exercise in Dec. 2000 but may never have achieved full operational capability, was built at Huludao Naval Base and Shipyard in the northern Bohai Gulf and was launched in Apr. 1981. The Julang I SLBM was initially test launched from a Golf Class diesel submarine in late 1982 and a full-scale submerged launch from the Xia took place in 1988. The following year the Xia was deployed to the Jianggezhuang Submarine Base, where the nuclear warheads for its Julang I missile are believed to be stored. The Xia began a major refit in 1995 and is not thought to have ever sailed beyond China's regional waters.

A second Xia Class submarine was begun but never finished. US sources say that a new SSBN project, designated Project 094, has begun. The first submarine is said to have begun construction, and 3–5 more may be planned, according to US Navy sources, although this prediction may be highly speculative. The new class is expected to carry 16 3-stage Julang II SLBMs, a variant of the DF-31 ICBM. The CIA expects the missile to be tested 'within the next decade'. Given previous difficulties in developing a sea-based deterrent and the lack of a multiple-warhead system on land, deployment of the Project 094 system may be many years away. The new Julang (Giant Wave) may have a range of up to 8000 km and is estimated by the CIA to 'probably' be able to target the USA from launch areas near China. A report in 1999 that the Xia Class SSBN may be upgraded to launch the Julang II has not been confirmed.

[i] Information on Chinese non-strategic nuclear weapons is limited and contradictory, and there is no confirmation of their existence from official Chinese sources. Several low-yield nuclear tests conducted in the late 1970s and a large military exercise in June 1982 simulating the use of non-strategic nuclear weapons suggest that they may have been developed. According to the US Defense Intelligence Agency (DIA), non-strategic weapons may consist of ADMs (which essentially are nuclear landmines), aircraft bombs and short-range ballistic missiles. The latter includes the DF-15 (CSS-6) and DF-11 (CSS-X-7) SRBMs, both of which were deployed in 1995, and are solid-fuelled and dual-capable. The DF-15 has a range of 200–600 km and may carry a 10-kt neutron warhead or a 20-kt warhead. The DF-11 is thought to have a range of 200–300 km. The exact number of SRBMs is not known, but estimates range from 100 to 300 DF-15s and from 40 to 100 DF-11s. In 1984 the DIA did not believe that Chinese ground forces had been equipped with artillery-fired nuclear projectiles, although this capability could have been added later.

China is also developing long-range cruise missiles with ranges of 1500–2500 km. A missile programme known as X-600 appears to be based partly on Russian and US cruise missile designs. Although there is speculation about a possible nuclear capability for 1 of the systems, none has been confirmed. Other cruise missiles include the SS-N-22 missiles on 2 Russian-built Sovremenny destroyers that China has purchased. In the Russian Navy the SS-N-22 is credited with a nuclear capability, but there are no reports that China plans to equip the missile with a nuclear warhead.

Sources: US Department of Defense, Office of the Secretary of Defense, 'Proliferation: threat and response', Washington, DC, Jan. 2001, URL <http://www.defenselink.mil/pubs/ptr20010110.pdf>; Department of Defense, Report to Congress Pursuant to the FY2000 National Defense Authorization Act, 'Annual Report on the Military Power of the People's Republic of China', June 2000, URL <http://www.defenselink.mil.news/Jun2000/china06222000.html>; Moore, F. W., *China's Military Capabilities* (Institute for Defense and Disarmament Studies: Cambridge, Mass., June 2000), URL <http:www.comw.org/cmp/fulltext/iddschina.html>; Kan, S. A. *et al.,* Congressional Research Service (CRS) Report for Congress, *China's Foreign Conventional Arms Acquisitions: Background and Analysis*

Table 6A.5 *contd*

(Library of Congress: Washington, DC, 10 Oct. 2000); US State Department International Information Programs, *Pentagon Spokesman's Regular Briefing,* 12 Dec. 2000; Baker III, A. D., 'Combat fleets', *US Naval Institute Proceedings*, Dec. 2000, p. 90; US Department of Defense, National Air Intelligence Center (NAIC), *Ballistic and Cruise Missile Threat* (NAIC: Wright-Patterson Air Force Base, Ohio, Apr. 1999); Norris, R. S. *et al., Nuclear Weapons Databook Vol. V: British, French, and Chinese Nuclear Weapons* (Westview: Boulder, Colo., 1994); US Central Intelligence Agency, various documents; 'NRDC Nuclear Notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates. Gee Gee Wong, research assistant with the Nautilus Institute for Security and Stable Development (Berkeley, Calif.), also contributed to this table.

