2. Nuclear weapons

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I. Introduction

The most significant event of 1987 was the signing of the Treaty on the Elimination of Intermediate-Range and Shorter-Range Missiles (the INF Treaty) by President Reagan and General Secretary Gorbachev (see also chapter 13). While the INF Treaty includes approximately 4 per cent of the world's total arsenal of some 55 000 nuclear weapons, the Strategic Arms Reduction Talks (START) cover some 24 000 nuclear warheads, or about 40 per cent of the total (see also chapter 10).

None the less, amidst great progress in arms control negotiations, nuclear weapon deployments continued during the year. The USA and the USSR deployed approximately 1250 new strategic weapons: almost 700 for the USA and over 550 for the USSR. For the USA, these include: the last 90 air-launched cruise missiles (ALCMs) which are now operational on B-52G/Hs at six Strategic Air Command (SAC) bases; 20 more MX missiles carrying 200 warheads at F. E. Warren Air Force Base (AFB), Wyoming; and approximately 400 new B83 gravity bombs for 50 B-1B bombers delivered during the year. The US ballistic-missile submarine force remained the same size. The USA removed approximately 20 Minuteman III missiles from silos to be able to deploy the new MX missiles. The most dramatic recent trend for the United States has been an increase in bomber weapons with the introduction of ALCMs for a portion of the B-52 force and new gravity bombs for the B-1B bomber.

The Soviet Union deployed new weapons in all three 'legs' of its triad. Approximately 50 SS-25 intercontinental ballistic missiles (ICBMs) were deployed, and the first few rail-mobile SS-24s were fielded. The fourth Typhoon and third Delta IV Class submarines became operational, and the next units of each model were launched. Bear bombers continued to be converted to the G model, and new H models were produced. Approximately 20 Bear-Hs with 160 new AS-15 long-range ALCMs were deployed during the year. The Soviet Union continued to retire SS-11s under the SALT (Strategic Arms Limitation Talks) agreements and began removing SS-17s and SS-19s as the SS-24 was fielded. The last 15 Bison bombers were removed from service during 1987. The MIRVing (equipping with multiple independently targetable re-entry vehicles) of the Soviet ballistic-missile submarine force continued, and expansion of the bomber force, both in quality and numbers of bomber weapons, continued.

During 1987, Britain and France moved towards a new level of defence co-operation that could include collaboration on developing a new air-

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launched, nuclear-armed missile. Joint development of such a missile would mark the first time Britain has collaborated with a country other than the United States on nuclear armaments and the first joint European nuclear weapon project.

China continued with its gradual nuclear force modernization programme in 1987 and pursued the development of a short-range ballistic missile using solid fuel. This missile could be the first step in an effort to use solid fuel for the rest of China's land-based nuclear missiles.

The tables showing the nuclear forces of all five nations (tables 2.1–2.8) appear in section III of this chapter.

II. US nuclear weapon programmes

The total US nuclear weapon stockpile contained 23 400 warheads at the beginning of 1987.[1] This figure, which was inadvertently revealed in congressional hearings, is about 3 per cent lower than when the Reagan Administration entered office. Ironically, one of the military goals of the Reagan Administration was to increase the size of the nuclear stockpile by some 13 per cent between 1983 and 1988.

US strategic nuclear forces have grown by over 5400 warheads since the signing of the SALT I Treaty (1972) and by almost 2400 warheads during the Reagan Administration (1981–88).[2] The Administration has almost completed the first wave of its strategic nuclear weapon modernization programme. A second wave, planned to begin in 1988, could be more expensive than the first.[3] These programmes include the small intercontinental ballistic missile (SICBM), 50 rail-based MX ICBMs, Trident II submarine-launched ballistic missiles (SLBMs), Advanced Technology Bombers (ATBs), Advanced Cruise Missiles (ACMs) and SRAM IIs. The broad-based modernization which has occurred during the Reagan Administration has not been without troubles, in terms of the capabilities of new weapons. During 1987 a number of nuclear weapon systems, notably the MX, B-1B bomber and ACM, were strongly criticized for technological problems and/or cost over-runs.

ICBMs

By the end of 1987, 30 MX missiles were deployed in underground silos, although some (reportedly 12) were unusable because of defective guidance systems. Throughout the year reports revealed problems with the inertial measurement unit (IMU), a key component of the guidance and control system. On 16 March 1987 the Air Force suspended payments to the prime contractor, Northrop Electronics Division in Hawthorne, California. In June a special panel of the House Armed Services Committee (HASC) conducted a review and criticized the systemic flaws in the acquisition process.[4]

On 19 December 1986 President Reagan announced that funds would be included in the FY 1988 defence budget to design an MX basing scheme, called rail-garrison, which would deploy the missiles on trains.[5] Current plans call for 50 MX missiles to be deployed on 25 trains at seven or more secure garrisons on existing Air Force bases. The main base would be at F. E. Warren AFB, Wyoming, the deployment site for silo-based MX missiles.[6] On 11 February 1987 the Air Force identified 10 more candidate installations for possible rail-garrison basing (all currently Strategic Air Command (SAC) bomber and/or missile bases).[7]

Each MX garrison would cover about 45–50 acres (about 0.2 km²) of land. Each train would have seven cars: a locomotive, two missile cars, two security cars, a launch command and control car, and a maintenance car. The specially designed missile launch cars would weigh in excess of 227 273 kg and be 27 metres long and 5.1 metres high. Three or four trains at each site would be parked in shelters constructed of earthen berms and corrugated steel. During normal day-to-day operations, the trains would be on strategic alert in their garrisons. They would be guarded by 15–20 security personnel on a 24-hour-a-day basis similar to bomber security operations today. Upon 'strategic warning' the trains would be dispersed on to the US civil railway system. The Reagan Administration received $300 million (of a requested $593 million) in FY 1988 for development of this basing mode. It is scheduled to become operational in December 1991.

Development of the SICBM continued, but by the end of the year the programme was in serious trouble. The FY 1988 budget request was cut from $2.2 billion to $700 million. Under directives by Secretary of Defense Frank Carlucci to reduce the FY 1989 Department of Defense (DOD) budget by $31 billion the Air Force offered to cancel the missile. Some in the Air Force have reportedly never been very enthusiastic about the missile and have from the start preferred the multi-warhead MX instead. Their strategy was to feign enthusiasm for the SICBM in order to get funding for 50 more MX missiles from the US Congress, which has promoted the SICBM. In technical developments, two in a series of three SICBM canister-ejection tests were conducted at Vandenberg AFB, California. A static first-stage rocket motor test was also conducted. A SICBM warhead was also selected during the year; it will be a modified higher-yield (475-kt) version of the W87 used on the MX missile.

Strategic submarine programmes

The Trident II (or D-5) missile test programme began on 15 January 1987; the missile was fired from Launch Complex 46 at Cape Canaveral. During the year, a total of eight Trident II development test flights were made, with various numbers of re-entry vehicles (RVs).[8] There was controversy over the eighth test, which had been planned to carry 12 RVs.[9] Because of the implications for a START agreement and for the future size of the ballistic-missile submarine fleet, the test with 12 RVs was not conducted. At the US–Soviet summit meeting in Washington, it was decided that the warhead counting rule for the Trident II would be eight, thus limiting the USA (and indirectly the UK) to no more than eight warheads for each Trident II missile. It is unclear what impact this development will have on the Navy's plan to put two different kinds of RV on Trident II missiles.

The D-5 test programme will be the largest and most expensive in the history of US ballistic missiles; it will have four parts and will use a total of 386 missiles.[10] The research and development (R&D) flight-test programme will use 30 missiles, 20 of which will be ground launched, and 10 of which will be used in performance evaluation tests and be fired from operational submarines beginning in the summer of 1989. A launch in this series is scheduled to be made on an average of every 40 days.[11]

The Operational Test (OT) programme will constitute 40 flights during the first three years that the Trident II is deployed. The purpose is to establish reliability and accuracy parameters for use in the development of targeting guidance for the Single Integrated Operational Plan (SIOP), the US nuclear war plan.

The Follow-on Test (FOT) programme, currently planned for 260 flight-tests over 20 years (16 flights per year during 1993–97 and 12 per year thereafter until the year 2012),[12] is designed to update SIOP parameters, to detect developing problems and to test potential remedies. The size of the FOT programme exceeds the minimum necessary to comply with the Joint Chiefs of Staff (JCS) guidance for identifying deterioration in missile reliability. Meeting JCS guidance would require only six flights a year. The Navy claims that it needs a larger than usual FOT programme to improve the quality of the accuracy estimate. It further justifies a large FOT programme by noting that launching SLBMs presents special operating requirements that increase the demand for test data. Unlike ICBMs, SLBMs may be launched from a variety of ranges and must be able to conduct a ripple launch—the sequential firing of a group of missiles from a single submarine. Finally, the Navy claims that because the Trident II missiles could carry two different RVs—the low-yield Mark 4 (100 kt) and the higher-yield Mark 5 (475 kt)—extra tests are required.[13]

Finally, the Demonstration and Shakedown Operations (DASO) launches will use 53 missiles to help detect and remedy engineering problems and to demonstrate that a newly completed or overhauled submarine is fully capable. The Navy plans to test two missiles from each of the first four submarines that carry the Trident II (i.e., SSBNs 734–737). One missile will be tested from each of the eight subsequent SSBNs (SSBNs 738–745, assuming a fleet of 20) and the initial eight Trident SSBNs that will be backfitted during their first overhauls (SSBNs 726–733). Finally, each Trident SSBN receiving a major overhaul will test-launch one missile; 32 overhauls are planned.

Strategic bomber programmes

Developments in US bomber forces were numerous during the year, including continued deployment of the B-1B and two nuclear bombs (B61 and B83), continued development of the 'stealth' ATB, and continued development of the SRAM II and a stealth ACM.

The second B-1B base—Ellsworth AFB, South Dakota—received its allotted 35 aircraft during the year, and the third, Grand Forks AFB, North Dakota, began to receive the first of its 17 B-1Bs in October. By the end of

1987, approximately 75 B-1Bs had been delivered. On 20 January 1988 the 100th, and last, B-1B bomber was rolled out of the Rockwell factory in Palmdale, California. Delivery of the final aircraft to the Strategic Air Command is expected in April 1988. Currently most bombers are being used for training, with only two on 15-minute ground alert. About 30 bombers will eventually be on alert.[14]

Throughout 1987 certain problems that have plagued the aircraft came to light.[15] The General Accounting Office reported that the B-1B would cost $6 billion more to build than the Reagan Administration originally stated.[16] A B-1B crashed on 28 September in southern Colorado, killing three of the six-member crew. The crash was caused by the plane hitting a large (6.8-kg) bird which in turn started a fire that ignited hydraulic systems and led to loss of control of the aircraft. The SAC suspended low-level B-1 flight training, pending the results of an investigation of the incident, throughout the rest of the year.

During the year it became clear that the ATB, now officially designated the B-2, is behind schedule and over-cost. A variety of technical and management problems associated with the ATB resulted in the FY 1988/89 DOD Authorization Act mandating that the Secretary of Defense improve the programme.[17] Despite the problems, the Northrop Corporation received a $2 billion contract on 19 November to begin producing the bomber.[18]

During 1987 the Air Force revealed that the ACM (AGM-129) programme was having difficulties.[19] The missile had not, as of April, completed six successful tests, which was a milestone required for a full rate of production. On 4 November McDonnell Douglas was awarded a second source contract to produce the ACM along with General Dynamics, partly as a safeguard against poor workmanship and management by General Dynamics. The ACM will be deployed first at K. I. Sawyer AFB, Michigan.[20]

Boeing Aerospace was selected on 8 December 1986 to develop a second-generation SRAM II to augment and eventually replace the current SRAM missiles. The SRAM is a nuclear-armed air-to-surface missile that would be used largely to destroy Soviet air defence installations. Additional roles are conceived for the SRAM II. It will be two-thirds the size of the current SRAM and will have greater range, accuracy and performance. One of the major innovations for the new missile is rapid targeting, a capability which will be used to target Soviet mobile systems. Plans call for the production of 1633 SRAM IIs for initial deployment on B-1B and B-2 bombers.

A new nuclear warhead for the SRAM II is about to enter engineering development (Phase 3 of Department of Energy R&D). Engineering development is the phase of a warhead's life cycle where a final design is selected from either the Los Alamos National Laboratory or the Lawrence Livermore National Laboratory. Thirteen designs were considered for the SRAM II warhead, and the final selection was made in November 1986. The first warhead was planned to be produced in July 1991 when the missile was planned to be operational in March 1992; the SRAM II is now scheduled to be operational in April 1993. This 13-month delay was ordered by the Office of the Secretary of Defense because of concerns over rushing into production without adequate testing. The new warhead will have a lower explosive yield than that originally requested by the Air Force.

When contemplating the impending INF Treaty, the SAC proposed a $3 billion plan to modify 150 B-52G bombers to carry only conventional weapons for NATO non-nuclear missions.[21] However, this would pose considerable problems for a START agreement.

Theatre nuclear forces and the INF Treaty

The bilateral INF Treaty calls for the elimination of all US and Soviet ground-launched missiles with a range of 500-5500 km (300-3400 miles) over a three-year period. The impact of the Treaty on the nuclear force structures of the USA and the USSR will be significant:

1. The USA will destroy 120 deployed Pershing II missiles and 309 deployed ground-launched cruise missiles (GLCMs).[22]
2. The USSR will destroy 405 deployed SS-20 Saber missiles, 65 deployed SS-4 Sandal missiles, 220 deployed shorter-range SS-12 Scaleboard missiles, and 167 deployed SS-23 Spider missiles.
3. Approximately 520 US and 2150 Soviet nuclear warheads will be deactivated.
4. Future missile modernization (nuclear or conventional), including development, production and flight-testing, is banned.

Even without INF reductions, the number of US European nuclear warheads has steadily declined during the Reagan Administration. By the end of 1987 the USA had approximately 4300 warheads deployed in Europe—fewer nuclear warheads than at any time since the early 1960s (see table 2.3). By 1992, when the INF missiles have been withdrawn, about 3250 US nuclear warheads will remain on European soil.

The publication of the INF Treaty provided unprecedented official detail concerning the numbers and locations of US and Soviet missiles (for the text of the Treaty and the MOU, see appendices 14A and 14B). The Memorandum of Understanding (MOU) revealed that, as of 1 November, 309 GLCMs were in Europe, 45 more than was publicly known. Also of interest was the fact that 178 Pershing 1a missiles, many of which had been withdrawn from the Federal Republic of Germany in 1983–85, still existed at an Army depot in Colorado. All Soviet information was new, since the Soviet Government has never previously released information on its nuclear weapon deployments (see section III).

