THE
UNITED STATES AIR FORCE
ADVANCED TECHNOLOGY
BOMBER

PROBLEMS AND PROSPECTS

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Dedicated to

the memory of

P.B. Hughes

I certify that this sub-thesis is my own original work and that all sources used have been acknowledged.

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ACRONYMS AND ABBREVIATIONS

ACC	Air Combat Command
ALCM	Air Launched Cruise Missile
ATB	Advanced Technology Bomber
C^3	Command, Control & Communications
C^3I	Command, Control, Communications & Intelligence
ICBM	Intercontinental Ballistic Missile
SAC	Strategic Air Command
SAM	Surface-to-Air Missile
SIGINT	Signals Intelligence
SIOP	Single Integrated Operational Plan (US Plan for Strategic Nuclear War)
SLBM	Submarine Launched Ballistic Missile
SSBN	Nuclear-powered ballistic missile-carrying submarine
START	Strategic Arms Reduction Treaty
USAF	United States Air Force
VPVO	Voyska Protivovozdushnoy Oborony ((Former) Soviet Air Defense Forces)

INTRODUCTION

From its inception the B-2 Advanced Technology Bomber was designed for a significant role in the Cold War strategic environment. Although this environment of US-Soviet confrontation has now passed, the future shape of any global nuclear balance remains unclear. Accordingly, it is useful to look at both the established arguments for introducing the B-2 in the context of the US-Soviet confrontation and at possible new roles in the post-Cold War era.

The official unveiling of the B-2 in November 1987 opened another chapter in the controversial debate concerning modernisation of the United States strategic bomber force. Questions regarding viability, utility, and cost-effectiveness have again been asked. In considering the earlier phases of the modernisation debate, it is worth noting that the B-2 programme has a close precedent in the form of the North American Valkyrie (USAF designation: B-70) programme cancelled in the 1960s.

Like the present B-2 programme, the B-70 was a costly and technologically demanding programme. It envisaged a large, delta-winged, supersonic strategic bomber carrying a wide variety of nuclear and conventional ordnance, flying unrefuelled to target and back (some 7600 nautical miles) at Mach 3. After consideration of the mission and overall cost both President Kennedy and Secretary of Defense McNamara concluded that the programme should be restricted to perhaps two or three aircraft dedicated to research and development only. The reasons given by both men provide interesting reading in the context of the B-2 debate.

President Kennedy stated that the development of the B-70 "as a full weapons system at this time [is] unnecessary and economically unjustifiable,"[1] while McNamara argued we have again re-studied the role of the B-70 in our strategic retaliatory forces ... and again we have reached the conclusion that the B-70 will not provide enough of an increase in our offensive capabilities to justify its very high cost.[2]

He went on to add later that the strategic forces programmed through 1967 could achieve practically complete destruction of the enemy target system even after absorbing an initial attack [and the addition of 200 B-70s or 150 RS-70s] either of which would cost about $10 billion, would not appreciably change this result.[3]

The abandonment of the B-70 programme by 1969 left the manned bomber leg of strategic nuclear triad supported by the increasingly elderly B-52. Despite the addition to the bomber fleet of the B1-B in the 1980s, questions remain regarding

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1. Cited in Desmond Ball, Politics and Force Levels. The Strategic Missile Program of the Kennedy Administration, (University of California Press, Los Angeles, 1980), p.216.

2. Ibid, pp.217-218.

3. Ibid, p.218.

the manned bomber force's vulnerability to reduced tactical warning brought about by significant improvements in Soviet Ballistic Missile Submarines (SSBNs) and Submarine-Launched Ballistic Missiles (SLBMs). Should the Soviet Union[4] become able to strike more of the Strategic Air Command (SAC)[5] bases and barrage aircraft egress routes, the effect on the manned bomber force could be devastating. The various assessments of bomber retaliatory capability after a surprise attack project a rather low figure of 1000 warheads to target. Solutions aimed at easing dependence on minimal warning and minimising the impact of expected SSBN and SLBM improvements remain problematic.

Nonetheless, there is vigorous justification of the manned bomber, including: their role in enhancing the survivability of silo-based Intercontinental Ballistic Missiles (ICBMs) and vice versa; that they are the most capable method of conducting large-scale retaliatory attacks against hard targets; are recallable and reusable after launch; and complicate Soviet air defence efforts. Equally vigorous counters are offered, so the debate over maintaining bombers continues. Moreover, the development of the B-2 has served to refocus attention on the viability, utility and cost-effectiveness of the strategic penetrating bomber in particular.

The previously highly secret B-2 bomber, revealed to the public some eight years after research was first begun, represents a major development in aerodynamic, avionic and materials technology. As with many highly technical programmes, however, the B-2 bomber has experienced a number of potentially serious production, performance and management problems.

As a result there has been a tremendous rise in the cost of the programme. A key contributor is the cut in aircraft numbers from 132 to 75 to 20, which result in a per unit cost approaching 2.26 billion dollars. Adding to these cost woes is the recent admission by the USAF that the B-2 is not as stealthy as first thought and that certain specifications may have to be relaxed. There is now a real possibility that the B-2 will be unable to perform some of its prescribed missions.

A cornerstone of the USAF's case for the B-2 is the identification of a plausible mission. From its inception the aircraft's primary mission was to penetrate Soviet airspace and hunt strategic relocatable targets such as nuclear, mobile missiles. The technical complexities of such a mission and the doubtful

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4. Following an abortive coup attempt against President Gorbachev in August 1991, the Soviet Union now ceases to exist as a unified entity. With the exception of the Baltic States and Georgia, the former Soviet Republics are now referred to as the Commonwealth of Independent States (CIS). Russia, Ukraine, Kazakhstan and Belarus are the only states that retain strategic nuclear weapons however, the latter three have expressed a desire to discard nuclear weapons entirely. Russia, which remains by far the largest and military powerful state, is to retain nuclear weapons and controls all of the former Soviet Union's SSBN fleet.