Table 6A.6. Indian nuclear forces, January 2001[a]

Type/Designation	Range (km)[b]	Payload (kg)	Comment
Aircraft[c]			
Jaguar IS/IB/Shamsher	1 600	4 775	At Ambala Air Base
MiG-27 Flogger/Bahadhur	800	3 000	At Hindan Air Base
Missiles[d]			
Prithvi I	150	1 000	May have nuclear role
Agni I	1 500	1 000	Tested but status unclear
Agni II	> 2 000	1 000	Test fired in Jan. 2001

[a] It is very difficult to estimate the size and composition of India's nuclear arsenal, with unofficial and semi-official estimates ranging from a few to 30 nuclear weapons. The US Defense Department estimates that India has a 'small stockpile of nuclear weapons components' and probably can deploy 'a few nuclear weapons' within a few days to a week. An estimate is made here of a stockpile of 20–30 nuclear weapon components.

India is thought to have produced enough weapon-grade fissile material for 45–95 nuclear warheads, and most assessments are that India is expanding its stockpile. The unsafeguarded 100-Megawatt research reactor at Trombay, which reportedly was the source of plutonium for the Pokhran nuclear tests of May 1998, is being accompanied by a second reactor that is expected to become operational in 2010. The Indian Atomic Energy Commission (AEC) stated that the series of 5 nuclear test explosions in May 1998 involved both fission and fusion designs. One of the tests, with a yield of 15 kt, reportedly was a weapon, while the other 4 were various 'weaponizable configurations'. The performance of the hydrogen device and possible use of reactor-grade plutonium in one of the other tests remain unresolved. AEC Chairman R. Chidambaram reassured in Oct. 2000 that the tests were 'completely successful' and provided India with 'the capability to design and fabricate weapons ranging from low yield to around 200 kilotons'.

On 17 Aug. 1999 a widely publicized draft document on Indian nuclear doctrine, prepared by a 27-member National Security Advisory Board, called for the creation of a 'credible minimum deterrent' to be based 'on a triad of aircraft, mobile land-based missiles and sea-based assets'. The Board's recommendations had no official standing, however, and, despite optimistic claims from various military officials and scientists, India only took relatively modest steps in 2000 to bring these plans closer to reality. The National Security Council established in Apr. 1999 to implement a nuclear policy is said to have been virtually dormant, and its important task of setting up a nuclear command and control system reportedly was put on hold in late 2000.

Both the Army and Air Force have been working on fine-tuning their nuclear strategies. In its Vision 2020 blueprint presented to Prime Minister Atal Behari Vajpayee in Nov. 2000, the Indian Air Force recommended creating a Nuclear Air Command that would consolidate the nuclear strike and reconnaissance forces under a Nuclear Air Command, essentially mirroring the creation of the US Strategic Air Command after World War II. Vision 2020 was also said to have recommended a deterrence posture aimed against both China and Pakistan in contrast to the current deterrence of Pakistan but only 'dissuasion' of China. This recommendation followed a Strategic Defense Review (SDR) completed in Sep. 2000, which highlighted China's nuclear and missile developments. Another proposal under consideration in the Cabinet Committee on Security is a proposal from the Chairman of the Chiefs of Staff Committee to create a 3-star general with overall responsibility for land-, air- and sea-based nuclear delivery systems, an arrangement similar to the current US Strategic Command.

Indian Air Chief Marshal Anil Yashwant Tipnis said in Oct. 2000 that 'India is committed to a no-first-use policy for nuclear weapons', but an Indian Foreign Ministry official subsequently told *Defense News* that a ''no first strike' policy does not mean India will not have a first strike capability'. He explained that India was 'working toward having a first strike capability' but that it was a political decision how to exercise this option within the 'no first strike' policy.

In addition to the current dyad of air- and land-based nuclear-capable forces, India is working on at least 2 naval systems that may be equipped to carry nuclear warheads in the future. The submarine-launched Sagarika (Oceanic) missile, which was begun in 1991 and is currently at an advanced stage of development, could be a candidate for an initial sea-based nuclear capability. Sagarika is thought to be a cruise missile with a range of 300 km, although some sources say it may have a ballistic capability. Another potential candidate is the Dhanush (Bow) SLBM, which has been under development since 1983 for possible completion in 2003. A test firing on 11 Apr. 2000 was only a 'partial success' and may delay the programme further. The 8.56-metre long missile, which is a Navy version of the Army's Prithvi (Earth) and capable of carrying a 1000-kg payload to a range of 250 km, was launched from the reinforced helicopter deck of the INS *Subhadra*, a modified patrol vessel anchored some 20 km offshore in the Bay of Bengal. Neither the Dhanush nor the Sagarika has officially been declared nuclear-capable.