In light of the INF Treaty many, including NATO Ministers, have called for the modernization and re-equipping of NATO's nuclear arsenal. Pressure has mounted to proceed with new programmes to 'compensate' for the impending removal of Pershing IIs and GLCMs from Europe. Any modernization of NATO's nuclear forces will be controversial. There are four conceivable means to increase NATO's nuclear capabilites: a nuclear Lance missile replacement; a new nuclear-armed, aircraft-delivered, air-to-surface missile (called the TASM); an increase in the number of nuclear artillery shells; and increased pressure on European governments to agree to deploy the neutron warheads which are stored in the USA.

Perhaps the only real option open to NATO is to increase the number and capability of nuclear-armed fighter aircraft and to introduce a medium-range nuclear ASM for them. Nuclear-capable fighter aircraft are not as controversial as artillery or short-range missiles, and numerous modernization programmes (including the ongoing production of modern non-strategic nuclear bombs for aircraft) are under way to bolster the fighter force. Fighter aircraft, in addition, would provide the flexibility to execute both short- and long-range nuclear strikes, a feature attractive to nuclear war planners.

During 1987 the US Air Force moved forward with development of a new tactical fighter, the F-15E, which will become the primary nuclear bomber and deep-interdiction aircraft in Europe starting in 1988, augmenting and eventually replacing the F-111.[23] The F-15E will perform all-weather, day-or-night, long-range bombing missions while retaining an air-to-air combat capability as well. The first research model of the F-15E was flight-tested by McDonnell Douglas in St Louis, Missouri, on 11 December. Current plans call for delivery of 392 F-15Es to four wings at a rate of 42 a year until 1997. The first operational wing will be at Seymour Johnson AFB, North Carolina.

After 18 months of negotiation, on 10 December Spain told the USA to remove its 72 F-16 aircraft from Torrejon Air Base over a three and one-half-year period. Under the current arrangement, the aircraft have a wartime mission to fly to Italy and Turkey to load their nuclear bombs.[24] Although one alternative was to relocate the planes in Italy, the US DOD announced plans to deactivate the 401st Air Wing as part of its reduced FY 1989 budget plan.

NATO nuclear war planning

During 1987 details of changes in the political guidelines for the employment of nuclear weapons in Europe came to light.

At the NATO Ministers' meeting in Gleneagles, Scotland, on 20–21 October 1986 NATO adopted new political guidelines for the use of its nuclear forces. Although a process of re-evaluating NATO's nuclear capabilities had been going on for about eight years, the deployment of long-range nuclear forces and the withdrawal of major portions of NATO's European stockpile required a restatement of nuclear strategy as it related to the initiation of the use of nuclear weapons, follow-on nuclear strikes and strikes on Soviet territory.

These new General Political Guidelines (GPG) are the NATO equivalent of the Carter Administration Presidential Directive 59 (PD-59), the Nuclear Weapons Employment Policy for US strategic forces that was approved in July 1980. The GPG, like PD-59 (and the Reagan Administration affirmation in National Security Decision Directive 13 in October 1981), sought to articulate better a counterforce nuclear doctrine that had been evolving during the 1970s.

The new GPG were prepared by a NATO working group of the Defence Planning Committee[25] which resulted in four drafts (the last was in 1982) that were discussed and debated at Defence Planning Committee, Nuclear Planning Group and ministerial meetings. They update and replace the 1969 Provisional Political Guidelines (known as the PPG) on the initial (or first) use of nuclear weapons, and the 1970 General Release guidelines. These, together with two other NATO statements previously in effect on the use of nuclear weapons, constituted NATO's nuclear employment policy:[26]

1. *Provisional Political Guidelines for the Initial Defensive Tactical Use of Nuclear Weapons by NATO* (DPC/D(69)58 (Revised)) (November 1969);
2. *Concept for the Role of Theater Nuclear Strike Forces in ACE* [Allied Command Europe] (DPC/D(70)59 (Revised)) (October 1970);
3. Guidelines for consultation procedures on use of nuclear weapons (November 1969);[27] and
4. Political guidelines for use of atomic demolition munitions (October 1970).[28]

The new General Political Guidelines do the following:

1. Reaffirm NATO's 1967 flexible response strategy, which calls for NATO to defend itself against attack in three phases: 'direct defense', 'deliberate escalation' and 'general nuclear response'.[29]
2. Reaffirm the policy of initial (first) use of NATO nuclear weapons in response to a Soviet conventional attack and discuss in great detail the selective use of NATO nuclear weapons. The GPG put greater emphasis on 'follow-on' nuclear strikes, assuming a Warsaw Treaty Organization (WTO) nuclear response to 'initial' NATO use. Since the assumption is one of a series of selective strikes, the priority for the 'deliberate escalation' phase of the flexible response strategy is to strike beyond the battlefield (i.e., not on NATO territory). Initial attacks, under the GPG, would be made 'mainly on the territory of the aggressor, including the Soviet Union'.[30] Strikes on Soviet territory in previous NATO employment policy were highly restricted to specific circumstances such as warfare on the Soviet–Turkish border.
3. State that nuclear weapons will be developed and deployed, to implement the new long-range employment doctrine: 'TNF [Theater Nuclear Force] modernization in Europe has shifted the weight of regional nuclear armaments and target options away from the battlefield towards the adversary's side with a tendency of striking deep in WP [Warsaw Pact] territory'.[31]
4. Contain guidance for nuclear targeting, stating that priority be given to militarily significant ('counterforce') strikes as a means to convey political messages, rather than 'countervalue' strikes. This is in contrast to the 1969 guidelines which stated that the objective of the initial NATO use of nuclear weapons 'would be essentially political and that initial use would therefore be very selective'.[32]
5. Contain new guidance on NATO declaratory policy dealing with nuclear weapons.
6. Contain new guidance on communicating NATO intentions to the Soviet Union in a crisis, as well as after selective use of nuclear weapons (such as in the case of demonstration nuclear strikes).

7. Provide new guidelines for political consultation to ensure control over battlefield commanders and reaffirm the traditional 'Athens' guidelines that consultation would be subject to, 'time and circumstances permitting'.

8. Provide guidelines on the use of sea-based nuclear weapons for the first time. The 1969 guidelines considered only the initial use of land-based nuclear weapons in response to an attack.

Naval nuclear weapons

The US Navy has apparently decided to shift the emphasis of its Tomahawk sea-launched cruise missile programme away from steady production of nuclear-armed land-attack missiles towards conventionally armed variants. The current five-year plan (FY 1988–92) significantly reduces the number of nuclear missiles to be purchased during that period. The plan in 1986 called for buying the remaining 440 of 758 nuclear Tomahawks during FYs 1988–91. The 1987 plan calls for buying only 93 missiles during the same period (19 in FY 1988, 28 in FY 1989, 46 in FY 1990, and none in FY 1991 and FY 1992), shifting the last 327 nuclear missiles to be produced to FY 1993. The Navy is currently buying three conventionally armed Tomahawk variants: a precision land-attack missile, an anti-ship missile, and a combined-effects bomblet missile for airfield attack. Previous projections were to purchase 618 of these in FYs 1988 and 1989, but the 1987 budget asked for 937. In 1987 the Navy was planning to buy 262 nuclear-armed Tomahawks in FYs 1988 and 1989 but now plans to purchase only 47.

The longer-range Sea Lance anti-submarine standoff weapon (ASW/SOW) was originally planned to replace the SUBROC in 1992, initially carrying the non-nuclear lightweight Mk-50 torpedo. However, budget reductions and technical dificulties will delay this programme considerably. The Navy would like to develop a nuclear warhead for the Sea Lance but has been unable to convince Congress to fund it. The Navy has said that it will decide in December 1990 whether it will try to develop a nuclear version.

Congress is also not convinced about the need for a nuclear version of the Standard Missile-2 (SM-2(N)) as a replacement for the Terrier (RIM-2F) surface-to-air missile (SAM) now on 31 cruisers and destroyers. The US Congress deleted funds for the nuclear version in the FY 1987 budget, and the Navy did not request R&D funding in the FY 1988 or FY 1989 budgets. The future of the programme is uncertain, but it appears that the Navy has lost interest in a nuclear SAM.

On 23 December the Navy selected General Dynamics and the McDonnell Douglas Corporation to develop and build the Advanced Tactical Aircraft (ATA). The ATA will be the next generation of carrier-borne attack aircraft, intended to replace the A-6 and A-7 aircraft, and will have a nuclear attack role and use low-observable (or stealth) technologies.

Congressional initiatives

Immediately upon convening in January, the Democrat-controlled 100th Congress took up from where it left off in 1986 and began to introduce arms control legislation. The major initiatives had to do with protecting the traditional interpretation of the 1972 Anti-Ballistic Missile (ABM) Treaty (see also chapter 14), returning the USA to compliance with the SALT limits and mandating limitations on nuclear weapon testing.

In October 1985 the Reagan Administration began to promote an interpretation of the ABM Treaty that would allow the development and testing of many of its Strategic Defense Initiative (SDI) programmes.[33] This 'broad' or permissive interpretation is almost universally rejected by all but one member of the US delegation that negotiated the Treaty, by NATO allies, by the Soviet Union and by many members of Congress.

The Administration claimed that the true meaning of the ABM Treaty can be found only in the detailed negotiating record and not in the public statements or hearings. Senator Nunn asked for and eventually received access to the negotiating record. In three speeches to the Senate on 11, 12 and 13 March he presented his report, which upheld the traditional interpretation.[34]

Beyond legalistic points about the meaning of the Treaty was the constitutional issue of the Senate's role in approving a treaty. Senator Nunn challenged the Administration's claim to reinterpret unilaterally a treaty and to disregard past official congressional testimony. In a letter of 2 September to the President he threatened to complicate the Senate approval process of the INF Treaty unless the Administration changed its position with regard to ABM Treaty interpretation. In early February 1988 he made good his threat by proposing to delay a Senate vote until the issue of the authoritativeness of Administration testimony is resolved.[35]

Republican senators who support the SDI conducted a four-month filibuster (from May until 11 September) to block the DOD authorization bill because it included SDI testing limitations. Eventually Congress passed legislation that requires that any SDI tests would have to fall within the traditional interpretation of the ABM Treaty.

On 2 October the Senate voted 57 to 41, as part of its authorization bill, to compel the USA to abide by the SALT limitations.[36] With a veto threatened by the President, Congress resolved the issue by denying money to overhaul the *USS Andrew Jackson* (SSBN 619).[37]

The year also saw the superpowers create nuclear risk reduction centres in Washington and Moscow. On 15 September Soviet Foreign Minister Eduard Shevardnadze and Secretary of State George Shultz signed the US–Soviet Agreement on the Establishment of Nuclear Risk Reduction Centers (for the text, see appendix 13E).

The inspiration for this idea began with Senators Henry Jackson, Sam Nunn and John W. Warner who in 1980 suggested the concept of a 'crisis control center'.[38] A more refined concept was eventually contained in a 1984 Senate resolution, sponsored by Nunn and Warner, which later became part of the FY 1985 DOD authorization bill. On 26 August 1985 the Reagan Administration gave its endorsement to a scaled-down version, and Senators Nunn and Warner discussed the idea with General Secretary Gorbachev on 3 September 1985. At the Geneva summit meeting in November 1985, Reagan and Gorbachev agreed 'to study the question of establishing centres to reduce nuclear risk at the expert level'.[39] Formal discussions began in 1986. The original Senate recommendation envisioned jointly (US–Soviet) manned centres which would focus on incidents or threats of nuclear terrorism, on matters of nuclear proliferation and on potential miscalculations during international crises. The signed agreement instead provides for the transmission of notifications, through the centres, of ballistic-missile launches and other information as agreed by the two nations. The Reagan Administration stressed that the centres would have no crisis-management role. According to the DOD, 'their principal function will be to exchange information and notifications as required under certain existing and possible future arms control and confidence building agreements'.[40] The centres will thus be used to provide the notifications and data updates required by the INF Treaty.

III. Soviet nuclear weapon programmes

Soviet strategic offensive forces continued to grow and be modernized in 1987; a net increase of nine launchers and 343 warheads was added. At the end of 1987, Soviet strategic forces comprised 1392 ICBMs with 6846 warheads, 968 SLBMs with 3408 warheads, and 155 bombers with 1170 warheads. Soviet strategic forces have grown by 8600 warheads since the signing of the SALT I Treaty and by 3100 warheads during the period of the Reagan Administration.[41]

The US Defense Intelligence Agency has predicted that, excluding a START agreement, the Soviet Union will have 12 000 strategic nuclear weapons (missile warheads and bombs) by 1990 and 16 000 by the mid-1990s.[42] Growth in strategic nuclear forces will continue to reflect MIRVing of the submarine missile force as well as expansion of bomber capabilities. According to the JCS, 'The Soviets have more than 30 new strategic offensive systems in various stages of development'.[43]

ICBMs

Deployment of new Soviet ICBMs continues. During 1987, the USSR deployed approximately 50 new road-mobile, single-warhead SS-25 missiles and the first few rail-mobile SS-24s. By the end of the year, some 126 SS-25 Sickle and 15 SS-24 Scalpel missiles were believed to be operational.

The SS-24 Scalpel, which was first deployed in August, is a new MX-size, 10-warhead, solid-propellant ICBM.[44] On 7 August, Senator Jesse Helms stated that the USA had detected at least five SS-24 launchers, a number which he claimed put the Soviet Union over the SALT sublimit for MIRVed ICBMs. Helms's disclosure was confirmed by the White House on 9 August. On 11 August, Victor Karpov, head of the arms control and disarmament directorate of the Soviet Foreign Ministry, confirmed that the SS-24 missile was being deployed. Karpov stated that the USSR was abiding by the SALT missile and MIRVing limits, and that the SS-24 was the one new ICBM permitted under the SALT II Treaty.

The US Central Intelligence Agency estimates that the Soviet Union will deploy more than 200 SS-24 launchers (with 2000 warheads).[45] Speculation continues about possible SS-24 deployment in silos, although evidence thus far indicates only mobile basing. Throughout the year, SS-11s continued to be retired to keep within the SALT limits; SS-17s and SS-19s also began to be withdrawn as SS-24s were fielded.[46]

The deployment of the two new, accurate Soviet ICBMs may change assessments of Soviet hard-target-kill capability. Since 1985 the US intelligence community has been reassessing its estimate of Soviet ICBM accuracy. Initially the multiple-warhead ICBMs deployed in the 1970s (SS-17, SS-18 and SS-19) were considered capable of destroying hardened targets. The new assessment concludes that only the SS-18s, or perhaps also the new SS-25s, are capable of destroying hardened targets.[47]

According to a US Air Force report of early 1987, 'three new ICBMs are expected to enter flight testing in the next four years'.[48] One of these new ICBMs, reportedly labelled the TT-09 (and to be designated the SS-X-26), was successfully flight-tested for the first time in December 1986, after two previous flight-test failures.[49] The TT-09 has been described as a liquid-propellant follow-on to the SS-18, with increased accuracy and throw-weight. The other two missiles, according to the US DOD, are a follow-on to the SS-24, and a new, possibly MIRVed version of the SS-25.[50] The DOD has predicted that the ICBM force (including the SS-24 and SS-25) will be almost entirely replaced with new systems by the mid-1990s.[51] On 29 and 30 September the USSR test-fired two ICBMs to within 575 km north-west of Hawaii, which caused a strong US protest.[52]

Strategic submarine programmes

The fourth Typhoon and third Delta IV Class ballistic-missile submarines became operational during the year, while the next units of each model were also launched. Sea trials of a fourth Delta IV submarine began in 1987; the submarine is expected to become operational in early 1988. Sea trials of the fifth Typhoon submarine also began in mid-1987.[53] It is assumed that older Yankee I Class submarines continue to be retired under the SALT II limits, but the number of those retired during 1987 is not publicly known.