5. On 27 September 1991, President Bush announced that SAC would be replaced by a new unified Strategic Command which will incorporate the peacetime nuclear alert force - land based ICBMs, the Navy SSBNs and manned bombers and tankers. The USAF portion of the force will be drawn from the new Air Combat Command, which merges fighter, bomber, reconnaissance, missile forces and Air Mobility Command which includes the bulk of airlift and tanker assets. The changes took effect in June 1992. "Statement to the Nation," President George Bush text Reprinted in Reuters, 27 September 1991.

viability of alternative nuclear roles has caused the USAF to look more closely at conventional roles. This interest in promoting the conventional utility strategic weapons such as heavy bombers gained considerable momentum with the Gulf war and developments in Eastern Europe and the Soviet Union. Accordingly the B-2 will now be oriented toward conventional rather than more dubious nuclear missions. On a similar note, the significance placed by the USAF on the generous bomber counting rules allowed under Strategic Arms Reduction Treaty (START) has faded. Declining bomber numbers, the small B-2 force size and the contraction of nuclear targets have detracted from its earlier value.

The fate of B-2 programme was settled with President Bush's January announcement that no more than 20 aircraft would be produced. As a result Congressional opposition has dissolved but funding for the remaining aircraft depends on Pentagon assurance that the $44.4 billion programme cost will not rise and that the aircraft will be as stealthy as advertised. The B-2, like its predecessors, has been dogged by controversy but with cancellation no longer an issue, the key question now concerns the adequacy or otherwise of only 20 aircraft.

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THE MANNED BOMBER AND THE NUCLEAR TRIAD

Modernising the Triad

For over twenty-five years US deterrence capability has rested on a triad of bomber aircraft, submarine launched ballistic missiles (SLBMs) and silo-based intercontinental ballistic missiles (ICBMs). Together these forces present a complex set of targeting and defence countermeasure problems for a potential attacker, and provide a hedge against changes in threat and technological breakthrough that might render one leg of the triad vulnerable or obsolete.

Each has its own unique features. Silo-based ICBMs are presently the most accurate means of striking hard targets and have particularly reliable command, control and communications (C^3). While attacks on submarines and bombers away from US bases may be disavowable, ICBMs can only be threatened now by a large strike against US territory. Also, due to the different time-to-target ratio between the strategic forces, ICBMs can provide cover for a manned bomber cruise missile carrying force, and vice-versa.[1] The ballistic missile carrying submarines (SSBNs), with their ability to stay submerged and hidden for long periods, are presently the most survivable element in the triad, thus constituting the best strategic reserve force. Should either or both of the land-based legs be destroyed SSBNs would become the primary counterforce weapons. Another advantage is their ability to attack from all azimuths, which serves to stretch and dilute Soviet air defences.[2] The manned bomber has advantages such as recallability, flexibility and reusability.

The key element of the triad's credibility is obviously the survivability of its component parts. While SSBN currently face no immediate threat, the same cannot be said for silo-based ICBMs and manned bombers. Qualitative improvements in Soviet SSBNs and SLBMs have raised serious doubts about the ability of US ICBMs and bombers to survive a surprise attack. In order to address this destabilizing situation, President Reagan appointed, in late 1982, the Bipartisan Commission on Strategic Forces (known as the Scowcroft Commission after its Chairman) in an effort to establish political consensus on the modernisation of strategic forces, especially ICBMs. The Commission's report, submitted in April 1983, stated that "strategic forces must be modernized, as necessary, to enhance to an adequate degree their overall survivability."[3] For ICBMs, this essentially

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1. Colin Gray, The MX ICBM and National Security, (New York 1981), p.39.

2. Barry Schneider, "Dyad or Triad?" Defense and Diplomacy, vol.7, no.9 (September 1989): p.33.

3. Report of the President's Commission on Strategic Forces, by Brent Scowcroft, Chairman (Washington, D.C., April 1983), p.6.

involved research and development toward deployment of mobile small, single warhead ICBMs (SICBMs) called Midgetman, and deployment of 100 multiple-warhead (MIRVED) MX Peacekeeper ICBMs in Minuteman silos.

A most acrimonious and protracted debate followed regarding both systems. The plan to deploy a full compliment of 100 Peacekeeper missiles suffered a major set-back when the Bush Administration rejected USAF plans to keep half the missiles in silos while the remainder were made mobile. Eventually it was decided to remove the existing 50 Peacekeepers from their silos and mount them on 25 trains carrying two missiles each. This concept, known as rail-garrison basing, envisaged Peacekeeper travelling on the existing US rail network during crises but being stationed at SAC bases under normal circumstances.[4] The Midgetman, if deployed, would be based on hardened mobile launchers operating on large military reservations and Minuteman bases in peacetime. On strategic warning the force would disperse into an area of about 20,000 square kilometres,[5] making it difficult to precisely locate and destroy.

On 27 September 1991 the future of both systems was settled when President Bush announced a series of sweeping arms reduction measures in response to changes in the former Soviet Union.[6] The Peacekeeper rail-garrison plan and the mobile-basing option for Midgetman were cancelled and four months later, the President announced the scrapping of Midgetman entirely with the Peacekeeper to be retired if the Republics of the former Soviet Union agree to eliminate land based MIRVED Systems.[7] While the President's decision undoubtedly reflects the realities of the ending of the cold war, the problems outlined in the 1983 Commission Report remain unresolved.

The Bomber Survivability Debate

Throughout the survivability debate, there has been one recurring factor which plays a key role in the pre-launch survivability of both ICBMs (mobile or not) and manned bombers - strategic and tactical warning.[8] If one follows the well-supported wisdom of the former Commander-in-Chief, Strategic Air Command General John Chain on this matter, then only two strategic nuclear attack scenarios appear likely. The first would have US forces already on full alert

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4. For detailed analysis on the rail-garrison MX Plan see in particular, Robert Zirkle, "Rail-Garrison MX ... No Way to Run a Railroad," Arms Control Today, vol.17, no.8 (October 1987): pp.17-21; and Barry Fridling and John Harvey, "On the Wrong Track? An Assessment of MX Rail-Garrison Basing," International Security, vol.13, no.3 (Winter 1988-1989): pp.113-141.