A launch platform for a navy nuclear weapon may be the Advanced Technology Vessel (ATV), a nuclear-powered submarine project that has been under way in various stages since at least 1985 and perhaps as early as the 1970s. Design and operational experience was gained from operation of a Charlie I Class cruise missile submarine (named INS *Chakra*) that India leased from the Soviet Union from 1988 to 1991. Full-scale work on the ATV began in 1991, shortly after the INS *Chakra* was returned, and construction started in 1997. A launch date may be scheduled for 2007 at the Mazagon Dockyard in Bombay (design has taken place in Vishakapatnam on the east coast), but technical challenges are likely to delay the ATV further. There were unconfirmed reports in 2000 that India was considering leasing another nuclear submarine from Russia. The ATV is thought to be partly based on the design of the INS *Chakra*, but the reactor is reported to be of Indian design. A land-based prototype reactor has been built. Vice-Admiral R. N. Ganesh, who commanded the INS *Chakra*, was appointed as new director-general of the ATV project in 2000 in an apparent attempt to jump-start the much delayed project.

[b] Range for aircraft indicates combat radius, without in-flight refuelling.

[c] India has several types of aircraft that could be used to deliver a nuclear weapon, and various sources give different estimates. Considerations of range, payload and speed, however, appear currently to narrow the choice to 1 or 2 types.

The most likely Indian aircraft for nuclear weapon delivery is the Jaguar IS/IB, known as the Shamsher (Sword). The Jaguar was nuclear-capable with the British Royal Air Force from 1975 to 1985 and with the French Air Force from 1974 to 1991. Originally a joint Anglo-French aircraft, the first 40 were supplied by British Aerospace, with the remaining 91

Table 6A.6 *contd*

assembled or manufactured by Hindustan Aeronautics. With a gross weight of 15 450 kg the aircraft has a range of 1600 km with a maximum external load of 4775 kg. There are 4 operational squadrons. Which of the Indian bases may host nuclear-capable aircraft is not known but 1 likely candidate where there could be some dedicated aircraft for a nuclear mission is Ambala, 525 km from Islamabad. A few aircraft from Squadrons 5 (Tuskers), 14 (Bulls) and 20 (Lightnings) may be specially modified to carry 1 or more nuclear bombs. In Indian Air Force organization, Hindan and Ambala are part of the Western Command, located at Palam and reporting to headquarters in New Delhi.

The MiG-27 Flogger, a nuclear-capable Soviet aircraft produced in the 1970s and 1980s, may also have a nuclear role. Hindustan Aeronautics assembled, under licence, 165 aircraft which India calls the Bahadur (Valiant or Brave). The single-seat aircraft weighs almost 18 000 kg when fully equipped and can fly to a range of *c.* 800 km. It can carry up to 3000 kg of bombs on external hardpoints. There are 9 operational squadrons. It is not known which of the bases may host nuclear-capable aircraft but one likely candidate where there could be some dedicated aircraft for a nuclear mission is Hindan, north of New Delhi. Some 50 MiG-27MLs are deployed there, less than 640 km from Lahore. A few aircraft from Squadrons 9 (Wolf Pack), 10 (Winged Daggers) or 18 (Flying Bullets) may be specially modified to carry 1 or more nuclear bombs.

Other aircraft, such as the Mirage 2000H and Su-30K, were initially acquired for air defence missions but could probably be equipped to deliver nuclear bombs. A Mirage 2000H is rumoured to have been used to test-drop a dummy nuclear bomb in May 1994, although this has not been officially confirmed. India was reported in late 1999 to have initiated preliminary talks with France about a possible purchase of up to 18 Mirage 2000Ds to form part of its nuclear strike force. Ten Mirage 2000s were ordered in Sep. 2000. In Dec. 2000 India signed a $3 billion contract with Russia for licensed production of 140 Su-30MKI aircraft at Hindustan Aeronautics over the next 17 years. Forty Su-30K fighters procured in 1996 will be upgraded to MKI standard. The first Indian-produced Su-30MKI is scheduled to roll out in 2004. India may also lease a small number of Russian Tu-22M Backfire bombers.