At the Washington summit meeting in December 1987, the USA and the USSR agreed on new START counting rules for warhead levels, *inter alia* for SLBMs deployed after the SALT II Treaty was signed. The SS-N-18 SLBM (on Delta III submarines), which was previously estimated to carry an average of 7 warheads, will be counted as carrying 6. The SS-N-20 Sturgeon (on Typhoon submarines), which was previously estimated to carry 6–9 warheads,[54] is now to be counted as carrying 10. The SS-N-23 Skiff SLBM (on Delta IV submarines), which was previously estimated to carry 10 warheads, is now to be counted as carrying only 4.[55]

The new counting rules significantly change the overall assessment of the SS-N-23 missiles deployed on Delta IV submarines. When the missile was in development, it was compared to the US Trident II missile regarding hard-target-kill capability and warhead load. After it was deployed, it was reported by DOD as having 10 warheads and accorded great importance in the growth of Soviet strategic submarine force capabilities. The Joint Chiefs of Staff and the US Navy now believe that the missile will be backfitted in the Delta III Class submarines, replacing the SS-N-18. This would result in a significant net decrease in MIRV warheads, important for the Soviet force structure under the START ceiling of 6000 warheads.[56]

According to DOD, 'The Soviets are developing replacements for the SS-N-20 and SS-N-23 SLBMs for their next round of modernization'.[57] A new class of nuclear-powered ballistic-missile submarine (SSBN) is also reported to be under development, for deployment in the early 1990s.[58]

Strategic bomber programmes

Overall modernization of the Soviet bomber forces continues and is taking on a more important role in the strategic force structure. Three types of bomber continue in production. The new variant of the Bear bomber, the Bear-H, continues to be deployed carrying the first Soviet long-range cruise missile, the 1600-nautical mile (3000-km) range AS-15 Kent. Approximately 20 Bear-Hs with 160 new AS-15s were deployed during the year. Bear-H bomber training has been repeatedly documented, and the bombers have reportedly been conducting 'regular combat patrols to various points off the North American coast'.[59]

A new long-range strategic bomber, the Blackjack-A, continues in flight-testing and could be deployed in 1988–89, although it experienced at least one crash during 1987.[60] The Blackjack will reportedly be capable of carrying the AS-15 Kent cruise missile as well. The Soviet Union continues to build about 30 Backfire medium bombers per year.

In addition to new production, older Bear bombers continue to be retrofitted. Older Bear-B/C models have been upgraded to the new Bear-G model, which permits the aircraft to carry two nuclear-capable AS-4 Kitchen air-to-surface missiles (ASMs) in place of the single nuclear AS-3 Kangaroo ASM. A new Soviet supersonic ASM, similar to the US SRAM and designated the AS-X-16, is also under development for deployment on the Blackjack-A and Bear-H bombers.[61] The Soviet Union also has a refuelling aircraft under development, the Il-76 Midas, which could be used to increase the range of strategic bombing missions. The last 15 Bison bombers were removed from service during 1987.

Strategic defence developments

Soviet strategic defensive capabilities continued to be a major focus of reporting and propaganda during 1987. Many of the contentious issues—the purpose of the Soviet radar under construction at Krasnoyarsk, Soviet laser and anti-satellite (ASAT) capabilities, and Soviet strategic defence research and capabilities—were directly tied to the fortunes of the US SDI programme.[62] General Secretary Gorbachev announced that the Soviet Union would cease construction of the controversial Krasnoyarsk radar for one year.[63]

Table 2.1. US strategic nuclear forces, 1988

Weapon system				Warheads		
Type	No. deployed	Year deployed	Range (km)	Warhead × yield	Type	No. deployed
ICBMs						
Minuteman II	450	1966	11 300	1 × 1.2 Mt	W56	450
Minuteman III (Mk 12)	220	1970	13 000	3 × 170 kt	W62	660
Minuteman III (Mk 12A)	300	1979	13 000	3 × 335 kt	W78	900
MX	30	1986	11 000	10 × 300 kt	W87	300
Total	**1 000**					**2 310**
SLBMs						
Poseidon	256	1971	4 600	10 × 40 kt	W68	2 560
Trident I	384	1979	7 400	8 × 100 kt	W76	3 072
Total	**640**					**5 632**
Bombers[a]						
B-1B	72	1986	9 800	ALCM	W80-1	1 614
B–52G/H	263	1958/61	16 000	SRAM	W69	1 140
FB-111A	61	1969	4 700	Bombs	[b]	2 316
Total	**396**					**5 070**
Refuelling aircraft						
KC-135	615	1957	. .	. .	. .	. .

[a] Bombers are loaded in a variety of ways, depending on mission. B-1Bs and B-52s can carry a mix of 8-24 weapons, and FB-111s can carry 6 weapons, excluding ALCMs and B53 and B28 bombs.

[b] Bomber weapons include six different nuclear bomb designs (B83, B61-0, -1, -7, B57, B53, B43, B28) with yields from sub-kt to 9 Mt, ALCMs with selectable yields from 5 to 150 kt, and SRAMs with a yield of 170 kt.

Sources: Cochran, T. B., Arkin, W. M. and Norris, R. S., *Nuclear Weapons Databook, Volume 1: US Forces and Capabilities*, 2nd edn (Ballinger: Cambridge, Mass., forthcoming); Joint Chiefs of Staff, *United States Military Posture for FY 1989*; authors' estimates.

The ABM system around Moscow has now been upgraded to a two-layer system that includes improved silo-based Galosh exo-atmospheric missiles and new silo-based Gazelle endo-atmospheric high-acceleration missiles, plus a modernized array of early-warning, acquisition and battle-management radars.

Soviet surface-to-air missile (SAM) forces also continued to be modernized. The SA-X-12B Giant mobile SAM continued to be developed. The missile is believed by DOD to have limited anti-cruise missile and anti-tactical ballistic missile capabilities.[64] Meanwhile, the SA-10 Grumble continued to be deployed, both around Moscow and in the Far East. The SA-10 is believed to have some capability against ballistic missiles, according to DOD.

On 28 May a West German teenager flew a single-engine Cessna aircraft across the Soviet Union to Moscow and into Red Square. This incident was used by General Secretary Gorbachev to consolidate his power within the military.[65]

Table 2.2. US theatre nuclear forces, 1988

Weapon system				Warheads		
Type	No. deployed	Year deployed	Range (km)	Warhead × yield	Type	No. in stockpile
Land-based systems:						
Aircraft[a]	2 250	. .	1 060–2 400	1–3 × bombs	Bombs[a]	1 800
Missiles						
Pershing II	120	1983	1 790	1 × 0.3–80 kt	W85	125
GLCM	309	1983	2 500	1 × 0.2–150 kt	W84	325
Pershing 1a	72	1962	740	1 × 60–400 kt	W50	100
Lance	100	1972	125	1 × 1–100 kt	W70	1 282
Honest John	24	1954	38	1 × 1–20 kt	W31	132
Nike Hercules	27	1958	160	1 × 1–20 kt	W31	75
Other systems						
Artillery[b]	3 850	1956	30	1 × 0.1–12 kt	[b]	1 540
ADM (special)	150	1964	. .	1 × 0.01–1 kt	W54	150
Naval systems:						
Carrier aircraft[c]	1 100	. .	550–1 800	1–2 × bombs	Bombs[c]	1 450
Land-attack SLCMs						
Tomahawk	150	1984	2 500	1 × 5–150 kt	W80-0	150
ASW systems						
ASROC	. .	1961	1–10	1 × 5–10 kt	W44	574
SUBROC	. .	1965	60	1 × 5–10 kt	W55	285
ASW aircraft[d]	710	. .	1 160–3 800	1 × <20 kt	B57	897
Naval SAMs						
Terrier	. .	1956	35	1 × 1 kt	W45	290

[a] Aircraft include US Air Force F-4D/E, F-16A/B/C/D and F-111A/D/E/F. Bombs include four types (B28, B43, B57 and B61) with yields from sub-kt to 1.45 Mt.

[b] There are two types of nuclear artillery (155-mm and 203-mm) with four different warheads: a 0.1-kt W48, 155-mm shell; a 1- to 12-kt W33, 203-mm shell; a 0.8-kt W79-1, enhanced-radiation, 203-mm shell; and a variable-yield (up to 1.1 kt) W79-0 fission warhead. The enhanced-radiation warheads will be converted to standard fission weapons.

[c] Aircraft include Navy A-6E, A-7E, F/A-18A/B and Marine Corps A-4M, A-6E and AV-8B. Bombs include three types with yields from 20 kt to 1 Mt.

[d] Aircraft include US Navy P-3A/B/C, S-3A/B and SH-3D/H helicopters. Some US B57 nuclear depth bombs are allocated to British Nimrod, Italian Atlantic and Netherlands P-3 aircraft.

Sources: Cochran, T. B., Arkin, W. M. and Norris, R. S., *Nuclear Weapons Databook, Volume 1: US Forces and Capabilities*, 2nd edn (Ballinger: Cambridge, Mass., forthcoming); Joint Chiefs of Staff, *United States Military Posture for FY 1989*; authors' estimates.

Table 2.3. US nuclear warheads in Europe, 1965–92

Type	May 1965	Dec. 1981	Dec. 1987	After INF (1992)
Artillery				
8-inch	975	938	738	240
155-mm	0	732	732	732
Tactical SSMs				
Lance	0	692	692	692
Pershing I	200	293	100	0
Pershing II	0	0	108	0
Honest John	1 900	198	0	0
Sergeant	300	0	0	0
Nike Hercules SAMs	990	686	100	0
Bombs	1 240	1 729	1 400	1 400
B57 NDB	–	192	192	192
ADMs	340	372	0	0
GLCMs	0	0	256	0
Total	**5 945**	**5 832**	**4 318**	**3 256**

Source: Authors' estimates.

Soviet non-strategic nuclear forces

The INF Treaty, signed by the USA and the USSR in December 1987, will have a considerable impact on Soviet land-based non-strategic nuclear forces. The Treaty requires the elimination of six Soviet missile systems that were either part of their non-strategic nuclear forces or that had been tested for future deployment. These include the SS-20, the SS-4, the SS-12 and the SS-23 (all operational); the non-deployed SS-5 missile, undergoing retirement and in storage; and the SSC-X-4 ground-launched cruise missile under development (tested but not deployed).

The Treaty also bans all future ground-launched ballistic or cruise missile systems with ranges between 500 and 5500 km. This will terminate or prevent any development programmes for INF systems not specifically mentioned in the Treaty, such as a follow-on missile for the SS-20, or a GLCM—the SSC-X-5—believed by the USA to be in development.

Thus, one unheralded benefit of the Treaty is that it will cancel the Soviet GLCM development programme before any missiles are operationally deployed. At least one and possibly two Soviet long-range GLCMs were under development: the SSC-X-4, which the USA expected would be deployed in 1988, and possibly the SSC-X-5, a large supersonic GLCM (derived from the naval SS-NX-24), which the USA believed was in development. The SSC-X-4 had been flight-tested, and the INF Treaty Memorandum of Understanding (MOU) revealed that 6 SSC-X-4 launchers and 84 missiles were at Jelgava, near Riga in Latvia.[66]

The INF Treaty MOU revealed extraordinary, new, detailed information

Table 2.4. Soviet strategic nuclear forces, 1988

Weapon system					Warheads	
Type	NATO code-name	No. deployed	Year deployed	Range (km)	Warhead × yield	No. deployed
ICBMs						
SS-11 Mod. 2	Sego	184	1973	13 000	1 × .950–1.1 Mt	184
Mod. 3		210	1973	10 600	3 × 100–350 kt (MRV)	630[a]
SS-13 Mod. 2	Savage	60	1973	9 400	1 × 600–750 kt	60
SS-17 Mod. 2	Spanker	139	1979	10 000	4 × 750 kt (MIRV)	556
SS-18 Mod. 4	Satan	308	1979	11 000	10 × 550 kt (MIRV)	3 080
SS-19 Mod. 3	Stiletto	350	1979	10 000	6 × 550 kt (MIRV)	2 160
SS-24	Scalpel	5	1987	10 000	10 × 100 kt (MIRV)	50
SS-25	Sickle	126	1985	10 500	1 × 550 kt	126
Total		**1 382**				**6 846**
SLBMs						
SS-N-6 Mod. 3	Serb	256	1973	3 000	2 × .375–1 Mt (MRV)	512[a]
SS-N-8 Mod. 1/2	Sawfly	286	1973	7 800	1 × 1–1.5 Mt	286
SS-N-17	Snipe	12	1977	3 900	1 × .5–1 Mt	12
SS-N-18 Mod. 1/3	Stingray	224	1978	6 500	7 × 200–500 kt	1 568
Mod. 2			1978	8 000	1 × .45–1 Mt	
SS-N-20	Sturgeon	80	1983	8 300	10 × 100 kt	800
SS-N-23	Skiff	64	1986	7 240	4 × 100 kt	256
Total		**922**				**3 434**
Bombers						
Tu-95	Bear A	30	1956	8 300	4 bombs	120
Tu-95	Bear B/C	30	1962	8 300	5 bombs or 1 AS-3	150
Tu-95	Bear G	40	1984	8 300	4 bombs and 2 AS-4	240
Tu-95	Bear H	55	1984	8 300	8 AS-15 ALCMs and 4 bombs	660
Total		**155**				**1 170**
Refuelling aircraft	. .	140–170	. .	. .	. .	. .
ABMs						
ABM-1B	Galosh Mod.	16	1986	320	1 × unknown	16
ABM-3	Gazelle	80	1985	70	1 × low yield	80
Total		**96**				**96**

[a] SS-11 and SS-N-6 MRV warheads are counted individually.