5. See Albert Gore Jr, "Verification of Arms Control Limits on Mobile Missiles," in M. Krepon and M. Umberger (eds), Verification and Compliance: A Problem-Solving Approach, (London 1988), p.5.

6. Annual Report to the President and Congress - Report of the Secretary of Defense Dick Cheney, (Washington, D.C., February 1992), p.59.

7. Ibid.

8. Strategic warning is warning that the Soviets may be preparing for a nuclear attack but have not yet launched their forces. Tactical warning is warning that an attack is underway; it is provided by systems such as launch detection satellites and early warning radars. A characteristic time for tactical warning is 30 minutes or less, the time it would take Soviet ballistic missiles to reach targets in the US. Strategic warning would provide several hours, days, or perhaps weeks of warning of attack.

because conventional war had begun in Europe and the second would involve a nuclear "bolt out of the blue". While the second scenario is considered unlikely critics argue that a surprise attack cannot be totally discounted. In short, American policy-makers should not be complacent about receiving strategic warning.[9] Several facts about the Soviet Union's SSBN fleet call into question the reliability of strategic warning. Firstly, Soviet SSBNs have been carrying a significantly increased number of warheads - from an average of 13 in the mid 1970s to 50 in the late 1980s.[10] This enables greater coverage of the US land-based target set. Secondly, the quietening of Soviet SSBNs reduced the effectiveness of US passive sonar such as the Sound Surveillance System (SOSUS). Furthermore, quietening of SSBNs might continue to outpace technological advances in anti-submarine warfare. A result of these quantitative and qualitative improvements, according to one analyst, will be that:

> SAC will no longer be able to count on 30 minutes of tactical warning, as it can in some scenarios today. Instead, SAC could be threatened by SLBM attacks with flight times of 10-15 minutes from the near Atlantic and near Pacific, 18-20 minutes from the near Arctic, or 20-25 minutes from the far Arctic near the Soviet coast. Even more ominously, SLBM flight times will be under 10 minutes if the Soviet Union tests and deploys depressed trajectory SLBMs.[11]

The effect on the manned bomber force could be devastating. With an overall increase in warheads being carried on each SSBN, the Soviets could dedicate a higher percentage of warheads to SAC bomber bases than previously and barrage aircraft egress routes. The act of escape under reduced tactical warning becomes extremely difficult. Nonetheless, destroying the 30 percent of bombers and tankers on day to day alert may be a difficult. Supported by early warning systems these aircraft are said to have a reaction time from SLBM breakwater to bomber brake release of six and one half minutes: one and one half minutes for the US early warning system to sound the alarm at SAC bases, and five minutes for SAC crews to move to their aircraft, start them and roll to takeoff position.[12] If the B1-Bs, B-2s and KC-135R (tankers) can fly out at five miles per minute, the six minute leeway between takeoff and SLBM warhead arrival (in the worst case) would allow the aircraft to be nearly 30 miles away. If blast overpressure of two pounds per square inch for KC-135R and four pounds per square inch for B-1Bs and B-2s will disable the aircraft, the lethal radius of a 100 kiloton

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9. See Michael E. Brown, "The US Manned Bomber and Strategic Deterrence in the 1990s," International Security, vol.14, no.2 (Fall 1989): p.9.

10. International Institute for Strategic Studies (IISS), The Military Balance 1974-1975, (London 1974), pp.8, 73; and The Military Balance 1988-1989, (London 1988): pp.33, 230.

11. Brown, "The US Manned Bomber," p.21.

12. See Alton H. Quanbeck and Archie L. Wood, Modernizing The Strategic Bomber Force Why and How, (Washington, D.C., 1976), pp.23-24, 46-47.

warhead will be four and one half miles for KC-135R and two and one half miles for B-1Bs and B-2s. For a 500 kiloton warhead the lethal radius is six and one half miles for KC-135R and four miles for B-1Bs and B-2s.[13] These figures look promising for the bombers if one or two warheads only are taken into account. However, two Soviet SS-N-20 SLBMs can carry 20 warheads, and therefore a barrage of airspace around a particular SAC bomber base would be feasible and extremely effective.

Estimates of just how much retaliatory capacity the bomber force could muster following a surprise attack are relatively low. The most generous estimates suggest that the bomber force could deliver nearly 5,000 warheads to target. To achieve this figure a minimum force of 95 B-52H, 97 B-1B, 75 B-2 bombers and supporting tankers would need to survive a surprise attack. Moreover, each bomber would need to be carrying a maximum load of 20, 16 and 16 nuclear weapons respectively to achieve this figure.[14] With this scenario unlikely, a more generally accepted figure is that bombers could deliver approximately 1000 warheads to target. Realistically, this would require a force of no less than a 100 bombers, which were not maximum loaded, and supporting tankers. In the 1990s, however, there will be a progressive decline in the total number of bombers and therefore a corresponding decline in deliverable warheads and survival rates.

At this stage, many observers of the bomber debate may draw the conclusion that bombers are rapidly becoming an irrelevant leg of the nuclear triad. While this is not an unreasonable conclusion, most of the aforementioned calculations are based on qualitative and quantitative improvements to Soviet SSBN and SLBM that are yet to be made. Indeed, such a surprise attack remains contingent not only on these improvements, but also on a major rupture in US-Soviet relations. This is not to say, however, that such an event could never happen. The US would be fool-hardy not to give some credence to the unlikely. The dramatic changes in recent years will not necessarily slow Soviet force modernisation and capability. The Strategic Arms Reduction Treaty (START), while imposing quantitative restrictions will probably fuel qualitative improvements.

On a specific note, SAC bombers and tankers will remain totally dependent on adequate warning in the forseeable future, and minimising the impact of expected SSBN and SLBM improvements will be problematic. Redeploying SAC bombers and tankers inland has occurred but there are geographical and cost limitations. Expanding alert rates[15] from 30 percent to 50 percent could create runway queuing

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13. See Brown, "The US Manned Bomber," footnote 48, p.23 and Quanbeck and Wood, Modernizing The Strategic Bomber Force, pp.48-50.