[d] India is developing and may deploy 1 or more types of ballistic missile for nuclear weapon delivery. At this stage, however, it is uncertain if any of them has yet achieved an operational nuclear capability. The CIA has estimated that Prithvi I may have a nuclear capability, but the Pentagon's proliferation threat and response report of Jan. 2001 only credits India's fighter aircraft with a capability to deliver nuclear weapons. However, an operational nuclear capability is expected to be imminent on one or more of the following ballistic missile systems:

The Prithvi is a single-stage, liquid-fuel, road-mobile SRBM which began development in 1983 and was first tested in 1988. There have been at least 16 tests since 1988. It is 9 metres long and 1.1 metres in diameter and weighs 4000 kg. Two versions exist, Prithvi I with a 150-km range for use by the Army, and the Air Force's Prithvi II, which has a range of 250 km. Of the 2 versions, only Prithvi I is assessed by the CIA to have a possible nuclear role.

The 2-stage Agni I (Fire) IRBM has been tested to a range of 1500 km. The first stage uses a solid propellant taken from the satellite launch vehicle based on the US Scout missile. The liquid-fuelled second stage is a shortened version of the Prithvi. The warhead section separates from the second stage during flight. India conducted 3 flight tests between 1989 and early 1994. The status and future of the weapon is unclear, however, and it may only have been a technology demonstration.

A new version of the missile, designated Agni II, is under development which uses solid propellant in both stages. Agni II was flight tested in Apr. 2000 and again on 17 Jan 2001 with a claimed range of over 2000 km. 'We will induct it into our arsenal', Indian Prime Minister Vajpayee said in his Independence Day speech on 15 Aug. 2000. After the Jan. 2001 test, scientific advisor to the defence minister, A. K. Aatre, said that the Agni II 'is in operational configuration'. When asked if the missile will be fitted with a nuclear warhead, Aatre told *The*

Times of India: 'Obviously'. During the initial flight test on 11 Apr. 1999, a missile was fired from a rail launcher on Inner Wheeler Island, a new part of the Chandipur missile test range in the eastern state of Orissa, flew 2000 km in 11 minutes and may have carried a nuclear warhead assembly without the plutonium core. The duration of the Jan. 2001 test was also about 11 minutes. The Agni II is 20 metres long, weighs *c.* 16 tons and has a 1000-kg payload. Road- and rail-mobile versions are under development. After the Jan. 2001 test, a senior Indian military official told *Defense News* that the air defence wings of the army and air force would jointly operate the missile, and that the two units have an immediate requirement of 20 missiles. Several more tests of Agni II may be planned before it enters series production.

A longer-range missile (Agni III) with a range of up to 3500 km is widely reported to also be under development, and there are rumours about a future ICBM named Surya (Sun) with a range of over 8000 km. Indian Defence Minister Fernandes denied these reports in May 1999 saying they were 'speculative' and with 'no substance', but an unidentified senior Indian Defence Ministry official told Reuters in Feb. 2001 that India plans to build the Agni III. The missile 'will obviously be of a higher range and better capabilities', he said, but added that a date has not yet been set for the first test launch.

Sources: US Department of Defense, Office of the Secretary of Defense, 'Proliferation: threat and response', Washington, DC, Jan. 2001, URL <http://www.defenselink.mil/pubs/ptr20010110.pdf>; Indian Ministry of Defence; Indian Air Force; Indian Ministry of External Affairs; Albright, D., 'India's and Pakistan's Fissile Material and Nuclear Weapons Inventories, end of 1999', Background paper, Institute for Science and International Security (ISIS), 11 Oct. 2000, URL <http://www.isis-online.org/publications/southasia/stocks1000.html>; US Air Force, National Air Intelligence Center, *Ballistic and Cruise Missile Threat* (Wright-Patterson Air Force Base, Ohio, Apr. 1999); 'Draft report of the National Security Advisory Board on Indian nuclear doctrine', 17 Aug. 1999, URL <http://www.meadev.gov.in/govt/indnucld.htm>; US Central Intelligence Agency, National Intelligence Office for Strategic and Nuclear Programs, *Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015*, Sep. 1999; Albright, D., Berkhout, F. and Walker, W., SIPRI, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press: Oxford, 1997); Burrows, W. E. and Windrem, R., *Critical Mass* (Simon & Schuster: New York, 1994); *Jane's Defence Weekly*, various issues; and authors' estimates.