Sources: Authors' estimates derived from: Cochran, T. B., Arkin, W. M. and Sands, J. I., *Nuclear Weapons Databook, Volume IV, Soviet Nuclear Weapons* (Ballinger: Cambridge, Mass., forthcoming); Arkin, W. M. and Sands, J. I., 'The Soviet nuclear stockpile', *Arms Control Today*, June 1984, pp. 1–7; US Department of Defense, *Soviet Military Power*, 1st, 2nd, 3rd, 4th, 5th, 6th edns; NATO, *NATO–Warsaw Pact Force Comparisons*, 1st, 2nd edns; Berman, R. P. and Baker, J. C., *Soviet Strategic Forces: Requirements and Responses* (Brookings Institution: Washington, DC, 1982); US Defense Intelligence Agency, *Unclassified Communist Naval Orders of Battle*, DDB-1200-124-85, Dec. 1985; Congressional Budget Office, *Trident II Missiles: Capability, Costs, and Alternatives*, July 1986; Collins, J. M. and Victory B. C., *U.S./Soviet Military Balance*, Library of Congress/Congressional Research Service, Report No. 87-745-S, 1 Sep. 1987; Background briefing on *SMP, 1986*, 24 Mar. 1986; SASC/SAC, *Soviet Strategic Force Developments, Senate Hearing 99–335*, June 1985; Polmar, N., *Guide to the Soviet Navy*, 4th edn (US Naval Institute: Annapolis, Md., 1986); Joint Chiefs of Staff, *United States Military Posture for FY 1989*.

Table 2.5. Soviet theatre nuclear forces, 1988

Weapon system					Warheads	
Type	NATO code-name	No. deployed[a]	Year first deployed	Range[b] (km)	Warhead × yield	No. deployed
Land-based systems:						
Aircraft						
Tu-26	Backfire	160	1974	4 000	1–3 × bombs or ASMs	320
Tu-16	Badger A/G	272	1954	3 100	1–2 × bombs or ASMs	272
Tu-22	Blinder A/B	120	1962	2 900–3 300	1–2 × bombs or 1 ASM	120
Tactical aircraft[c]		2 700	. .	700–1 300	1–2 × bombs	2 700
Missiles						
SS-20	Saber	405	1977	5 000	3 × 250 kt	1 215
SS-4	Sandal	65	1959	2 000	1 × 1 Mt	65
SS-12	Scaleboard	135	1969/78	900	1 × 500 kt	405
SS-1c	Scud B	500	1965	280	1 × 1–10 kt	500
SS-23	Spider	102	1985	500	1 × 100 kt	167
. .	FROG 7	370	1965	70	1 × 1–25 kt	200
SS-21[d]	Scarab	130	1978	120	1 × 10–100 kt	1 100
SS-C-1b	Sepal	100	1962	450	1 × 50–200 kt	100
SAMs[e]	. .	. .	. .	40–300	1 × low kt	. .
Other systems						
Artillery[f]	. .	<7 700	1973–80	10–30	1 × low kt	. .
ADMs	. .	?	?	?	?	?
Naval systems:						
Ballistic missiles						
SS-N-5	Sark	39	1963	1 400	1 × 1 Mt	39
Aircraft						
Tu-26	Backfire	130	1974	4 000	1–3 × bombs or ASMs	260
Tu-16	Badger A/C/G	205	1955	3 100	1–2 × bombs or ASMs	205
Tu-22	Blinder	35	1962	2 900–3 300	1 × bombs	35
ASW aircraft[g]	. .	390	1966–82	. .	1 × depth bombs	390
Anti-ship cruise missiles[h]						
SS-N-3 b/a,c	Shaddock/Sepal	228	1960	450	1 × 350 kt	120
SS-N-7	Starbright	90	1968	65	1 × 200 kt	44
SS-N-9	Siren	208	1969	280	1 × 200 kt	78
SS-N-12	Sandbox	200	1976	550	1 × 350 kt	76
SS-N-19	Shipwreck	136	1980	550	1 × 500 kt	56
SS-N-22	Sunburn	80	1981	100	1 × 200 kt	24
Land-attack cruise missiles						
SS-N-21	Sampson	12	1987	3 000	1 × n.a.	12
SS-NX-24	?	0	1988?	<3 000	1 × n.a.	0
ASW missiles and torpedoes						
SS-N-15	Starfish	400 (SS-N-15 and SS-N-16)	1973	37	1 × 10 kt	?
SS-N-16	Stallion		1979	120	1 × 10 kt	?
FRAS-1	. .	10	1967	30	1 × 5 kt	10
Torpedoes[i]	Type 65	?	1965	16	1 × low kt	?
	ET-80	?	1980	>16	1 × low kt	?

Table 2.5 *cont.*

Weapon system					Warheads	
Type	NATO code-name	No. deployed[a]	Year first deployed	Range[b] (km)	Warhead × yield	No. deployed
Naval SAMs						
SA-N-1	Goa	65	1961	22	1 × 10 kt	65
SA-N-3	Goblet	43	1967	37	1 × 10 kt	43
SA-N-6	Grumble	33	1981	65	1 × 10 kt	33

[a] For missile systems, the number is for operational or deployed missiles on launchers (see the Memorandum of Understanding of the INF Treaty).

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

[c] Nuclear-capable tactical aircraft models include MiG-21 Fishbed L/N, MiG-27 Flogger D/J, Su-7 Fitter A, Su-17 Fitter C/D, and Su-24 Fencer A/B/C/D/E.

[d] Includes SS-21s in GDR and Czechoslovakian units.

[e] Nuclear-capable land-based surface-to-air missiles probably include SA-1 Guild, SA-2 Guideline, SA-5 Gammon, SA-10 Grumble and SA-12 Gladiator.

[f] Nuclear-capable artillery include systems of three calibres: 152-mm (M-1976, 2S3 and 2S5), 203-mm (2S7 and M-1980) and 240-mm (2S4 and M-240). Some older systems may also be nuclear-capable.

[g] Includes 95 Be-12 Mail, 50 Il-38 May and 55 Tu-142 Bear F patrol aircraft. Land- and sea-based helicopters include 140 Ka-25 Hormone and 50 Ka-27 Helix models.

[h] Based on an average of two nuclear-armed cruise missiles per nuclear-capable surface ship, except for 4 per Kiev and Kirov Classes, and 4 per nuclear-capable cruise missile submarine, except for 12 on the Oscar Class.

[i] The two types of torpedo are the older and newer models, respectively, with the ET-80 probably replacing the Type 65.

Sources: Cochran, T. B., Arkin, W. M. and Sands, J. I., *Nuclear Weapons Databook, Volume IV, Soviet Nuclear Weapons* (Ballinger: Cambridge, Mass., forthcoming); Arkin, W. M. and Sands, J. I., 'The Soviet nuclear stockpile', *Arms Control Today*, June 1984, pp. 1–7; Polmar, N., *Guide to the Soviet Navy*, 4th edn (US Naval Institute: Annapolis, Md., 1986); Department of Defense, *Soviet Military Power*, 1st, 2nd, 3rd, 4th, 5th, 6th edns; NATO, *NATO–Warsaw Pact Force Comparisons*, 1st, 2nd edns; Joint Chiefs of Staff, *United States Military Posture for FY 1989*; interviews with US DOD officials, Apr. and Oct. 1986; 'More self-propelled gun designations', *Jane's Defence Weekly*, 7 June 1986, p. 1003; Handler, J. and Arkin, W. M., *Nuclear Warships and Naval Nuclear Weapons: A Complete Inventory*, Neptune Paper no. 2 (Greenpeace/Institute for Policy Studies: Washington, DC, 1988).

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about the location, support, production, storage and repair facilities for the SS-20, SS-4, SS-12 and SS-23 missiles. Virtually all previous public estimates of the size of Soviet INF forces were in error. As of 1 November 1987:

1. 405 SS-20 missiles were deployed with 405 launchers at 48 bases. The DOD continued to use the number 441, refusing to acknowledge that 36 launchers were removed. An additional 245 missiles and 122 launchers will have to be eliminated under the terms of the INF Treaty.

2. 65 SS-4 Sandal missiles were deployed at 13 bases, as opposed to 112 missiles commonly cited by DOD. Another 105 missiles and a total of 81 launchers will have to be destroyed.

3. 220 SS-12 Scaleboard missiles were deployed on 115 launchers at 6 bases in the Soviet Union, 4 bases in the German Democratic Republic and 1 base in Czechoslovakia. In addition there were 506 non-deployed missiles and 20 launchers.

4. 167 SS-23 Spider missiles were deployed with 82 launchers at 5 bases in the

Table 2.6. British nuclear forces, 1988[a]

Weapon system				Warheads		
Type	No. deployed	Year deployed	Range (km)[b]	Warhead × yield	Type	No. in stockpile[c]
Aircraft						
Buccaneer S2B	25[d]	1962	1 700	1 × 5–200 kt bomb	WE-177[e]	25
Tornado GR-1	220[f]	1982	1 300	1–2 × 5–200 kt bombs	WE-177	220
SLBMs						
Polaris A3-TK	64	1982[g]	4 700	2 × 40 kt	MRV	128
Carrier aircraft						
Sea Harrier FRS. 1	34	1980	450	1 × 5–200 kt bomb	WE-177	34
ASW helicopters						
Sea King HAS 5	56	1976	–	1 × depth bomb	?[h]	56
Lynx HAS 2/3	78	1976	–	1 × depth bomb	?	78

[a] British systems certified to use US nuclear weapons include 31 Nimrod ASW aircraft based in the UK, and 20 Lance launchers (1 regiment of 12 launchers, plus spares) and 135 artillery guns in 5 regiments (120 M109 and 15 M110 howitzers) based in FR Germany.

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

[c] Some sources put the total number of nuclear warheads in the British stockpile as low as 185 warheads, comprised of: 80 WE-177 gravity bombs, 25 nuclear depth bombs and 80 Chevaline A3-TK warheads.

[d] Plus 18 in reserve and 9 undergoing conversion, probably the remainder from FR Germany.

[e] The WE-177 is thought to be a tactical 'lay-down' type bomb.

[f] Some Buccaneer and Jaguar aircraft, withdrawn from bases in FR Germany and replaced by Tornado GR-1, may still be assigned nuclear roles in the UK.

[g] The Polaris A3-TK (Chevaline) was first deployed in 1982 and has now completely replaced the original Polaris A-3 missile (which was first deployed in 1968).

[h] The RN nuclear depth bomb is believed to be a low-yield variation of the RAF tactical bomb.

Sources: UK Ministry of Defence, *Statement on the Defence Estimates*, 1980 through 1986 (Her Majesty's Stationery Office: London, annual); Rogers, P., *Guide to Nuclear Weapons 1984–85* (University of Bradford: Bradford, 1984); Campbell, D., 'Too few bombs to go round', *New Statesman*, 29 Nov. 1985, pp. 10–12; US Defense Intelligence Agency, *Ground Order of Battle: United Kingdom*, DDB-1100-UK-85 (secret, partially declassified), Oct. 1985; Nott, J., 'Decisions to modernise U.K.'s nuclear contribution to NATO strengthen deterrence', *NATO Review*, vol. 29, no. 2 (Apr. 1981); International Institute for Strategic Studies, *The Military Balance 1987–1988* (IISS: London, 1987); authors' estimates.

Soviet Union and 2 bases in the GDR. Before the Treaty was signed, a figure of 36 launchers was commonly cited by official Western sources.

The INF Treaty data confirmed the deployment of SS-12 *and* SS-23 missiles in Eastern Europe. Previously, it had been believed that only SS-12 missiles had been forward deployed.

Table 2.7. French nuclear forces, 1988

Weapon system				Warheads		
Type	No. deployed	Year deployed	Range (km)[a]	Warhead × yield	Type	No. in stockpile
Aircraft						
Mirage IVP/ASMP	18	1986	1 500[b]	1 × 300 kt	TN 80	20
Jaguar A	45	1974[c]	750	1 × 6–8/30 kt bomb	ANT-52[d]	50
Mirage IIIE	30	1972[c]	600	1 × 6–8/30 kt bomb	ANT-52[d]	35
Refuelling aircraft						
C-1325F/FR	11	1965	. .	. .	. .	. .
Land-based missiles						
S3D[e]	18	1980	3 500	1 × 1 Mt	TN-61	18
Pluton	44	1974	120	1 × 10/25 kt	ANT-51[f]	70
Submarine-based missiles						
M-20	64	1977	3 000	1 × 1 Mt	TN-61	64
M-4A	16	1985	4 000–5 000	6 × 150 kt (MIRV)	TN-70[g]	96
M-4 (modified)	16	1987	6 000	4–6 × 150 kt (MIRV)	TN-71	<96
Carrier aircraft						
Super Etendard	36	1978	650	1 × 6–8/30 kt bomb	ANT-52[d]	40

[a] Range for aircraft indicates combat radius, without refuelling.

[b] Range does not include the 80- to 250-km range of the ASMP air-to-surface missile.

[c] The Mirage IIIE and Jaguar A aircraft were first deployed in 1964 and 1973, respectively, although they did not carry nuclear weapons until 1972 and 1974, respectively.

[d] Gravity bombs for these aircraft include: the ANT-52 warhead (incorporating the same basic MR 50 charge as that used for the Pluton SSM), reported as being of 25- and 30-kt by CEA and DIA, respectively; and an alternate low-yield gravity bomb of 6-8 kt.

[e] S3D ('Durcie') is the designation for the hardened S3 missile. The original S3 missile was deployed in 1980.

[f] Warheads for the Pluton include the ANT-51 (incorporating the same basic MR 50 charge as the ANT-52) with a yield of 25 kt, and a specially designed alternate warhead of 10 kt.

[g] The *Inflexible* will be the only SSBN to receive the TN-70. All subsequent refits of the M-4 into Redoutable Class SSBNs will incorporate the improved TN-71 warhead. The M-4As of the *Inflexible* will eventually also be changed to hold the TN-71, dockyard space and budgets permitting.

Sources: Commissariat à l'Energie Atomique (CEA), 'Informations non classifiées sur l'armement nucléaire français', 26 June 1986; CEA, 'Regard sur l'avenir du CEA', *Notes d'Information*, Jan.–Feb. 1986, p. 7; CEA, *Rapport Annuel 1985*, pp. 77–79; US Defense Intelligence Agency (DIA), *A Guide to Foreign Tactical Nuclear Weapon Systems under the Control of Ground Force Commanders*, DST-1040S-541-83, 9 Sep. 1983, with CHG 1 and 2 (secret, partially declassified), 17 Aug. 1984 and 9 Aug. 1985; DIA, *Air Forces Intelligence Study (AFIS): France*, DDI-1300-FR-77 (secret, partially declassified), Apr. 1977; DIA, *Military Capability Study of NATO Countries*, DDB-2680-15-85 (secret, partially declassified), Sep. 1985 and Dec. 1977; Laird, R. F., 'French nuclear forces in the 1980s and the 1990s', *Comparative Strategy*, vol. 4, no. 4 (1984), pp. 387–412; International Institute for Strategic Studies, *The Military Balance 1987–1988* (IISS: London, 1987); authors' estimates.