14. Given the demands of the penetration mission which would require a bomber to make trade-offs between electronic countermeasures, defence suppression, nuclear and conventional ordinance, it is unlikely that an aircraft would be carrying its maximum load of nuclear ordnance. Although stand-off, cruise-missile-carrying bombers would operate in a less demanding environment, a similar situation would apply. According to one analyst 10 weapons per aircraft would be quite realistic. See Brown, "The US Manned Bomber," pp.24-25.

15. On 27 September 1991, President Bush announced that all US strategic nuclear bombers would be removed from day to day alert status and their weapons downloaded to storage areas. "Statement to the Nation," President George Bush, text reprinted in Reuters, 27 September 1991.

problems, while having more aircraft on airborne alert increases accident potential and reduces life of type. Improving aircraft performance for faster take-offs and climb rates is also not feasible considering the present status of the B-1B and B-2 programmes. Ballistic missile defences around SAC bases make little sense as only one is permitted under the amendment to the 1974 Anti-Ballistic Missile Treaty.[16] Moreover, SAC bomber bases are soft targets and limited defences would be easily saturated. Limiting the accuracy of SLBMs would be opposed by the Soviet Union as the US Trident II D-5 SLBM is already a fait accompli. Similarly, limits on SLBM and SSBN loadings, would be opposed due to the effects on retaliatory capability. Finally, and perhaps the most promising approach, is prohibition of depressed trajectory SLBMs.[17] Bomber vulnerability per se would not be solved, but tactical warning would not be decreased adding a stabilising influence to the overall situation.

Justifying the Manned Bomber

If the problems concerning pre-launch survivability of the manned bomber seem insurmountable in the face of a surprise attack, this does not necessarily mean there can be no justification at all. In fact there remain several arguments in favour of the manned bomber.

The first is that the manned bomber enhances the survivability of silo-based ICBMs and vice versa. As the Scowcroft Commission pointed out, it is inherently difficult to attack silo-based ICBMs and bomber bases simultaneously. Should the Soviet Union launch its ICBMs and SLBMs at the same time, the latter would arrive some 15-20 minutes before the ICBMs reach US missile silos. While many non-alert bombers may be caught on the ground, the US could still launch its ICBMs under attack. Similarly, if the Soviet Union arranges to have its ICBMs and SLBMs reach their targets at the same time, the US would still have 30 minutes tactical warning of impending attack, enabling the bombers to scramble out of their bases.[18] In essence, ICBMs and bombers "work together in a synergistic relationship to ensure that at least one land-based leg of the triad survives even a carefully planned surprise attack".[19]

As discussed above, however, this may not continue to hold true should the Soviet Union develop its SSBN/SLBM forces to the extent that they can significantly cover a declining US land-based target set. The US is then left in the exposed position of entrusting its entire survivable retaliatory capacity to submarines. A sudden technological breakthrough in anti-submarine warfare

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16. A defensive ring would only protect one base and perhaps a dozen aircraft. Furthermore, defensive deployments are generally cost-prohibitive - perhaps $8-10 billion to save 12 aircraft. See Brown, p.29.

17. See Walter Slocombe, "Danger: Low-Flying Missiles," Washington Post, 13 May 1988, p.23; and Quanbeck and Wood, Modernizing The Strategic Bomber Force, p.44.

18. Report of the Presidents Commission, pp.7-8.

19. Brown, "The US Manned Bomber," p.9.

(although unlikely in the immediate future)[20] could render SSBNs vulnerable. Moreover, SSBN are imperfect retaliatory tools suffering from C^3 problems which could prevent them receiving prompt launch instructions.[21] They are also unable to launch a portion of their missiles without betraying their location, and under START it is possible that fewer US SSBN will be deployed - perhaps 16 to 20, of which only 10 or 12 would be on station at any given time.[22]

A possible solution to this dilemma may have been to make US ICBMs mobile. The now cancelled road-mobile Midgetman offered one of the best chances of survival for land-based ICBMs. Simply put, when considering the land area such missiles could disperse into, the Soviets would have had a very difficult task conducting a barrage attack of known basing locations. But this development, while limiting ICBM vulnerability, added little to the synergistic relationship. If mobile Midgetman could ostensibly withstand a surprise attack in its own right, then bombers could have contributed little to its survivability. Conversely, deployment of Midgetman would not have assisted bomber survivability as the Soviet Union would have been unlikely to expend valuable SLBM warheads on futile barrages of Midgetman basing areas while allowing US bomber bases to remain unscathed.[23]

A second argument is that the present vulnerability of silo-based ICBMs, along with the accuracy and yield limitations of SLBMs, makes the manned bomber the most capable method of conducting large-scale retaliatory attacks against hard-targets.[24] Should the US find itself in a situation of being unable to significantly threaten Soviet hard-targets in a retaliatory strike, the country would therefore be vulnerable to nuclear blackmail.[25] In this case, bombers would certainly play a major part in the strategic force structure.

This bomber advantage may, however, be mitigated by technology. Development of the accurate Trident II D-5 SLBM gives the submarine leg an independent, survivable, hard-target capability.[26] The upshot of this may be more hard-target

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20. For a useful discussion on the problems of hunting modern submarines and possible technological solutions, see Mike Witt, "Subhunting Technology - Processing Progress," Asian Defence Journal, (December 1991): pp.66-74.

21. The main criticism of SSBN C^3 concerns the speed and suvivability under nuclear attack of the US Navy's shore-based global very-low-frequency (VLF) network, extra-low-frequency (ELF) transmitters and "Take Charge and Move Out" (TACAMO) VLF relay aircraft. For contrasting views on communication links to SSBN see Rear Admiral W.J. Holland USN (Rtd.), "The Link to the Boomers:The Triads Best!," United States Naval Institute Proceedings, Vol.114, No.1 (January 1988): pp.48-49; and Richard B. Kelly, "The Link to the Boomers:A Bad Connection," Ibid, pp.48.