Table 6A.7. Pakistani nuclear forces, January 2001[a]

Type/Designation	Range (km)	Payload (kg)	Comment
Aircraft[b]			
F-16A/B	1 600	5 450	At Sargodha AB
Missiles[c]			
Ghauri I (Hatf-5)	1 300–1 500	500–750	Version of North Korean Nodong missile
Ghauri II (Hatf-6)	2 000–2 300	750–1 000	Test fired on 14 Apr. 1999

[a] It is very difficult to estimate the size and composition of Pakistan's nuclear arsenal. The US Defense Department states that Pakistan has a 'small stockpile of nuclear weapons components' and that it can 'probably assemble some weapons fairly quickly' for delivery by 'fighter aircraft and possibly missiles'. It is estimated that Pakistan may have a stockpile of 15–20 nuclear components, assuming a solid-core implosion design using *c.* 15–20 kg of HEU per warhead. Enough fissile material for 30–52 nuclear weapons is estimated to have been produced, but Pakistan has provided assurances that it will not assemble or deploy its nuclear weapons, nor will it resume testing unless India does so first.

Table 6A.7 *contd*

Over a 20-year period Pakistan pursued a gas centrifuge uranium-enrichment method to produce material for its nuclear weapons. There is some uncertainty about how many centrifuges Pakistan has and thus how much weapon-grade uranium has been produced. A moratorium on HEU production was declared in 1991, but production is thought to have resumed well before the nuclear tests in May 1998. The reprocessing plant in Rawalpindi began operation in 2000, and plutonium separation may have begun from fuel produced in the Khushab reactor. With the announcement of India's ambitious plan to build a triad of nuclear forces consisting of ground-, air- and sea-launched weapons and the generally worsening relations between the 2 countries, Pakistan may increase its nuclear forces significantly in the coming years.

In Nov. 2000 Pakistan placed its key nuclear institutions under the control of the National Command Authority (NCA), established on 2 Feb. 2000, in an apparent effort to create an effective nuclear command and control system. Located at the Joint Strategic Headquarters (JSHQ), the NCA is responsible for formulating nuclear policy and 'will exercise employment and development control over all the strategic forces and strategic organizations'. Pakistan has not disclosed which key facilities will be under NCA control, but it is likely to include uranium and plutonium production and/or reprocessing facilities at Kahuta, Khushap, Rawalpindi and Wah, uranium mining and processing facilities, the single heavy water factory at Multan, aircraft and missile bases at Multan and Sargodha which may have nuclear functions as well as key command and control facilities.

The NCA consists of three units: the Employment Control Committee, which decides on the role of the nuclear arsenal; the Development Control Committee, which 'controls the development of strategic assets;' and the Strategic Plans Division, which 'acts as the secretariat for the NCA and perform functions relating to planning, coordination, and establishment of a reliable command, control, communications, computers and intelligence network.'

[b] Range for aircraft indicates combat radius, without in-flight refuelling. The aircraft in the Pakistani Air Force that is most likely to be used in the nuclear weapon delivery role is the US-manufactured F-16, although other aircraft, such as the French-produced Mirage V or the Chinese-produced A-5, could also be used. Twenty-eight F-16A (single-seat) and 12 F-16B (2-seat) trainers were delivered to the Pakistani Air Force between 1983 and 1987. At least 8 of the original order are no longer in service. In Dec. 1988 Pakistan ordered 11 additional F-16A/Bs as attrition replacements, but to date they have not been delivered by the USA because of the 1994 Pressler Amendment, which prohibits US military aid to suspected nuclear weapon states. The US Government announced on 6 Oct. 1990 that it had embargoed any further arms deliveries to Pakistan. The 11 embargoed aircraft are being stored in the Arizona desert near Davis-Monthan AFB. In Sep. 1989 plans were announced for Pakistan to acquire 60 more F-16s. Of that order, 17 were built by the end of 1994, but because of the embargo they joined the others at Davis-Monthan and have not been delivered.

Some of the F-16s most likely to have been modified to carry nuclear weapons are deployed with Squadrons 9 and 11 at Sargodha AB, 160 km north-west of Lahore. There are also F-16s with Squadron 14 at Kamra AB. The F-16 has a range of over 1600 km, or more if drop tanks are used. It can carry up to 5450 kg externally on 1 under-fuselage and 6 underwing stations.