Table 2.8. Chinese nuclear forces, 1988

Weapon system				Warheads	
Type	No. deployed	Year deployed	Range (km)	Warhead × yield	No. in stockpile
Aircraft[a]					
B-5 (Il-28 Beagle)	15–30	1974	1 850	1 × bomb[b]	15–30
B-6 (Tu-16 Badger)	100	1966	5 900	1–3 × bombs	100–130
Land-based missiles					
DF-2 (CSS-1)	40–60	1966	1 100	1 × 20 kt	40–60
DF-3 (CSS-2)	85–125	1972	2 600	1 × 1–3 Mt	85–125
DF-4 (CSS-3)	~10	1978	7 000	1 × 1–3 Mt	10
DF-5 (CSS-4)	~10	1980	12 000	1 × 4–5 Mt	10
Submarine-based missiles[c]					
CSS-N-3	24	1983	3 300	1 × 200 kt–1 Mt	26–38

[a] All figures for these bomber aircraft refer to nuclear-capable versions only. Hundreds of these aircraft are also deployed in non-nuclear versions.

[b] Yields of bombs are estimated to range from below 20 kt to 3 Mt.

[c] Two missiles are presumed to be available for rapid deployment on the Golf Class submarine (SSB). Additional missiles are being built for new Xia Class submarines.

Sources: Joint Chiefs of Staff, *Military Posture (annual report) FY 1978, 1982, 1983*; Department of Defense, *Annual Report for 1982*; Defense Intelligence Agency, *Handbook on the Chinese Armed Forces*, Apr. 1976; Defense Intelligence Agency, 'A guide to foreign tactical nuclear weapon systems under the control of ground force commanders', DST-1040S-541-83-CHG 1 (secret, partially declassified), 17 Aug. 1984; Godwin, P. H., *The Chinese Tactical Airforces and Strategic Weapons Program: Development, Doctrine, and Strategy* (Air University: Maxwell AFB, Ala., 1978); Washburn, T. D., *The People's Republic of China and Nuclear Weapons: Effects of China's Evolving Arsenal*, ADA 067350 (National Technical Information Service, US Department of Commerce: Washington, DC, 1979); US Congress, Joint Economic Committee, *Allocation of Resources in the Soviet Union and China* (annual hearing) 1976, 1981, 1982, 1983; Anderson, J., 'China shows confidence in its missiles', *Washington Post*, 19 Dec. 1984, p. F11.

Meanwhile, deployment of the new short-range SS-21 Scarab missile continued at a steady rate with Soviet ground forces. Virtually all of the 130 SS-21 transporter-erector-launchers (TELs) deployed until the end of the year have been assigned to the Western Theatre of Military Operations (*Teatr Voennykh Deistvii*, abbreviated TVD).[67] By the end of the year, all of the FROG missiles in Soviet divisions in the GDR had been equipped with the SS-21. Nuclear-capable self-propelled artillery also continued in production during the year. The US Defense Intelligence Agency estimates that, when fully deployed, the number of new nuclear-capable artillery guns and the older 152-mm howitzers will exceed 10 000.[68]

Naval nuclear forces

The Soviet Navy continued to increase its nuclear weapon capabilities during 1987, particularly with a long-range sea-launched cruise missile (SLCM). In contrast, the year witnessed the continued slow-down in shipbuilding, foretelling a shrinking but more capable Soviet Navy.

The first Soviet long-range nuclear SLCM, the SS-N-21 Sampson, was made operational in 1987.[69] The SS-N-21, a land-attack SLCM with a maximum range of approximately 3000 km, is small enough to be fired from a standard Soviet torpedo tube. Possible launch platforms include the Akula, Sierra, Victor II and converted Yankee Class attack submarines. Another Soviet SLCM, the supersonic SS-NX-24, continued to be tested during the year. This large SLCM, estimated to be more than 12-m long and to have a wingspan of more than 5 m,[70] will be flight-tested again from a converted Yankee Class submarine (SSGN). It is expected to be deployed during 1988–89.

In addition to its many models of nuclear-capable anti-ship cruise missiles, the Soviet Navy has a wide variety of naval nuclear weapons, including nuclear-armed torpedoes. The US JCS identified two of these nuclear torpedoes as the Type 65 and the ET-80.[71] In the Soviet Navy, according to the JCS, 'almost all major surface combatants (about 290), all submarines (about 340), as well as a few other combatants (some 31) are armed with at least one, or a mix of, nuclear weapon systems'.[72]

In the shipbuilding programme, the first aircraft-carrier of the 65 000-ton Kremlin Class, the *Leonid Brezhnev*, continued under construction. The US Navy told Congress early in the year that the *Brezhnev* should commence sea trials within two years, that a second aircraft-carrier is being built, and that two more will be built by the year 2000.[73] Significantly, the USA acknowledged for the first time that it will be a V/STOL (vertical/short take off and landing) carrier with a 'ski-jump', instead of the US large deck-type for operating advanced aircraft with catapults and arresting gear.[74] This means that the Soviet Navy will not, contrary to US predictions, be able to operate high-performance aircraft from carriers for many years.

Other naval deployments during 1987 included:

1. A fourth Kiev Class aircraft-carrier began sea trials.
2. A third Kirov Class nuclear cruiser was launched.
3. An eighth Sovremennyy Class guided-missile cruiser became operational.
4. A second Slava Class guided-missile cruiser became operational.
5. The first Sierra Class nuclear-powered attack submarine became operational.

All these vessels are nuclear-capable.

The Backfire-C bomber continued in production and was assigned to both Strategic Air Armies and Soviet Naval Aviation (SNA), replacing the Badger bomber in SNA. The nuclear-capable Su-24 Fencer also continued in production, for the Air Force and the Navy, and a strike/reconnaissance version of the aircraft, the Fencer-E, was introduced in SNA during the year.

IV. British nuclear weapon programmes

Britain moved forward in 1987 with the idea of developing a nuclear-armed air-launched cruise missile jointly with France. This would be the first such joint effort between the two nations and the first time Britain has worked on a joint nuclear weapon programme with a country other than the USA. All other British nuclear weapon programmes were continued during 1987, including possibly the last Chevaline-equipped SLBM modernization before the Trident submarines and missiles are introduced in the mid-1990s. The fourth and last British SSBN to be equipped with the Chevaline system began operations in 1987.

British–French nuclear co-operation

British Defence Secretary Younger and French Defence Minister Giraud met seven times in 1987 to discuss joint nuclear weapon development and procurement. Following their last meeting in December 1987 in London, the British and French defence staffs were ordered to study the feasibility of jointly developing a nuclear-armed, air-launched cruise missile as a 1990s successor to older nuclear weapons in their respective arsenals.[75]

The proposed jointly developed missile is currently envisioned as arming the British Tornado aircraft in the late 1990s and replacing the current French ASMP missile on French aircraft (see section V for details). The missile would have a range of more than 480 km, which is similar to that planned for a French missile under development, or about 180 km greater than that of the current French ASMP. Whether any future missile development work would be based on the ASMP or would start from a new design has not as yet been determined.[76]

The nuclear warheads for the joint missile would be developed by each country independently. As far as the British warhead is concerned, it was reported that the Atomic Weapons Research Establishment (AWRE) has considered fitting a modified Trident warhead to the cruise missile, which could give it a 150-kt warhead.[77]

In addition to the emerging British–French ALCM programme, the United Kingdom has expressed interest in joining the USA in developing a nuclear stand-off air-to-surface missile (ASM) for NATO.[78] (This nuclear ASM is one of the 'modernization' ideas which have been under consideration by NATO since before 1983.) The Royal Air Force (RAF) has previously expressed interest in a nuclear ASM for the late 1990s to replace their ageing WE-177 gravity bomb.[79] Such a missile would enable the Tornado aircraft to survive improved WTO air defences.

Polaris/Chevaline

It is estimated that Britain's strategic squadron number 10, comprising four Resolution Class SSBNs, has completed some 188 operational patrols since the maiden patrol of *HMS Resolution* in 1968.[80]

A mid-life refurbishment of the 'front end module' of the Chevaline A3-TK missile started in January 1988 and is expected to take a number of years.[81] This programme could be the last major contract on the Chevaline before the system is replaced by the Trident system in the mid-1990s. All four submarines equipped with Chevaline are now operational.

The US Navy Strategic Systems Project Office (SSPO) sells Polaris[82] and Trident II missiles (without the warheads), equipment and supporting services to the UK under the Polaris Sales Agreement, and certain services under the 1958 USA–UK Agreement for Cooperation on the Uses of Atomic Energy for Mutual Defense Purposes. Since the inception of the Polaris Sales Agreement on 6 April 1963, the UK has spent (through the SSPO) some $2.1 billion (through the end of FY 1987) in the USA on the Polaris, Chevaline and Trident weapon systems.[83] Expenditures in FY 1987 are estimated to have been $30.6 million for the Polaris and Chevaline.[84]

Trident submarine and warhead

Rear Admiral Slater, Chief, Strategic Systems Executive, announced after the re-election of Prime Minister Thatcher in early 1987 that the entire Trident programme is 'on time, on target for full deployment of four subs, each carrying 16 Tridents, by 1994–95'.[85] While all four SSBNs will probably be commissioned by 1994, full deployment may not be achieved until a few years later because of the time required for sea trials and for demonstration and shakedown operations. The first submarine, *HMS Vanguard*, is scheduled to put to sea in 1991.

The British Government stated in 1987 that each British Vanguard Class SSBN 'will carry no more than a maximum of 128 warheads'.[86] This would be 8 MIRV warheads per missile, although individual missiles might be loaded with fewer than 8 warheads. Following the December 1987 US–Soviet counting rule agreement (see sections II and III) that would prevent the USA from testing Trident II SLBMs with more than eight RVs, the British Trident SLBMs could have no more than eight RVs, as the British SLBMs are tested by the USA at the Eastern Test Range in Florida.

Although shrouded in heavy secrecy, the issue of warhead production for the Trident programme was raised again in 1987. After newspaper investigations, Defence Ministry sources acknowledged in January 1988 that the planned production facility A90 at Aldermaston is several years behind schedule.[87] As a result, it will not be able to produce components for Trident warheads until at least 1992, thus raising the prospect of a shortage of warheads for the Trident programme. There was no open public or parliamentary debate on the issue since such details are considered secrets.

The introduction of the Trident II D-5 SLBM aboard the new Vanguard Class SSBNs will result in a great increase in the numbers, accuracy and destructiveness of the British sea-based nuclear force. Britain will no longer have a 'minimum deterrent'. The deployment of Trident will result in a fourfold increase in total warheads over the present Resolution Class SSBNs armed with Polaris A3-TK missiles (Chevaline), each with two MRV warheads and decoys.[88]

The introduction of a MIRVed missile allows for greater target coverage. Basically the two Chevaline front-ends on each Polaris missile have only one target, whereas the eight warheads possible on each Trident II missile could have up to eight separate targets. However, even with this extra capability, the British Ministry of Defence (MOD) has stated that 'the essential capability for us is to be able to continue to hold at risk key aspects of Soviet state power, not to threaten the maximum possible number of individual targets'.[89] Thus the main target area will continue to be Moscow, although the fact of having hundreds of additional warheads may force changes in targeting policy.[90]

As of 31 March 1987, total expenditure for the Trident programme was approximately £1000 million, with a further £2000 million committed.[91] Expenditures through the SSPO in FY 1987 were US $33.1 million for Trident,[92] most of which is accounted for by the Trident Strategic Weapons System (SWS) (missiles, related support equipment, etc.). Ninety-five per cent of the costs for the Trident SWS are incurred in the USA,[93] and most fall under the provisions of the Polaris Sales Agreement which has been extended to cover the sale of Trident II.

A report issued by the British National Audit Office on 14 July 1987 disclosed some puzzling statistics about the work on the British Trident warhead.[94] Of the three major areas of expenditure (development, production and fissile material), the document stated that 'most of the expenditure on development and production is incurred in the US'.[95] This revelation runs contrary to official British statements that the British Trident warhead will be of 'British design and manufacture'.[96]

There are two possible explanations: first, as concerns 'production', the National Audit Office (NAO) may be confused as to what constitutes a warhead. It is possible that the NAO was referring to the re-entry vehicles instead of actual nuclear warheads, which may explain the NAO statement that 'most of the development and production expenditure is incurred in the US', and the USA will supply 'certain warhead-related components and services'. Second, there may be confusion concerning 'development' and 'production', which were included in the same category. Some development will take place in the USA, such as costs incurred at the Nevada Test Site, while production will not.[97]

The document also disclosed that the largest element of British expenditure on the Trident nuclear warhead was on fissile materials. The current estimate for procurement has gone down 16 per cent in real terms since 1981.

V. French nuclear weapon programmes

There were a number of important developments in French nuclear forces during 1987, including the delivery of the first Mirage 2000N nuclear aircraft and the operational deployment of the modernized strategic submarine *Le Tonnant*, that will have a considerable effect on the character and composition of these forces through the end of the century. These developments are described below (see table 2.7).

Hadès missile

The Hadès tactical nuclear missile programme remains on schedule, to be deployed in 1992, presumably with a neutron warhead. In April 1987 Prime Minister Jacques Chirac announced that the French Government will decide 'in the near future' whether to produce and deploy neutron warheads. However, a decision is needed soon if the neutron warheads are to be mounted on the Hadès missile in 1992.[98] A 22 October 1987 dispatch from the German Press Agency quotes President Mitterrand as saying that France will soon have the neutron bomb in its arsenal but hopes they will never be used.[99]

The enhanced-radiation weapons will cost France about 6 million francs ($1.03 million) each, while development of the warhead is costing 1 billion francs ($171 million), according to a report published by the Finance and Economic Affairs Committee of the French National Assembly.[100]

The first development flight of France's Hadès tactical nuclear missile is planned in 1988 from the French Centre d'Essais des Landes (CEL). Hadès will be launched from mobile tractor/trailers and will have a range of more than 480 km, a fourfold increase from the 120-km range of the Pluton tactical missile it will replace.[101] The development costs of the Hadès missile (excluding the warhead) are likely to reach 4.5 billion francs. The total cost, taking into account the manufacture of about 100 transporters, is about 15 billion francs.[102]

In October 1987 President Mitterrand conducted a high-profile visit to FR Germany during which he sought to calm the longstanding fears in the FRG over whether France would ever fire its short-range Pluton nuclear missiles at a WTO invasion force after it entered the FRG. German officials welcomed Mitterrand's carefully worded suggestions that France should not use its Pluton missiles against West German territory, even though the weapons' 120-km range makes them unsuitable for any other purpose. The Hadès, which would have a range of 480 km, would be able to reach the GDR (as well as eastern Czechoslovakia). However, Bonn takes little comfort at this statistic and believes that France should not use nuclear weapons over German territory, east *or* west.[103]

According to a document released by the US Army War College in 1987,[104] it appears that tactical operational doctrine in the early 1980s for French land–air forces in the Central Region called for the warheads of the 70 Pluton missiles, and air support from the Tactical Air Force (FATAC) with 15 warheads, to be used in FR Germany to destroy the first echelon of an invading Soviet Army before it could cross the Lorraine plateau, and to channel the enemy advance to obtain the maximum effect from nuclear weapons if their use were approved by the President. According to the document, if such approval were given, France would be restricted to fire only at military targets farther than 4 km from urban centres with populations of 5000 or more.