22. For an in-depth assessment of the effects of a START treaty on US submarine forces see Desmond Ball, Some Implications of Fifty Per Cent Reductions In Strategic Nuclear Forces For Sea-Based Systems, a paper prepared for the 52nd Pugwash Symposium on Naval Forces: Arms Restraint and Confidence Building, (Oslo, 23-26 June 1988): pp.1-18; and Robert McFarlane, "Effective Strategic Policy," Foreign Affairs, vol.67, no.1 (Fall 1988): pp.41-42.

23. See Brown, "The US Manned Bomber," p.12.

24. It is likely these hard targets would primarily be hardened C^3I assets.

25. See Paul H. Nitze, "Deterring Our Deterrent," Foreign Policy, no.25 (Winter 1976/1977): pp.95-210.

26. For a discussion of the advantages of Trident II D-5 compared to ICBM and manned bombers see Owen Cote, "The Trident and the Triad:Collecting the D-5 Dividend," International Security, Vol.16, No.2 (Fall 1991): pp.117-145.

warheads carried on ballistic missiles, fewer targets assigned to high yield gravity bombs and a corresponding decline in the bomber's contribution to coverage of the hard-target set.[27]

One of the least contestable arguments in favour of manned bombers is their recallability after launch. The bomber's ability to flush from their bases during periods of tension, their slow time-to-target (six to 12 hours over the Soviet Union)[28] and low alert rate, enables the bomber to be eschewed as a first-strike system which in turn enhances strategic stability. While these points have validity, the fact remains that bombers are dependent upon adequate warning time for survival. The same does not apply to the SSBN fleet on station or a mobile missile force.

A fourth argument is that manned bombers complicate Soviet air defence efforts. Illustrative of this is a statement by General Chain:

> A mix of stand-off and penetrating bombers spreads Soviet defenses very thin by forcing them to protect the far forward approaches to the Soviet Union as well as maintain extensive internal air defenses that would try to prevent our retaliation.[29]

By deploying two kinds of air-breathing systems the Soviet Union is prevented from concentrating all its air defence efforts on a single threat. This argument has been a major rallying point for defenders of the penetrating bomber in particular. As put by retired USAF Chief of Staff, General Larry Welch:

> If you lose the penetrating bomber then over time you lose your cruise missile carriers [because the Soviets can concentrate on defeating them] ... When you allow one leg to atrophy you solve one-third of the Soviets [defense] problems.[30]

There is also an economic aspect to this defence of the penetrating bomber. According to Senate Armed Services Committee Chairman, Sam Nunn:

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27. See Brown, "The US Manned Bomber," p.13.

28. Schneider, "Dyad or Triad," p.31.

29. US Congress, Senate, Senator Exon requesting that General Chain's letter concerning the B-2 bomber be published in the Congressional Record. 101st Congress, 1st sess, 9 May 1989. Congressional Record, vol.135, no.57, p.54964.

30. Quoted in Peter Almond, "House Committee Finds Stealth in its Gun Sights," Washington Times, 13 July 1989, p.3.

> the Soviets have something like ... $400 billion in air defenses. The Stealth Bomber is going to require them to either give up on those air defenses in large or they're going to have to revamp them. So there's a huge economic premium here for the Stealth Bomber[31]

Although the B-2 threat to Soviet air defences will be discussed in greater detail later, there is currently no evidence to suggest the Soviet Union will greatly increase its spending in this area in order to counter a yet to be proven penetration system. Defence against cruise missiles, especially the AGM-129A advanced cruise missile, may well prove impossible, leading the Soviets to conclude that increased spending is a pointless exercise. Penetrating bombers may help complicate the Soviet air defence problem through diversifying the threat, but they do not necessarily appear more adept at overcoming air defences than cruise missiles. Moreover, even without penetrating bombers, combating the threat posed solely by cruise missiles remains difficult.

In terms of the issues addressed above, the case for manned bombers appears weak. A declining synergistic relationship between ICBMs and bombers caused by deployment of more survivable systems would not be altered by the B-2. While the B-2 has a capacity to carry up to 16 nuclear weapons (less for long-range war-time strikes) for hard-target capability, this would not alter the trend towards basing more hard-target warheads on ballistic-missile systems such as Trident II D-5. As with all bombers, the B-2 is recallable and reusable, but as for the aircraft not posing a first-strike threat, the point remains moot. Pre-launch survivability and the linkage with warning time also remain unchanged. In terms of complicating Soviet air defences supporters of the B-2 have accorded it a dubious special status. Nonetheless, two key advantages accredited to the B-2 bomber remain. These are the ability to hold at risk Soviet strategic relocatable targets and conventional roles. The former was intrinsic to development of the B-2 while the latter now assumes considerable importance in the B-2's case for deployment.

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31. Quoted in "B-2 Advanced Technology Bomber A Revolution In Deterrence," Northrop Publicity Brochure, 22 November 1988.

THE B-2 PROGRAMME

Special features

On 22 August 1980, President Carter's Defense Secretary, Harold Brown, disclosed that research on a highly survivable, strategic penetration bomber, with even lower observable characteristics than the B-1B would be developed.[1] President Reagan confirmed in October 1981 a requirement for 132 aircraft of which 120 would be nuclear-capable. After these revelations a veil of secrecy descended over the B-2 programme until 19 November 1987 when Northrop Aircraft Division was awarded a $2 billion contract for production of the B-2. Major sub-contractors to the programme would be Boeing Advanced Systems, LTV Aircraft Products Group, General Electric Aircraft Engine Group, Hughes Radar Systems Group and the Link Flight Simulation Group. Initial operating capability was set for the early 1990s.