[c] According to Abdul Qadeer Khan, the head of 1 of the 2 major Pakistani nuclear weapons and missile laboratories, the Ghauri missile is currently the only nuclear-capable missile, although other missiles in the Pakistani armed forces could be configured to carry a nuclear warhead. The single-stage, liquid-fuelled Ghauri I, which is thought to be a modified version of the North Korean Nodong missile, was first flight tested on 6 Apr. 1998 to a distance of 1100 km, probably with a payload of up to 700 kg. The Ghauri II was tested on 14 Apr. 1999, 3 days after the Indian Agni II test flight. It was launched from a mobile launcher at Dina, *c.* 60 km east of the Pakistani capital of Islamabad, and landed in Jiwani, in the south-western Baluchistan province. A third version of the Ghauri, with an unconfirmed range of up to 3000 km, is under development and was test launched on 15 Aug. 2000.

Pakistan has also developed the solid-fuelled Shaheen-I (Eagle), which may have been reverse-engineered from the Chinese M-9 missile. Pakistani officials claim that the Shaheen-I has a range of 750 km and is capable of carrying a nuclear warhead, although the validity of this claim is yet unclear. Pakistan conducted the initial flight test of Shaheen-I from the coastal town of Sominani on 15 Apr. 1999, 1 day after the first Ghauri II test. The Shaheen-II medium-range missile, which was unveiled at the Pakistan Day parade on 23 Mar. 2000, is claimed by the government to have a range of 2000-2500 km and carry a 1000-kg payload. The missile is carried on a 16-wheel mobile launcher similar to the Russian MAZ-547V used to transport the Soviet Union's SS-20 prior to 1987.

Sources: 'Islamic Republic of Pakistan, Official Website, URL <http://www.pak.gov.pk/>; Embassy of Pakistan, Washington, DC; US Department of Defense, Office of the Secretary of Defense, 'Proliferation: threat and response', Washington, DC, Jan. 2001, URL <http://www.defenselink.mil/pubs/ptr20010110.pdf>; Albright, D., 'India's and Pakistan's fissile material and nuclear weapons inventories, end of 1999', Background Paper, Institute for Science and International Security (ISIS), 11 Oct. 2000, URL <http://www.isis-online.org/publications/southasia/stocks1000.html>; Albright, D., Berkhout, F. and Walker, W., SIPRI, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press: Oxford, 1997); Burrows, W. E. and Windrem, R., *Critical Mass* (Simon & Schuster: New York, 1994); Three-Four-Nine: The Ultimate F-16 Site, URL <http://www.f-16.net/reference/users/f16_pk.html>; *Jane's Intelligence Review,* various issues; and authors' estimates.

Table 6A.8. Israeli nuclear forces, January 2001[a]

Type	Year first deployed	Range (km)	Comment
Aircraft[b]			
F-16A/B/C/D/I Fighting Falcon	1980	1 600	Bombs probably stored at Tel Nof, possibly also at Ramat David
F-15I Thunder	1998	3 500	Selected for long-range strike role
Land-based missiles[c]			
Jericho I	1972	1 200	Possibly 50 at Zekharyeh
Jericho II	1984–85	1 800	Possibly 50 at Zekharyeh, on TELs in caves
Non-strategic/battlefield[d]			
Artillery and landmines			

[a] Estimating the size and composition of the Israeli nuclear stockpile is extremely difficult. It is estimated that Israel may have as many as 200 warheads, consisting of aircraft bombs, missile warheads and non-strategic/battlefield types. The Israeli Government has not confirmed or denied the widespread assumption that it has a limited but significant stock of nuclear weapons. Although the Pentagon report *Proliferation: Threat and Responses* of Jan. 2001 omits Israel from its review of the Middle East, a US Strategic Air Command study from 1991 lists Israel as a 'de facto' nuclear weapon state along with India and Pakistan. Israel has been a nuclear weapon power since late 1966, when its first bombs were manufactured. An explosion high in the atmosphere on 22 Sep. 1979 off the coast of South Africa in the South Indian Ocean is believed by some to have been a clandestine Israeli test, possibly of a neutron weapon.

Although small in size and population, Israel has created an extensive and modern nuclear infrastructure. The weapons are assembled at the design laboratory at Rafael, outside Haifa, known as Division 20. Dimona, in the Negev desert, is the location of a plutonium–tritium production reactor and underground chemical separation and nuclear component fabrication

Table 6A.8 *contd*

facilities. A facility in the town of Yavne, south of Tel Aviv near the coast, controls and monitors test flights of missiles launched into the Mediterranean Sea. According to some sources, there are nuclear weapon bunkers for aircraft and missiles at Tel Nof AB, in the Negev desert. A second set of bunkers, near the village of Tirosh, is believed to be a nuclear storage site.