Air Force programmes

On 19 February 1987 the French manufacturer Dassault-Breguet delivered the first nuclear version of its Mirage 2000 combat aircraft, the 2000N, to the French Air Force training base at Bordeaux-Merignac.[105] The Mirage 2000N is due to replace the nuclear-armed Mirage IIIE and Jaguar A aircraft of the tactical air force (FATAC).

The Dauphiné Squadron (EC 1/4) of the Fourth Fighter Wing at Luxeuil will be the first to receive the nuclear-capable Mirage 2000N aircraft, in July 1988, replacing their Mirage IIIE nuclear-armed aircraft.[106]

France plans to build 112 Mirage 2000Ns for the FATAC, at an overall cost of 30.3 billion francs for the aircraft and 3.2 billion francs for the nuclear Air-Sol-Moyenne-Portée (ASMP) missile it will carry. Although all 112 Mirage 2000N aircraft will be able to carry nuclear or conventional weapons, 70 of them will now be dedicated to nuclear roles and armed with the ASMP. The remaining 2000Ns will be equipped to fire either the ASMP, or conventional weapons for non-nuclear strike missions.[107]

The Super Etendard carrier-based aircraft will also be equipped with the ASMP missile in 1988, replacing ANT-52 gravity bombs. This modification began in 1985 with Squadron 11F based at Landivisiau. Modification of all aircraft of Squadrons 11F and 17F (based at Hyères) will be completed in 1988. The remaining Squadron, number 14F (also at Landivisiau), will be modified to carry the ASMP after 1988.

The ASMP, now operational on Mirage IVP aircraft and soon to be deployed on the Super Etendard and Mirage 2000N aircraft, is a wingless air-to-surface nuclear missile, programmed to fly at a constant angle of attack of 1 degree (i.e., almost horizontal),[108] with a cruise speed of Mach 2.5–2.7 (under ramjet power) and a maximum range of 300 km. Propulsion is by solid-fuel rocket booster followed by a liquid-fuel ramjet which ignites when the rocket propellant is expended. Compared to the US air-launched cruise missile, the ASMP is slightly smaller, has about half the weight, has almost one-tenth the range, but has twice the yield at 300 kt.[109]

Concerning the British–French joint ALCM development plan, France has not only interest but also experience in nuclear-armed ASMs. The French ASMP missile has provided France with more than five years of knowledge of various aspects of air-launched, guided nuclear missile systems and related technologies. In addition, the French company Aérospatiale is already working on a longer-range supersonic variant of the ASMP missile, the Air-Sol-Longue-Portée (ASLP), which would have a maximum range of 480 km.[110] The joint cruise missile would replace the ASMP on such aircraft as the Mirage 2000N and the Rafale model being developed.

France also has experience in ALCM-compatible warheads and might use some future variant of its TN-80 series of warheads. The TN-81, an improved warhead for the ASMP, is now under development by the French Commissariat à l'Energie Atomique (CEA) and is expected to be deployed in 1988 on the Mirage 2000N and Super Etendard aircraft.[111]

Force Océanique Stratégique

It is estimated that six submarines of the Force Océanique Stratégique (FOST) have to date (March 1988) completed some 205 operational patrols since the first SSBN entered active service in 1971.[112]

At the end of 1987 the submarine *Le Tonnant* was put into operation. It is the first submarine to carry the TN-71 warhead on its newly installed M-4 missiles, and is the last of the Redoubtable Class submarines to be modified before new SSBNs join the fleet. The TN-71 warhead configuration permits an extended range of 6000 km. It is unclear how many warheads would be placed on each missile, but it could be fewer than the standard six. The TN-71 is known to be lighter and to have a smaller 'surface-equivalent' radar image than the original TN-70.

The first submarine of a new class, *Le Triomphant*, is expected to enter service with the French Navy in 1994. It will displace 14 200 tonnes submerged and have a length of 138 m and a crew of 100 (compared to 138 men on current Redoubtable Class SSBNs).[113] A second model, called the new-generation submarine and abbreviated SNLE-NG, is expected to be extended to 16 000 tonnes and 170 m, possibly to accommodate the larger M-5 SLBM.[114] In preparation for the future generation of SSBNs, France has opened new shipbuilding facilities at the Cherbourg naval dockyard, which will allow the construction of new and larger SSBNs.[115]

Le Triomphant, the seventh French SSBN, will carry 16 modified M-4 missiles, armed with the new TN-75 warhead. According to French officials, the TN-75, now in development, is an 'almost invisible' miniaturized warhead.[116] The first M-5 missiles are expected to appear on board the third submarine in the SNLE-NG programme that should be operational in 1999. The M-5 will be equipped with 8–12 very light and compact MIRV TN-76 warheads with a range exceeding 6000 km.[117]

Strategic communications

Recently France has taken an interest in redundant and survivable nuclear weapon communications. The ASTARTE (Avions Station Relais de Transmissions Exceptionelles) strategic communications programme entered operational service in early 1988. ASTARTE consists of four airborne communications aircraft derived from the French TRANSALL C 160 Nouvelle Génération aircraft. These are to be used for airborne VLF (very-low-frequency) communications with submerged ballistic-missile submarines and other strategic forces. The ASTARTE programme was launched in 1981, with the first experimental flight with VLF transmitters in 1986.[118] All four aircraft are expected to be operational in 1989.

The success of the ASTARTE programme has depended upon equipment from companies in the United States. The Rockwell Collins company has sold France four improved versions of the VLF transmitters used in US Navy/Lockheed EC-130Q TACAMO nuclear communications aircraft for $97 million. In addition, Rockwell International provided electromagnetic pulse (EMP) hardening for the aircraft, bringing the total cost for US involvement in ASTARTE to $120 million.[119] Rockwell has provided spares, training and support to France for the ASTARTE programme; for this purpose Rockwell has established 10 offices in France.

The CERTEL (Centre d'Études et de Recherches en Télécommunications) of the French Ministry of Armaments (DGA) is responsible for the elaborate and redundant forms of communication with French SSBNs. In a military crisis, or a situation in which the French land-based VLF system were threatened or destroyed, the ASTARTE plan would be put into action.[120] One of four aircraft would rise from an underground shelter at the Evreux Air Base

(Eure), take off, unroll 'several kilometres of antenna',[121] and be able to remain in flight for 10 hours without refuelling (although the aircraft are capable of being refuelled).

Future nuclear programmes

Development of the new French lightweight S4 land-based ballistic missile continued in 1987. When the S4 becomes operational in 1996 it will carry the new TN-75 warhead. The TN-75, now in development, is a miniaturized warhead using stealth techniques. This is the same warhead that will be carried by the M-4 missiles on the seventh French SSBN, *Le Triomphant*.[122]

Over the past decade the French Navy has debated the value of tactical nuclear weapons at sea. Unlike the USA, the UK and the USSR, France does not possess nuclear anti-submarine warfare (ASW) and anti-surface warfare (ASUW) weapons.[123] France's two Clemenceau Class aircraft-carriers were the first and only French vessels to have a nuclear capability: the Super Etendard strike aircraft, armed with the ANT-52 gravity bomb and from 1988 with the ASMP air-to-surface missile. Both the ANT-52 and the ASMP could be used against enemy surface ships, although it is more likely that they would be used to attack land targets.

Recently the debate has been revived by an article by the Commander of the French Navy, Admiral Louzeau, in the journal *Défense Nationale*. Admiral Louzeau cites the need for a French nuclear ASW weapon, while claiming the inadequacies of conventional ASW weapons against modern Soviet nuclear submarines.[124] It is unclear whether such a weapon would be intended for launch from a ship, submarine, helicopter or aircraft.

VI. Chinese nuclear weapon programmes

During 1987 China continued its programme of reform with the main emphasis on economic modernization. The military, which has been accorded last place in the 'four modernizations', is undergoing a major reform that will reduce its size but eventually increase its combat capabilities. The armed forces are also contributing to civilian production and economic improvement. A decision was taken in 1985 by the Central Military Commission of the Communist Party, which is the highest-level decision-making body on military affairs in China, that a major war is highly improbable for the rest of this century, and that China can concentrate on its economy while modernizing its military in a limited way.

Consequently, China's nuclear weapon programmes have generally stressed qualitative, rather than quantitative, improvements. China has an interest in appearing to have a minimal, yet credible, nuclear force. None the less, the US intelligence community predicted in 1986 that China's nuclear arsenal will double by 1996.[125] This could mean that China would have some 600-700 warheads, possibly including MIRVed missiles. China's existing nuclear forces are being modernized while kept at roughly the same overall number. Since China has neither the desire nor the resources to engage in a costly nuclear buildup, it is satisfied to carry out R&D efforts on a number of nuclear weapon programmes and to keep as many options as possible open for the future. The current programmes are described below (see table 2.8).

Land-based missile programmes and technology

China is developing a new short-range ballistic missile (SRBM) called the M-9, or simply the M missile, which it is advertising for sale.[126] This missile, which is expected to be introduced into Chinese missile units before any versions are sold abroad, uses solid fuel, has a maximum range of 600 km and is mounted on a truck for transport and launching.[127] A full-scale model was displayed at a defence exposition in 1987 along with a list of the missile's characteristics. Its advertised high degree of mobility, use of solid fuel and consequent rapid reaction time—30 minutes—would represent considerable advances in Chinese missile technology and capability. It is unclear what effect, if any, the US–Soviet INF Treaty will have on China's interest in deploying the short-range nuclear M-9. Under the terms of the Treaty, the USSR will eliminate all its ground-launched ballistic missiles with ranges between 500 and 5500 km, including hundreds of nuclear missiles deployed within range of Chinese targets.

All Chinese land-based nuclear ballistic missiles currently use liquid fuel. China's newest nuclear missiles, CSS-N-3 SLBMs, use solid fuel, which is safer and more reliable than liquid fuel. By developing the M-9 missile with solid fuel, China may be starting a programme to convert all its land-based missiles from liquid to solid fuel. This would represent a considerable increase in Chinese nuclear capabilities for several reasons. First, liquid fuel imposes limits and dangers on missile operations. Liquid-fuelled missiles must be kept still in a vertical position when fuelled. They cannot be placed or transported in a horizontal position: the weight of the fuel would rupture the missile. As several liquid fuel accidents have proved, even small leaks can be disastrous.[128]

All of China's land-based missiles can be transported on or launched from trailers, but they must travel without fuel. To launch a missile, it must first be raised from a horizontal (travelling) to a vertical position and then fuelled. The fuelling process is dangerous, slow and cumbersome, requiring a large fuel crew, a fleet of special fuel trucks and pumping equipment. It generally takes hours to prepare a liquid-fuelled missile for operation, compared to 30 minutes claimed for the M-9 missile.[129]

Second, if China were to use solid fuel it would not only avoid the liquid fuel problems, but it could increase the mobility and survivability of its land-based missile force, both important qualities for China. In addition, the relative ease of maintaining communication with and control of land-based missile forces would increase Chinese incentives to convert them to solid fuel.

During 1987 China continued to work on the effectiveness of its land-based nuclear missiles by such measures as: modernizing and computerizing communications networks, improving the nuclear support and logistics system, preparing pre-surveyed launch sites for various kinds of missiles and launchers, training for nuclear war in all weather and geographic conditions, and generally improving and expanding the Chinese capability to launch nuclear weapons all year round.[130] There were no public official reports of further tests of MIRVed systems during the year.

Other programmes

China continues to modernize its strategic submarine forces. There were prominent announcements that one of the Xia Class SSBNs had completed its training programme and had joined active service.[131] In 1987 the Chinese Navy announced the improvement of a VLF communications station with world-wide range, probably at Changde, that has been in operation since 1980. According to an article from the official news agency Xinhua, the station 'has been successfully communicating with submarines', and 'can transmit information . . . pertinent to the launching of carrier rockets', which means SLBMs.[132] The same article states that VLF 'is used for transmission through deep-water', and 'is not influenced by the ionosphere or atomic explosions'. China also has several VLF stations capable of regional transmission.[133] All five nuclear weapon nations use VLF as the primary means of communicating with their submerged submarines; it is an essential means for China to maintain control of its submarine forces. Other naval communications developments were also reported during the year.[134]

China is producing only a few, perhaps three, medium bombers per year at the Xian aircraft plant.[135] These are naval variants of the B-6 bomber designed for anti-shipping missions but potentially capable of using nuclear weapons. Given China's drive for economic modernization, there is a strong need to expand the civil air transport capacity throughout the country, thus subordinating military to civilian programmes. China has undertaken several joint ventures to build modern passenger aircraft, is reorganizing its civil air traffic management system and has converted a number of former military air bases into civilian airports. There are, however, several R&D programmes reported for new military aircraft, including a bomber, but these are a lower priority than the expansion of civilian air traffic service, and apparently do not yet involve any testing.

Modern bombers would be one option for China to increase its nuclear capabilities if the superpowers, particularly the USSR, proceed to develop nation-wide ballistic missile defences (BMD). Nuclear-armed cruise missiles would be another option as a countermeasure to BMD systems. China has considerable experience with non-nuclear anti-ship cruise missiles, but large nuclear weapon development and production programmes would be very costly, and the deployment of superpower strategic defences would undermine China's limited nuclear force. China hopes to avert such a situation and has been campaigning hard to dissuade the further development of strategic defence systems.

VII. Developments in nuclear proliferation[136]

In considering nuclear weapon developments it is important also to consider the situation of the so-called nuclear threshold countries, that is, states which have neither acknowledged the possession of nuclear weapons nor joined the 1968 Non-Proliferation Treaty (NPT), but conduct significant nuclear activities and operate nuclear plants not under safeguards but capable of making weapon-usable material. There is a constant danger that some of them might cross the threshold to become fully-fledged nuclear weapon states. This would be a serious blow to the non-proliferation regime, which has been laboriously developed over several decades, and a set-back to the cause of regional and international stability and security. The most important developments that became clear or took place in 1987 for the six states in this category are described in this section.

Israel

The information provided in 1986 by a former technician in an Israeli nuclear facility that Israel has a substantial nuclear arsenal may, if proved correct, mean that there actually exist six states in the world which are in possession of nuclear weapons rather than five, as had been previously believed. Actions taken against the author of these revelations—his prompt abduction, arrest, trial and conviction of treason for disclosing secret data—confirm the seriousness with which Israeli authorities treat this affair, but the official position of Israel on nuclear matters remains unchanged. It continues to affirm, somewhat ambiguously, that it will not be the first country to introduce nuclear weapons into the Middle East.[137]

Israel imported heavy water from Norway and the United States from 1959 to 1963 with the agreement to use it solely for peaceful purposes; it also agreed to accept on-site inspection of the heavy water supply. In September 1987, Norway made a formal demand to check the use made of its heavy water supply, but this was refused, adding to the suspicion that it was used for other than peaceful purposes. While the USA holds the same inspection rights, it has not taken any such action.