Official information regarding the aircraft's design, technology, materials and cost was non-existant in the public domain, but informed commentators were predicting the basic design would be of the flying wing concept.[2] They were proved correct on 20 April 1988 when the USAF released an artist's impression of the B-2, although several details had been obscured for security reasons. One of the most important milestones in the B-2 programme was reached on 22 November 1988 when the aircraft was towed from its hangar at Palmdale, California and presented to the public. At this juncture a considerable amount of information concerning the B-2's characteristics quickly became declassified.[3]

Perhaps the most remarkable features of the aircraft are its use of "stealth" technologies especially in the aerodynamics, avionics and materials. The B-2's all-wing shape was intended to reduce its radar cross-section[4] and infra-red signature making it less visible to air defence sensors. This was achieved by eliminating highly radar-reflective flat surfaces and angular joints, and by burying of the engines in the fuselage with the exhausts extensively masked and mixed with cool air to reduce their temperature. Although the B-2's avionics suite remains classified the aircraft is expected to have a very sophisticated offensive avionics system including forward-looking infra-red, terrain-following

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1. The project was known officially as "Senior CJ."

2. Northrop's experience with such a concept dates back to 1928 when designer Jack Northrop left Lockheed to pursue the idea of a flying wing privately. His endeavours produced the N-IM in 1939, the piston-engined XB-35 in 1946 and the jet-engined YB-49 in 1947. Neither the XB-35 or YB-49 reached significant production capability and when the latter crashed in 1949 killing the pilot, the programme died also.

3. The aircraft's key statistics [including dimensions, weights, armament and range] are listed in Appendix 1.

4. The radar cross-section of a B-2 is estimated to be 0.01 square metres (approximately the size of a small bird) compared to 60 square metres for the B-52. See John W.R. Lepingwell, "Soviet Strategic Air Defense and the Stealth Challenge," International Security, vol. 14, no.2 (Fall 1989): pp. 84-86; and Bill Sweetman, "Bomber forces mission and equipment," International Defense Review, vol.22 (August 1989): p.1040.

and terrain-avoidance radars. Some aviation writers have speculated that the B-2 will utilise low-probability of intercept radar technology such as the use of very low side-lobe antennas and constant variations in frequency and waveform.[5] Defensive avionics, such as radar and communications jammers, chaff, flare and decoy dispensers, are unlikely to be carried owing to the aircraft's low-observable characteristics.[6] Much secrecy also surrounds the nature of the materials from which the B-2 is constructed, but experts believe the B-2's structure relies heavily upon graphite/epoxy (carbonfibre) and other advanced composites, with extensive use of honeycomb radar-absorbant structure, and radar-absorbant material skinning.[7]

The B-2 also breaks new ground in the way it is designed and built. Extensive use has been made of computer-aided design and manufacturing. This has allowed each aircraft to be constructed on production standard tooling, or in final as opposed to prototype configuration. Final assembly is conducted at Palmdale with flight-testing conducted at Edwards Air Force Base, also in California. In terms of both individual sub-systems and the total aircraft, the B-2 is probably the most extensively pre-flight tested aircraft ever. Over seven years, a total of 740,000 hours of pre-flight tests were completed[8] enabling Northrop and the USAF to claim that technological risks in the B-2 programme had been minimised. The maiden flight of the B-2 on 17 July 1989 vindicated this faith and by 1 May this year the first four aircraft had logged 544 hours on 125 flights operating over the full operational speed range and conducting aerial refuelling behind both KC10 and KC135 Tanker aircraft. Overall, 3600 hours of planned light-testing are scheduled during the full-scale development phase.[9]

The radar signature or "low-observable" testing phase is critical to the B-2's operational prospects. If results are not up to expectation and the B-2 proves less stealthy than claimed, there is every likelihood Congress will block further funding for the B-2 programme. To facilitate low-observable testing, the USAF has added on extensive electronic warfare capability to its Utah test and training range. The goal of the electronic combat test capability programme is to provide

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5. See Bill Sweetman, "B-2 Bomber for the 21st Century," Interavia, vol. 44 (January 1989):p.25.

6. Michael Brown, "B-2 or not B-2: Crisis and Choice in the US Strategic Bomber Programme," Survival, vol. xxx, no.4 (July/August 1988): p.356.

7. See Marvin Leibstone, "Stealth: The US Advanced Technology Bomber," Military Technology, vol. x (September 1986): pp. 219-224.

8. This testing phase comprised: 24,000 hours of wind tunnel testing; 6,000 hours of manned operations by USAF and Northrop pilots in advanced flight and mission simulators; 16,000 hours of engineering development testing for refinement and evaluation of flight controls, cockpit avionics and human factors; nearly 42,000 hours of reliability testing; 67,000 hours in acceptance testing; 122,000 hours testing computer-related systems; 291,000 hours of flight qualification testing; two aircraft lifetimes of durability testing; and full production qualification of the B-2's engines. "B-2 ATB-A Revolution In Deterrence," Northrop Publicity Brochure, 22 November 1988.

9. B-2 test crews have flown the aircraft in 95% of its operational flight envelope and from sea level to "almost 50,000 feet". About 30% of planned flying qualities and flight control testing, 80% of the aerial refuelling envelope and more than 50% of the planned vibro-acoustics testing with weapons bay doors open are completed. Testing of the B-2s ability to complete take-off and landing and refuelling at night commenced in May. See William B. Scott, "B-2 Test Program Remains on Track to Meet Aero-Structural Milestones," Aviation Week and Space Technology, 18 November 1991, pp.63-64; and Barbara Opall, "U.S. Air Force to Initiate Nighttime B-2 Test Flights," Defense News, 25-31 May 1992, p.8.

layers of threats over a 70 nautical mile corridor containing up to 100 electronic warfare threats which lead to target areas. Aircraft would drop down to levels as low as 100 feet above ground level and attempt to penetrate the corridor at high sub-sonic speeds.[10]

Another major feature of the full-scale development programme has been the focus on logistic support. To ensure increased reliability, maintainability and supportability, the B-2 programme has emphasised early involvement of maintenance personnel in the design and test phases. This approach should ensure that when the first B-2 is delivered to ACC, a cadre of qualified maintenance personnel will have the technical data, spares and support equipment necessary to generate sorties. As noted by B-2 programme director, Major General Richard Scofield:

> This was one of the lessons learned on the B-1B program - have a maintenance capability in place when aircraft arrive at the first base. We're not doing this program just to get the first airplane out the door. We're doing it to provide a useful capability that can be [employed] the way SAC wants from the time they get [the B-2].[11]

The first operational site for the B-2 is Whiteman Air Force Base, Missouri, where specialised maintenance docks and hangars are being constructed.