Official Israeli comments on its nuclear capability are rare, but the Knesset held an unprecedented debate on Israel's nuclear policy in Feb. 2000. The debate, which was instigated by the Democratic Front for Peace and Equality (the former Communist Party), disclosed no secrets and the Israeli Government reiterated that 'Israel will not be the first to introduce nuclear weapons in the Middle East'. After Pakistan's underground tests in May 1998, and a subsequent public statement by Iranian Foreign Minister Kamal Kharrazi that 'Muslims now feel more confident that Pakistan's nuclear capability will play a role of deterrence to Israel's nuclear capability', Israeli officials expressed concern that the act would encourage Iran and Iraq to acquire nuclear weapons. A few months later, in late 1998, Israel launched a major review of its defence strategy, including the role of nuclear weapons. Then Defence Minister Yitzhak Mordechai stated that the 30-year policy not to be the first to introduce nuclear weapons into the region was 'a formula that has served us well and, at least for the time being, should remain in place'. The policy 'has achieved a deterrent', a senior defence official told *Defense News*, 'yet it hasn't broken any taboos'.

In addition to missile and air forces listed in the table, there are unconfirmed rumours that Israel may also pursue a sea-based nuclear capability. According to the rumours, the IDF/N may plan to equip three new Dolphin Class submarines with a nuclear land-attack capability by modifying US-supplied UGM-84 Sub Harpoon anti-ship missiles (130-km range) with an indigenously developed nuclear warhead and guidance kit. In 2000 Israeli officials repeatedly dismissed the rumours of a nuclear capability for the Dolphin submarines as fantasies. The Israeli Navy said that the submarines 'are completely conventional'. Rumours of a cruise missile test launch conducted by an Israeli submarine in the Indian Ocean were also denied, and the German Foreign Ministry said that it had asked for, and been provided with, 'clarification' from Israel that the German-produced submarines had 'no role in any cruise missile tests whatsoever'. Israel contracted with the German company Howaldtswerke-Deutsche Werft in Kiel to build 3 diesel-powered submarines for the Israeli Defense Force Navy (IDF/N). Designated the Dolphin Class, they are 57.3 metres long, displace 1900 tons, can reach a speed of 20 knots and have a crew of 35. The first submarine, the *Dolphin*, arrived in Haifa on 27 July 1999, and the second, the *Leviathan,* joined the fleet by the end of the year. The third submarine, the *Tekuma*, arrived at Haifa on 24 Oct. 2000 and was scheduled to achieve operational deployment by the end of the year. Israel has also attempted to acquire long-range BGM-109 Tomahawk cruise missiles, but the US Government rejected an Israeli request for 4 dozen missiles in Mar. 2000. The Tomahawk sea-launched cruise missile exists in a nuclear-tipped version for delivery by US attack submarines.

[b] Range for aircraft indicates combat radius, without in-flight refuelling. Over the past 30 years Israel has had many different types of aircraft capable of carrying nuclear bombs. These include the F-4 Phantom, the A-4 Skyhawk, and more recently the F-16 and F-15E. In 1999 the Israeli Government announced that it would purchase 50 F-16Is worth *c.* $2.5 billion. Israel will begin to receive the aircraft at the beginning of 2003, and the last aircraft will be supplied 2 years later. Under the terms of the contract Israel has an option to purchase 60 more aircraft but must decide by Sep. 2001. If the government exercises the option, delivery of the extra aircraft will continue until 2008. In 4 previous orders Israel purchased or received 260 F-16s from 1980 to 1995. These include 103 F-16A, 22 F-16B, 81 F-16C and 54 F-16D models. Some number of nuclear bombs may be allocated to specific dedicated, certified aircraft, probably at the Tel Nof AB.

In Jan. 1994 Israel selected the Boeing F-15E Strike Eagle for the long-range strike and air-superiority roles. Called the F-15I Ra'am (Thunder) in Israel, 25 aircraft were delivered to the Israeli Air Force from Jan. 1998 to May 1999.

A second, but less likely, airbase where nuclear bombs may be stored is Ramat David, in northern Israel, home to the 109, 110 and 117 Squadrons, flying the F-16C/D. Aircraft from Squadrons 110 and 117 attacked and destroyed the Iraqi Osirak nuclear reactor outside Baghdad on 7 June 1981.