In addition to possessing the technology and materials for nuclear weapons, Israel also has a nuclear-capable ballistic missile. In May 1987 it was reported that Israel successfully tested a longer-range version of its Jericho missile, dubbed the Jericho II. It flew 510 miles (816 km) across the Mediterranean Sea.[138] The report estimates the maximum range to be about 900 miles (1440 km).

The establishment of a zone free of nuclear weapons in the Middle East has been repeatedly proposed in recent years, but the realization of this proposal is conceivable only within the framework of an overall political settlement of the Middle Eastern imbroglio and the consequent significant cuts in all categories of weapons. Given Israel's precarious security situation, the International Atomic Energy Agency (IAEA) or UN resolutions on 'Israeli nuclear capabilities and threat', requesting Israel to place all its nuclear facilities under IAEA safeguards,[139] apparently have no chance of being complied with.

Pakistan and India

Evidence has accumulated in the past few years that both countries possess all the essential elements for the manufacture of nuclear weapons. It is thus now an established fact that, owing to the technology and hardware clandestinely obtained from abroad,[140] Pakistan is producing highly enriched, weapon-grade uranium and is probably testing a high-explosive 'triggering package' for a nuclear device.[141] It may not yet have assembled a complete nuclear explosive device but, according to independent experts, its unsafeguarded enrichment plant has the capacity to produce enough fissile material for one to four weapons annually.[142] There have been reports that Pakistan is building one more plant, which will increase this capacity.[143]

India tested a nuclear device in 1974 and has greatly increased its plutonium production capacity in unsafeguarded facilities; it is considered by some analysts to be able to produce about 15 nuclear weapons per year.[144] Moreover, its nuclear weapon delivery capability by far exceeds that of Pakistan, its rival neighbour. On 4 May 1987 Radio Delhi announced that India had successfully launched a short-range missile, the RH-560. A Defence Ministry spokesman said that other missiles 'at an advanced stage of development' will be ready by 1993, including a medium-range missile.[145] In fact, since India has an indigenous space launch capability (and has launched its own satellite), it has a latent ICBM capacity.

In spite of these developments, in recent years international attention has been diverted from India's nuclear potential to that of Pakistan, even though the Pakistani posture can be regarded as primarily a reaction to India's nuclear ambitions. If attempts by the US Administration to restrain Pakistan's nuclear activities have not succeeded, and if the Pakistani Government continues with its unsafeguarded nuclear programme, it is mainly for the following reason. Pakistan's proposals for signing the NPT simultaneously with India, or declaring the denuclearization of the South Asian region, or at least accepting reciprocal inspections of nuclear facilities, have been repeatedly rejected by India, and political relations between the two countries have again deteriorated.

It has been suggested in the UN that a bilateral Indian–Pakistani comprehensive nuclear test ban might be more acceptable to India than the nuclear weapon-free concept. Significantly, this suggestion was also made by Pakistan,[146] even though, by precluding further development of nuclear capabilities, a test ban would freeze India's advantage in the nuclear field.[147]

South Africa

Accusations have been repeatedly made, mainly in the United Nations, that South Africa has clandestinely manufactured and tested a nuclear weapon. The suspicion is compounded by South Africa's refusal to submit to IAEA inspection its uranium enrichment facility which has the capacity of producing weapon-grade uranium. (The South African nuclear power reactors and a research reactor are under non-NPT safeguards.)

The attitude of South Africa towards the NPT has been ambivalent. Unlike India, Pakistan or Israel, South Africa has no obvious military incentives to build a nuclear arsenal. Its conventional armed forces are stronger than those of its possible regional adversaries. Nuclear weapons would also be useless in dealing with a possible internal insurgency against the apartheid regime. This may be one reason why South Africa has never expressed hostility to the NPT. In 1968 it voted for the UN General Assembly resolution which 'commended' the Treaty, and the South African representative subsequently took part in discussions at the IAEA of the model-NPT safeguards agreement.

On 21 September 1987 the South African President stated that his government was prepared to commence negotiations with each of the nuclear weapon states on the possibility of 'signing' the NPT and would consider including, in these negotiations, safeguards on its installations subject to the NPT conditions. The statement went on to express the hope that South Africa would soon be able to sign the NPT but added that any safeguards agreement which might subsequently be negotiated with the IAEA would have to be along the same lines as, and in conformity with, agreements with other NPT signatories.[148] The South African statement may carry significance, but it is unclear in several respects. First, the Treaty is not subject to signature because it is already in force; it can only be acceded to by a state willing to join it. Second, to become a party to the NPT, a state need not conduct negotiations with other states, be they nuclear or non-nuclear weapon states; deposit of the instrument of accession with all or any of the three depositaries (the USA, the UK or the USSR) would suffice. And third, the question of safeguards under the NPT must be discussed with the IAEA, not with individual parties; and it goes without saying that an agreement to safeguard South African nuclear activities would have to be similar to those concluded with other non-nuclear weapon parties to the NPT, that is, it would have to be comprehensive. If by that time South Africa had acquired nuclear weapons, it would have to dismantle them, and the IAEA would have to ensure that *all* fissionable material in the territory of South Africa was used exclusively for peaceful purposes.

The preparedness of South Africa to negotiate adherence to the NPT was made conditional on the outcome of the 1987 IAEA General Conference, which opened in Vienna on the same day the South African statement was made. The obvious aim of this diplomatic manoeuvre was to stave off an effort by several Third World states, led by Nigeria, to expel South Africa from the IAEA. The manoeuvre proved to be successful, at least in part: the view prevailed that for the time being it was better to have South Africa inside the Agency rather than outside it. None the less the General Conference resolved to consider, at its 1988 session, the June 1987 recommendation by the IAEA Board of Governors to suspend South Africa from the exercise of the privileges and rights of membership. It also requested the Director-General to take measures to ensure the implementation of its 1986 resolution which *inter alia* demanded that South Africa submit all its nuclear installations and facilities to Agency safeguards.[149]

Brazil and Argentina

It was revealed in 1987 that Brazil had mastered the centrifuge technology for uranium enrichment (a process used by only a few developed countries) and had begun the construction of a large enrichment plant soon to be put into operation.[150] This was achieved, presumably without outside help, in a secret, so-called parallel nuclear programme centred at an institute in São Paulo.[151] The enrichment plant, to be run by the Brazilian Navy, is not to be covered by international safeguards and can therefore be used for the manufacture of uranium for weapon purposes. Brazil can even make its own special steel needed for the centrifuges.

In announcing this technological breakthrough, Brazil reiterated its commitment to using nuclear energy exclusively for peaceful purposes.[152] However, of the three reactors now possessed or being built by Brazil, one—constructed by the US Westinghouse company—barely functions owing to constant breakdowns, and the construction of the other two reactors—following the co-operation agreement between FR Germany and Brazil—is almost at a standstill; the cost of the operation has proved to be unbearable.[153] The planned building of a Brazilian nuclear-powered submarine is even more remote; according to the Brazilian Minister of the Navy, the submarine could not be completed before the turn of the century, and the cost would exceed US $300 million.[154] In this situation, it is questionable what peaceful purposes can be served by the production of enriched uranium, which is expected to start in 1988,[155] if there are no power reactors or submarine reactors to use it. The prospects for exporting substantial quantities of enriched uranium to other countries are not bright either, considering the competition among the established suppliers on a saturated world market.

Given this situation, the production of enriched uranium could—in the opinion of José Goldemberg, rector of the University of São Paulo—enable Brazil to manufacture a nuclear weapon within five years.[156] Indeed, in the light of Brazil's adamant refusual to join the NPT or to assume unreservedly the obligations under the Treaty of Tlatelolco, the discovered preparatory work on what was presumed to be a Brazilian nuclear test site[157] and the development of rockets capable of delivering nuclear weapon payloads have both raised doubts regarding the intentions of the Brazilian military.

Argentina, which operates an unsafeguarded uranium enrichment plant using gaseous diffusion technology, does not appear to be able as yet to produce weapon-grade uranium. But as regards reprocessing—that is, the technique for separating plutonium from spent reactor fuel—Argentina is more advanced than Brazil.[158] It is noteworthy, however, that the role of the Argentine military in directing nuclear affairs has been reduced. The National Atomic Energy Commission of Argentina is now, after years of monopolistic military rule, responsible only for technical matters, whereas the Foreign Ministry takes all the relevant political decisions, including the choice of recipients of Argentine nuclear supplies.

The danger of nuclear weapon proliferation in Latin America has been somewhat dampened by a considerable improvement of political relations between Brazil and Argentina. A regional policy centred on economic co-operation, in particular in the nuclear field, seems to be replacing the traditional rivalry between the two countries, based on nationalistic military considerations. The July 1987 visit by the President of Brazil to Argentina's uranium enrichment facility—never before visited by a foreign official—and the planned visit by the President of Argentina to a similar facility in Brazil symbolize the changes.

Other countries

In addition to these threshold countries, there are three parties to the NPT—Iran, Iraq and Libya—whose commitments to the Treaty have been publicly questioned even though their nuclear activities are safeguarded. However, all three countries are at a very early stage of nuclear development and lack the industrial infrastructure to support a significant indigenous programme.

Notes and references

[1] 'Nuclear Notebook', *Bulletin of the Atomic Scientists*, Mar. 1988, p. 55.

[2] See Norris, R. S., Arkin, W. M. and Cochran, T. B., 'US–USSR strategic offensive nuclear forces 1946–1987', *Nuclear Weapons Databook* Working Paper 87-1 (Rev. 1), Dec. 1987.

[3] Congressional Budget Office, *Modernizing U.S. Strategic Offensive Forces: Costs, Effects, and Alternatives*, Nov. 1987.

[4] House Armed Services Committee (HASC), *The MX Missile Inertial Measurement Unit: A Program Review*, Committee Print no. 11, Aug. 1987; Moore, M., 'MX reliability in question', *Washington Post*, 28 Dec. 1987, p. A1.

[5] This was in response to the FY 1986 legislation which required a report from the President on future survivable basing modes for an additional 50 MX missiles to be deployed.

[6] Ballistic Missile Office, 'Peacekeeper in rail garrison', briefing by Colonel Glenn H. Vogel, 9 Apr. 1987; *Aviation Week & Space Technology*, 5 Jan. 1987, pp. 20–21; *Aviation Week & Space Technology*, 6 Apr. 1987, pp. 18–9; Senate Armed Services Committee (SASC), *Hearings on DOD Authorization for Appropriations for FY 1988* (hereafter cited as SASC, FY 1988 DOD), Part 4, pp. 1899–903.

[7] Blytheville AFB, Arkansas; Little Rock AFB, Arkansas; Barksdale AFB, Louisiana; Wurtsmith AFB, Michigan; Whiteman AFB, Missouri; Malmstrom AFB, Montana; Grand Forks AFB, North Dakota; Minot AFB, North Dakota; Dyess AFB, Texas; and Fairchild AFB, Washington; US Department of Defense, OSD(PA) News Release No. 73–87; Senate Appropriations Committee (SAC), *Hearings on Department of Defense Appropriations for FY 1988* (hereafter cited as SAC, FY 1988 DOD), Part 1, pp. 223–46.

[8] 15 Jan. 1987, 4 Mk 5 RVs; 17 Mar. 1987, 8 Mk 5 RVs; 30 Apr. 1987, 4 Mk 5 RVs; 12 June 1987, 4 Mk 5 RVs; 21 July 1987, 4 Mk 5 RVs; 8 Sep. 1987, 9 Mk 4 RVs plus one instrumentation package; 6 Oct. 1987, 8 Mk 5 RVs; and 11 Dec. 1987, number of RVs unknown.

[9] Gordon, M. R., 'U.S plans to test submarine missile with 12 warheads', *New York Times*, 7 Oct. 1987, p. A1; Congressional Budget Office, *The Trident II Missile Test Program: Implications for Arms Control*, Nov. 1987; Pincus. W., 'Test of 12-warhead missile delayed', *Washington Post*, 7 Nov. 1987, p. A11; Pincus, W., 'U.S. delays test of 12-warhead sub missile', *Washington Post*, 10 Nov. 1987, p. A3.

[10] Each test will cost upwards of $50 million, approximately $45 million for the missile and $5 million for conducting each flight-test.

[11] *Aviation Week & Space Technology*, 30 Sep. 1985, pp. 76–79; *Aviation Week & Space Technology*, 27 Aug. 1984, pp. 60, 65–6.

[12] The Navy could prolong the FOT programme by testing fewer missiles per year before the year 2012 and/or using the missiles from the first Trident II carrying SSBNs which will probably be retired between the years 2015 and 2020.

[13] The two RVs will have different masses, drag coefficients and ablation characteristics, all of which affect the performance of the RVs when they re-enter the atmosphere.

[14] Silber, H., 'B-1Bs begin to swell ranks of N-arsenal', *Omaha World Herald*, 16 Aug. 1987, p. 12.

[15] House Armed Services Committee, *Review of the Air Force B-1 Program*, House Report 100–8; House Armed Services Committee, *The B-1B: A Program Review*, Committee Print No. 2, 30 Mar. 1987; General Accounting Office (GAO), *Supportability, Maintainability, and Readiness of the B-1B Bomber*, GAO/NSIAD-87-177BR, June 1987; Marshall, E., 'Bomber number one', *Science*, 29 Jan. 1988, pp. 452–5.

[16] General Accounting Office, *Estimated Costs to Deploy the B-1B*, GAO/NSIAD-88-12, Oct. 1987.

[17] See Section 121 of the *National Defense Authorization Act for Fiscal Years 1988 and 1989*, Conference Report, House Report 100–446, pp. 23–4; Vartabedian, R., 'Bomber costs soar', *Los Angeles Times*, 8 July 1987, p. IV-1; Morrocco, J. D., 'Management problems delay first flight of Northrop B-2', *Aviation Week & Space Technology*, 11 Jan. 1988, pp. 16–7. One financial analyst estimated that ATB bomber funding for the period FY 1983–88 is $12.64 billion; Schemmer, B. F., 'Financial analysts estimate Stealth bomber costs within 4% of each other', *Armed Forces Journal International*, Oct. 1987, pp. 26–8.

[18] Read, E. W., 'Northrop gets stealth award, sources say', *Wall Street Journal*, 25 Jan. 1988, p. 7; *Aviation Week & Space Technology*, 1 Feb. 1988, p. 18.

[19] House Appropriations Committee (HAC), *Hearings on Department of Defense Appropriations for 1988* (hereafter cited as HAC, FY 1988 DOD), Part 6, p. 700.

[20] Silber, H., 'SAC preparing for advanced cruise missile', *Omaha World Herald*, 13 Sep. 1987, p. 9-B.

[21] Halloran, R., 'Plan to re-equip B-52's is proposed', *New York Times*, 18 Sep. 1987, p. 7.

[22] 'Deployed missiles' are defined in Article 11, para. 11 of the INF Treaty (see appendix 13A).

[23] *Air Force Magazine*, Feb. 1987, pp. 74–6.

[24] Hoagland, J., 'Spain tells U.S. to remove F16s', *Washington Post*, 24 Dec. 1987, p. A1.