Problems

Although there are many positive factors in the B-2 procurement programme, Defense Secretary Cheney probably understated the case when he said "we've got problems with the B-2."[12] Extant in the programme are a number of potentially serious production, performance and management problems.

Attracting the most criticism is the decision to make the B-2 a highly "concurrent" programme; that is, compress the traditional stages of the procurement process so that research, engineering development, prototype testing and production occur simultaneously. The USAF and Northrop argue that concurrency in the B-2 programme is less than that found in any major modern aircraft procurement by Defense. Moreover, by building all B-2s on production-standard tooling, considerable costs are saved by not building preliminary tooling for just a few prototypes. While this plan looked solid in theory, it has proved a false economy in one key instance.

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10. The first B-2 (AV-1) has now been dedicated to this phase and about one year of low observables testing is completed. The Director of the B-2 combined Test Force, Colonel Frank Birk, has said the test force has "looked at the entire radar spectrum, from low to high frequencies, focusing on those frequencies that represent potential threats." Ibid, p.64. For details of the testing range see "Planned Air Force Electronic Warfare Range Would Be Used to Test B-2, ATF," Aviation Week and Space Technology, 11 September 1989, p.59.

11. Cited in William B. Scott, "Success of B-2 Programme Linked to Decision to Build, Deploy B-1B," Aviation Week and Space Technology, 5 February 1990, p.73.

12. Quoted in Defense Week, 26 June 1989, p.7.

In 1983 SAC assessed that the B-2 would have to fly at very low altitudes, similar to the B-1B, as well as mid-to-high level altitudes. This requirement for an all-altitude capability required Northrop to undertake a massive effort to redesign the B-2's wings in order to cope with the greater aerodynamic stresses experienced at lower altitudes. Accordingly the production tooling which was already in place had to be redesigned.[13] The end result was a $1 billion increase in programme cost and an 18 month delay in the projected first flight date. Northrop itself was said to have written off some $214 million.[14] Although the first three B-2s are now flying, there is no concrete guarantee that a major design or structural fault may not arise requiring rectification and hence costly changes to production tooling.[15] This issue is of particular concern to Congress which has responded by linking programme funding to an ongoing and thorough test programme.

A report issued by the General Accounting Office (GAO)[16] on 22 February 1990, drew attention to several manufacturing problems, including defects and inefficient labour, being encountered by the programme contractors. Despite corrective measures, the report found that "quality in the manufacturing process has not improved" and the rate of worker defects is higher on later models than on the first two aircraft.[17] Lax quality control also received attention from the Pentagon's outgoing Undersecretary for Acquisitions, Robert Costello, who said in an interview that Northrop's quality controls on the development of the planes are "terrible" and improved little between official visits to the Palmdale Plant over 18 months.[18] Costello said he observed nicks in composite structures and other defects which he subsequently reported to then Defense Secretary Frank Carlucci. When asked later by Carlucci why he kept "trying to kill the B-2", Costello apparently replied, "because Mr Secretary, it's being brought to you by the same company that brought you [a series of troubled programmes including guidance systems for the Peacekeeper and ALCM] ... what makes you think they'll do better [with the B-2]."[19]

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13. See Ralph Vartabedian, "Redesign of Stealth Wing Caused Long Delay, Higher Cost," Los Angeles Times, 29 October 1988, Part IV, p.1, 4.

14. Michael Brown, "B-2 or not B-2," p.360.

15. On 26 July 1991 (acknowledged by the USAF in September 1991), AV-1 experienced what was described as a minor stealth testing anomaly. By obtaining a less than expected radar cross-section reduction the possibility was raised that the B-2 might require changes in configuration. Air Force Secretary Donald Rice was adamant, however, that the shortcoming may only require small scale design changes involving no more than edges, surfaces and treatments along the leading edge of the wing. "It does not go to the structure, shape or plan form of the airplane" and "in no sense does anyone see any prospect of any requirement for significant design changes" Rice said. Cited in David F. Bond, "USAF Resists Change in B-2 Configuration," Avation Week and Space Technology, 4 November 1991, p.69. See also Barbara Opall, "Pentagon Downplays Failure in B-2 Test," Defense News, 16 September 1991, p.22.

16. The General Accounting Office is the investigating agency for Congress.

17. The defects were caused mainly by improperly drilled holes and difficulties in sealing a fuel tank. The GAO reported that the first aircraft took 1.5 million work hours to build - 84 percent more than anticipated. Late last year engineers were making nearly 2,000 changes per month to engineering drawings adding extra disruption. See Molly Moore, "B-2 Costs Could Rise Sharply," Washington Post, 23 February 1990, p.1; and Rowan Scarborough," GAO drops $70 billion bomb on B-2 Stealth hearing," Washington Times, 23 February 1990, p.7.

18. See Barbara Amouyal, "Air Force, OMB Eye Cuts in B-2 Bomber Purchases," Defense News, 22 May 1989, p.1.

19. Cited in Molly Moore, "B-2 Bomber Cancellation Is Urged," Washington Post, 19 May 1989, p.1.

A major performance-related problem appeared publicly in October 1989 when reports circulated in Congress indicated that the B-2 had less unrefueled cruising range than the B-1B. The documents reported that the B-2's advertised unrefueled range of 6000 nautical miles compared badly against the B-1B's range of 6400 nautical miles. With House Armed Services Committee Chairman Les Aspin describing this revelation as "not good news for the plane",[20] the USAF countered firstly by charging that the reports were using outdated information and secondly, by releasing detailed performance figures which claimed the B-2 would in fact be capable of flying 6600 nautical miles and of 50 percent better fuel efficiency than the B-1B for unrefueled profiles. Furthermore, the USAF figures indicate that the B-2 required less than half the aerial refuelling support of the B-1B for nuclear strike missions against the Soviet Union.[21] In terms of weapon load, however, only loads of 24,000 and 37,300 pounds were included in the analysis. The USAF has consistently been claiming a payload capability of 50,000 pounds.