[c] Israel's quest for a missile capability began simultaneously with its quest for nuclear weapons. In Apr. 1963—several months before the Dimona reactor began operating—Israel signed an agreement with the French company Dassault to produce a surface-to-surface ballistic missile. Israeli specifications called for a 2-stage missile capable of delivering a 750-kg warhead to 235–500 km with a CEP of less than 1 km. The missile system, known as the Jericho (or MD-620), should take less than 2 hours to prepare, be launched from fixed or mobile bases, and be capable of firing at a rate of 4–8 per hour. In early 1966 *The New York Times* reported that Israel had purchased the first instalment of 30 missiles, but soon after the June 1967 Six-Day War France imposed an embargo on new military equipment. Because of the embargo Israel began to produce the Jericho missile on its own. In 1974 the US Central Intelligence Agency (CIA) cited the Jericho as evidence that Israel had made nuclear weapons—the CIA said that the Jericho made little sense as a conventional missile and was 'designed to accommodate nuclear warheads'.

Israel subsequently developed the Jericho II, a missile with similarities to the US Pershing II. In May 1987 Israel tested an improved version of the Jericho II that flew 800 km. A second test was conducted in Sep. 1988 and a third in Sep. 1989, which reportedly flew 1300 km. A document published in 1989 by the US Arms Control and Disarmament Agency gave the maximum range of the improved Jericho as 1450 km, long enough to reach the southern border of the Soviet Union. Israel vigorously pursued certain technologies in the USA and elsewhere for the missile, including a terminal guidance system using radar imaging. It is thought that the range has been increased to 1800 km. According to an article published in 1997 in *Jane's Intelligence Review*, there were *c*. 50 Jericho II missiles at the Zekharyeh missile base, some 45 km south-east of Tel Aviv in the Judean Hills. According to an analysis of satellite images of the base, the missiles appear to be stored in caves. Upon warning they would be dispersed on their TELs so as not to be destroyed. The shorter-range Jericho I is deployed nearby in approximately equal numbers. In Apr. 2000 Israel test launched a Jericho missile into the Mediterranean Sea. The missile impacted near a US warship, which reportedly thought it was under attack. Israel did not inform the USA of the test in advance.

[d] There are also reports that Israel has developed nuclear artillery shells and possibly ADMs. Following a report in *The Times* in Mar. 2000 that Israel planned to lay neutron landmines to deter a Syrian attack following a withdrawal from the Golan Heights, Israeli Deputy Defense Minister Ephraim Sneh responded that 'this report is truly stupid. The person that wrote it not only doesn't know, but also doesn't understand anything'.

Sources: Albright, D., Berkhout, F. and Walker, W., SIPRI, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press: Oxford, 1997); Hough, H., 'Could Israel's nuclear assets survive a first strike?', *Jane's Intelligence Review*, vol. 9, no. 9 (1997), pp. 407–10; Burrows, W. E. and Windrem, R., *Critical Mass* (Simon & Schuster: New York, 1994), pp. 275–313; 'US Strategic Air Command/XP, "Secret/Phoenix"', 11 Sep. 1991, p. 67, released under the US Freedom of Information Act and available at URL <http://www.nautilus.org/nukestrat/USA/Force/phoenix.html>; Hersh, S. M., *The Samson Option* (Random House: New York, 1991); *Jane's Defence Weekly*, various issues; and authors' estimates.

Acronyms

AB	Airbase
ACM	Advanced cruise missile
ADM	Atomic demolition munition
AFB	Air force base
ALCM	Air-launched cruise missile
ASW	Anti-submarine warfare
CALCM	Conventional air-launched cruise missile
CEP	Circular error probable
FY	Fiscal year
GLCM	Ground-launched cruise missile
HEU	Highly enriched uranium
ICBM	Intercontinental ballistic missile
IOC	Initial operational capability
IRBM	Intermediate-range ballistic missile
MIRV	Multiple independently targetable re-entry vehicle
MRV	Multiple re-entry vehicle
MOU	Memorandum/Memoranda of Understanding
RV	Re-entry vehicle
SAM	Surface-to-air missile
SIOP	Single Integrated Operational Plan (US)
SLBM	Submarine-launched ballistic missile
SLCM	Sea-launched cruise missile
SRAM	Short-range attack missile
SRBM	Short-range ballistic missile
SSBN	Nuclear-powered, ballistic-missile submarine
SSGN	Nuclear-powered, guided-missile submarine
SSN	Nuclear-powered submarine
TEL	Transporter–erector–launcher
TLAM	Tomahawk Land Attack Missile