[25] The Defence Planning Committee of NATO consists of the Defence Ministers under the chairmanship of the NATO Secretary-General.

[26] See Secretary of Defense James R. Schlesinger, *The Theater Nuclear Force Posture in Europe*, A Report to the United States Congress in compliance with Public Law 93–365, 1975, p. 26.

[27] These procedures recognized that 'special weight should be given in the consultation process to the country on or from whose territory the weapons would be employed; to the country providing the delivery system concerned; and to the country providing the warhead'; Legge, J. M., *Theater Nuclear Weapons and the NATO Strategy of Flexible Response*, Apr. 1983 (Rand Corporation R-2964-FF), p. 22. The procedures are regularly practised in the biennial NATO 'Wintex' command post exercises.

[28] As a result of a 1980 study of the role of Defensive Nuclear Forces (DNF) in NATO strategy by the High Level Group of the Nuclear Planning Group, Nike Hercules missiles and atomic demolition munitions (ADMs) were earmarked for withdrawal. All ADMs were withdrawn from Europe in 1985.

[29] NATO flexible response strategy is contained in the NATO document *Overall Strategic Concept for the Defense of the North Atlantic Treaty Organization Area* (MC 14/3).

[30] See Ruehl, L. (State Secretary of the Ministry of Defence, FR Germany), 'The nuclear balance in the Central Region and strategic stability in Europe', *NATO's Sixteen Nations*, Aug. 1987, p. 19. This is the only known public discussion or mention of the GPG by a NATO or US official.

[31] Ruehl (note 30), p. 19.

[32] Legge, J. M., *Theater Nuclear Weapons and the NATO Strategy of Flexible Response*, Apr. 1983 (Rand Corporation R-2964-FF), p. 20.

[33] For background on how the Administration came to reinterpret the ABM Treaty, see Garthoff, R. L., *Policy vs. the Law: The Reinterpretation of the ABM Treaty* (Brookings Institution: Washington, DC, 1987); Joint Hearings before the Committee on Foreign Relations and the Committee on the Judiciary, United States Senate, *The ABM Treaty and the Constitution*, Senate Hearing 100–110; Senate Foreign Relations Committee, *The ABM Treaty Interpretation Resolution*, Report 100–164, 22 Sep 1987; and chapter 14.

[34] *Congressional Record*, 11 Mar. 1987, pp. S2967–86; *Congressional Record*, 12 Mar. 1987, pp. S3090–5; *Congressional Record*, 13 Mar. 1987, pp. S3171–3. A fourth installment was published in the *Congressional Record*, 19 May 1987, pp. S6623–91.

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[36] Senators Dale Bumpers, John Chafee and Patrick Leahy, 'Salvaging SALT: the new congressional compromise', *Arms Control Today*, Dec. 1987, pp. 3–6.

[37] National Defense Authorization Act for Fiscal Years 1988 and 1989 (note 17), p. 630.

[38] Blechman, B. M. and Krepon, M., *Nuclear Risk Reduction Centers* (Georgetown University Center for Strategic and International Studies: Washington, DC, 1986).

[39] See the communiqué of the 1985 Geneva summit meeting.

[40] US Department of Defense, *Report of the Secretary of Defense Frank Carlucci to the Congress for FY 1989* (annual report), (hereafter cited as DOD FY 1989), p. 113.

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[47] Compare US Department of Defense, *Soviet Military Power 1984* (hereafter cited as DOD, SMP 1984), p. 23; DOD, SMP 1987, p. 29. See also *National Journal*, 20 July 1985, p. 1692.

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[53] Senator Jesse Helms, *Congressional Record*, 7 Aug. 1987, p. S11562.

[54] JCS, FY 1988, p. 35.

[55] See, for example, DOD, SMP 1987, p. 33, which reports that the SS-N-23 missile carries 10 MIRV warheads.

[56] JCS, FY 1988, p. 35.

[57] DOD, FY 1988 *Annual Report*, p. 26; DOD, SMP 1987, p. 35.

[58] DOD, SMP 1987, pp. 27, 34.

[59] JCS, FY 1988, p. 36.

[60] 'Blackjack bomber crashes in USSR', *Aviation Week & Space Technology*, 25 May 1987, p. 19.

[61] JCS, FY 1989, p. 41.

[62] Broad, W. J., 'The secrets of Soviet star wars', *New York Times Magazine*, 28 June 1987, pp. 22–8.

[63] Markham, J. M., 'Shultz declares missile pact needs no summit meeting', *New York Times*, 25 Oct. 1987, p. 1.

[64] The SA-12A 'Gladiator' variant, intended for deployment in non-strategic forces, is already being fielded.

[65] For example, Moscow Air Defence Commander Anatoly U. Konstantinov was replaced by Col. Gen. V. Tsarkov, although there were also reports that this replacement may have occurred before the flight. More importantly, Defence Minister Sergei L. Sokolov was replaced by General Dimitri Yazov, who supports Gorbachev. The Commander of Soviet air defence forces, Aleksander I. Koldunov, was also dismissed.

[66] MOU of the INF Treaty (see appendix 13B).

[67] DOD, SMP 1987, p. 66.

[68] DOD, SMP 1987, p. 41.

[69] JCS, FY 1989, p. 40.

[70] DOD, SMP 1987, p. 38.

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[72] See note 71.

[73] HAC, FY 1988 DOD, Part 2, p. 296.

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[81] Daly, M., 'Chevaline refurbishment to begin this month', *Jane's Defence Weekly*, 16 Jan. 1988. p. 54.

[82] A total of 133 Polaris missiles were ordered; all have been delivered.

[83] Authors' estimates: $1.816 billion for Polaris and Chevaline (87%) and $280 million for Trident (13%).

[84] Authors' estimates.

[85] Webb, A., 'Thatcher reelection puts Trident back on track in United Kingdom', *Armed Forces Journal International*, Aug. 1987, p. 42.

[86] British Ministry of Defence, *Statement on the Defence Estimates 1987* (HMSO: London, 1987), Cmd 101-I, p. 41.

[87] Urban, M., 'Warheads shortage threatens Trident', *The Independent*, 26 Jan. 1988; see also articles of 27 and 28 Jan. 1988 in *The Independent*.

[88] However, it is also true, as the MOD has stated, that the deployment of Trident will result in 'an increase of up to two and a half times the payload of the Polaris boats, when they entered service in the 1960s each carrying 48 warheads'; see note 86. This translates to a fourfold increase over the present two-warhead Chevaline missile.

[89] See note 86.

[90] Freedman, L., 'British nuclear targeting', in eds. D. Ball and J. Richelson, *Strategic Nuclear Targeting* (Cornell University Press: Ithaca, N.Y., 1986), pp. 109–26.

[91] As of Aug. 1987, $280 million was expended and $713.31 million committed on Trident through SSPO; authors' estimates. Comptroller and Auditor General, National Audit Office, *Ministry of Defence and Property Services Agency: Control and Management of the Trident Programme* (HMSO: London, 14 July 1987), p. 3.

[92] Authors' estimates.

[93] See note 91, p. 8.

[94] See note 91.

[95] See note 91, p. 10.

[96] The latest such statement was made by British Defence Minister George Younger on 6 Nov. 1987 in Washington, DC, in response to questions by the press. When asked about British Trident production and development costs incurred in the USA, Younger stated that the 'warheads are totally British, in every way, including service, manufacture, etc.'. Transcript of press conference, National Press Club, mimeo.

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[98] 'Washington roundup', *Aviation Week & Space Technology*, 6 Apr. 1987, p. 17.

[99] 'France/nuclear weapons', Pentagon review of the press in the DOD press clipping service *Current News*, 23 Oct. 1987.

[100] Isnard, J., 'France considers the cost of neutron warheads', *Jane's Defence Weekly*, 12 Nov. 1987, p. 1163.

[101] *Aviation Week & Space Technology*, 10 Aug. 1987, p. 13.

[102] See note 100.

[103] McCartney, R. J., 'Mitterrand, ending visit to Bonn, seeks to calm German fears about French missiles', *Washington Post*, 23 Oct. 1987, p. A-26.

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33–34. This is based on instructional material used at the French War College, specifically the War College's 'Lorraine' Plan.

[105] 'Nuclear Notebook', *Bulletin of the Atomic Scientists*, July/Aug. 1987, p. 63.

[106] 'Unit name for nuclear capable Mirage 2000Ns', *Jane's Defence Weekly*, 24 Oct. 1987, p. 929.

[107] See note 106.

[108] As the missile is wingless, sufficient lift is provided by the air intakes. DIA, 'Super Etendard weapon system (U)', DST-1320S-712-85 (secret, partially declassified), 21 Feb. 1985, p. 40.

[109] ASMP specifications: length, 5.380 m; diameter, 0.420 m; weight, 850 kg.

[110] De Young, K., 'France, Britain consider joint nuclear weapon', *Washington Post*, 22 Dec. 1987, p. A-16.

[111] Commissariat à l'Énergie Atomique (CEA), *Rapport Annuel 1986*, p. 19.

[112] The 172nd patrol of the FOST was commenced at the end of February 1986 by the SSBN *Le Terrible*. See SIPRI (note 79), p. 32.

[113] 'France opens new shipyard for next-generation SSBN's', *Jane's Defence Weekly*, 7 Nov. 1987, p. 1024.

[114] See note 113.

[115] See note 113.

[116] See SIPRI (note 79), p. 34.

[117] See SIPRI (note 79), p. 34.

[118] 'Avions Station Relais de Transmissions Exceptionnelles', document received by NRDC from the NASC under the Freedom of Information Act.

[119] See note 118.

[120] This system has its main transmitter at Rosnay; however, other back-up land-based, low frequency (LF) and VLF communication transmitters are known to exist, including two VLF stations and at least eight LF stations. See Arkin, W. M. and Fieldhouse, R. W., *Nuclear Battlefields: Global Links in the Arms Race* (Ballinger: Cambridge, Mass., 1985), pp. 282–8.

[121] 'Les sous-marins sont au bout du fil', *DGA Info*, no. 9, May 1987, p. 17.

[122] Assemblée Nationale (Commission des Finances, de l'Économie Générale et du Plan), *Rapport sur le Project de loi de Finances pour 1988 (Annexe no. 39: Défense Titre V et VI)*, document no. 960, 9 Nov. 1987, p. 19.

[123] In the late 1970s France was purportedly researching a sea-to-sea nuclear missile to be mounted on French surface warships. Work concerned the miniaturization of warheads, so that they could be launched by a missile the size of the MM 38 Exocet or Otomat missiles. The programme was low-scale, and it is unsure if it still exists. See 'Work on the French Navy's ships', *Aviation & Marine International*, Feb. 1979, p. 19; 'Army chief says France ponders making neutron bomb', *New York Times*, 12 June 1978.

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[126] See *Interavia Air Letter*, 16 Dec. 1986.

[127] US Defense Intelligence Agency (DIA), 'A Guide to Foreign Tactical Nuclear Weapon Systems Under the Command of Ground Force Commanders', DST-1040S-541-87, 4 Sep. 1987 (secret, partially declassified), p. 79.

[128] In 1986 a Soviet Yankee II class SSBN suffered a fire and explosion in a missile launch tube. The liquid fuel of the SS-N-6 SLBM apparently exploded after an accident, causing several deaths and sinking the submarine. In 1980 a US Titan II ICBM was blown out of its silo because of a fuel accident. A technican dropped a large socket which hit the missile and caused a leak in a fuel tank. Several hours later the leaking fuel vapour exploded. The silo cover, which weighed 740 tons, was blown off by the force of the explosion, and the warhead was found more than 180 m away. One person was killed and several were injured.

[129] DIA (note 127).

[130] See British Broadcasting Company (BBC), *Summary of World Broadcasts* (SWB), Part 3, 30 May 1987, reprinted by the Institute for Defense Studies and Analyses (IDSA, New Delhi) in *News Review on East Asia*, July 1987, p. 670; and SWB, Part 3, 1 Aug. 1987, reprinted in *News Review on East Asia*, Sep. 1987, p. 892.

[131] See, for example, 'Nuclear submarine ends maiden voyage', *Beijing Review*, 12 Jan. 1987, p. 8.

[132] 'Navy now using ultra-longwave information system', Xinhua, 15 July 1987, reprinted by the

Institute for Defense Studies and Analyses (IDSA, New Delhi) in *News Review on East Asia*, Aug. 1987, p. 784.

[133] See Arkin and Fieldhouse (note 120), pp. 290–1.

[134] See *Renmin Ribao*, 28 May 1987, reprinted in US Department of Commerce, *Foreign Broadcast Information Service—China* (FBIS-China), 3 June 1987.

[135] O'Lone, R. G., 'China reshaping industry to meet extensive needs', *Aviation Week & Space Technology*, 16 No. 1987, pp. 16–21.

[136] For an extensive discussion of the problem of nuclear threshold countries, see also Goldblat, J. (ed.), SIPRI, *Non-Proliferation: The Why and the Wherefore* (Taylor & Francis: London, 1985); and Goldblat, J. and Lomas, P., 'The threshold countries and the future of the nuclear non-proliferation regime', in ed. J. Simpson, *Nuclear Non-Proliferation: An Agenda for the 1990s* (Cambridge University Press: Cambridge, 1987).

[137] Cohen, A. and Frankel, B., 'Israel's nuclear ambiguity', *Bulletin of the Atomic Scientists*, Mar. 1987.

[138] *International Defence Review*, 21 July 1987, p. 857.

[139] IAEA Press Release PR 87/28.

[140] *New York Times* and *Los Angeles Times*, 15 July 1987.

[141] Testimony of Amb. Richard T. Kennedy, *Hearings on US Aid to Pakistan before the Subcommittee on Asian and Pacific Affairs of the Committee on Foreign Affairs*, US House of Representatives, 22 Oct. 1987; *International Herald Tribune*, 7–8 Nov. 1987.

[142] *Nuclear Weapons and South Asian Security*, Report of the Carnegie Task Force on Non-Proliferation and South Asian Security, Carnegie Endowment for International Peace, Washington, DC, 1988.

[143] *Financial Times*, 11 Dec. 1987.

[144] See note 142.

[145] Reported in US Department of Defense, *Current News*, 7 May 1987, p. 5.

[146] UN document A/C.1/42/4.

[147] *New York Times*, 25 Sep. 1987.

[148] IAEA document GC (XXXI)/819 with Attachment.

[149] IAEA Press Releases PR 87/17 and PR 87/29.

[150] *Financial Times*, 7 Oct. 1987.

[151] *Washington Post*, 10 Sep. 1987.

[152] *International Herald Tribune*, 7 Sep. 1987.

[153] *Frankfurter Rundschau*, 11 Sep. 1987.

[154] *International Herald Tribune*, 8 Dec. 1987.

[155] *Le Monde*, 15 Oct. 1987.

[156] See note 155.

[157] *Folha de São Paulo*, 8 and 9 Aug. 1986.

[158] See note 150.