On a similar note, the aforementioned GAO report noted that the bomber's projected weight (critical to range and weapon payload) had grown by several thousand pounds. Efforts to lighten the aircraft produced the opposite effect with further weight being added. In a classified supplement to the report, the GAO is reported to have warned that if the weight problem is not solved, the B-2 may have less range and require longer take-offs.[22]

Compounding the impression of poor quality control and management is a $20 billion false-claims lawsuit filed against Northrop by former employees.[23] The suit maintains that there was:

> ... widespread and long-term mismanagement, fraud and abuse within the stealth bomber program that resulted in mischarging, false statements and misrepresentation to the USAF concerning progress on the B-2 ... All of the money acquired by Northrop was fraudulently received because the company misled its USAF customer.[24]

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20. Cited in George C. Wilson, "B-2 Stealth Bomber Has Shorter Cruising Range Than Older, Cheaper B-1," Washington Post, 6 October 1989, p.14.

21. See David F. Bond, "USAF Say's B-2 Range Exceeds B-1B's With Varied Payloads, Flight Profiles," Aviation Week and Space Technology, 23 October 1989, pp.30-31.

22. As part of the B-2 development process, a number of weight-saving changes in the aircraft wiring will be incorporated on AV-12, the sixth production aircraft, and subsequent aircraft. The planned changes, including the elimination of junction boxes and the use of lighter, thinner insulation, are expected to reduce aircraft weight by about 300 pounds. William B. Scott, "Structural Cracking Detected in B-2 Ground Test Article," Aviation Week and Space Technology, 13 May 1991, p.60. See also Moore, "B-2 Costs Could Rise Sharply," p.1; and Scarborough, "GAO drops $70 billion bomb," p.7.

23. The suit was originally filed in 1988, but after Northrop and federal government officials investigated the allegations for eight months, they determined there was insufficient evidence on which to intervene at that time. Undeterred, the complainants filed an expanded claim in the Los Angeles District Court on 2 October 1989.

24. Bruce A. Smith, "Suit Claims Northrop Wrongfully Took $20 Billion for Stealth Bomber Work," Aviation Week and Space Technology, 13 November 1989, p.26.

Specific allegations include poor design of critical electronic systems, installation of systems known to be faulty, false certification of equipment and maintenance of unnecessarily high work-force levels. These allegations are still subject to ongoing investigation and substantiation. On 15 February 1990 Northrop's problems were increased when Federal Bureau of Investigation agents searched the company's Pico Rivera Plant (where B-2 parts are made) and took possession of several documents. According to one source:

> A raid is a drastic measure ... It would not be happening 18 months into an investigation without some sort of major breakthrough or other event in the case. You can always subpoena records. You don't conduct a raid unless you are worried the documents won't be there when you want them.[25]

The numerous allegations and investigations have not been encouraging for the programme, particularly in a time of increasing budgetary scrutiny.

As noted earlier, a critical element in the B-2 test programme is the low observables phase. Ever since the B-2 programme was officially acknowledged to exist, the aircraft's proponents have continually extolled the virtues of its (anticipated) ability to avoid detection. In 1987, then Defense Secretary, Casper Weinberger, stated that to cope with the B-2 the:

> Soviets will be forced to make an enormous investment in new defense systems over a span of many years, while their existing enormous investment becomes rapidly obsolete. The [B-2] will not only dramatically degrade existing Soviet air defense, but those of Moscow's Warsaw Pact allies and Third World client states.[26]

No less emphatic was Lieutenant General Randolph when he claimed "the B-2 will render useless some $200 billion the Soviets have invested in spectacular air defenses".[27] Similarly, Defense Secretary Cheney argued, the B-2:

> is virtually invisible to all known radar defenses and certainly [to] those that the Soviet Union has invested in past years ... It will have the capacity to penetrate Soviet airspace, even if they make significant additional investments in their defenses for a long time to come.[28]

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25. Cited in Ralph Vartabedian, "FBI Agents Raid Northrop's B-2 Bomber Plant," Los Angeles Times, 22 February 1990, p.D2.

26. Cited in Doug Richardson, "Is Stealth misleading?," Interavia Aerospace Review (October 1989): p.969.

27. Randolph, "The B-2 Bomber Technology In Transition," p.495.

28. Cited in Mark Thompson, "B-2's touted Stealth in dispute," Philadelphia Inquirer, 30 July 1989, p.2D.

Given the relative infancy of the B-2 low-observables testing programme at the time these remarks were extremely optimistic. Not surprisingly, the scientific and defence industrial community quickly accepted the opportunity to propose a wide range of prospective counter-stealth technologies, including over-the-horizon-backscatter, long-wave-length, bistatic and ultra-wide-band radar and airborne warning and control systems, which were thought to be capable of detecting the B-2. The B-2s large planform, jet plume and choice of sensors were also identified as potential aids in the detection process.[29]

In September 1989 Air Force Secretary Rice signalled the USAF move away from claims that the B-2 was virtually radar invisible when he conceded that "systems and techniques exist which can detect it."[30] At the same time, however, the counter-stealth debate was put into perspective when it was pointed out that vunerability assessments must look past yes-or-no detectability and ask whether a prospective counter-stealth system can:

- Detect the B-2 at all altitudes and flight profiles with suitable coverage to defend a large area.
- Track the B-2 accurately enough and long enough to direct a weapons system against it.
- Guide a weapon and fuze it so that its warhead will explode close to the aircraft.[31]

On the strength of analyses by a stealth technology "Red Team"[32] of how effective existing Soviet air defences would be against the B-2, the USAF was confident that no "Archilles heel" had been found which would negate the value of stealth technology for the forseeable future. For existing defences the team found that:

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29. For detailed evaluation of radar technologies supposedly able to detect the B-2, see: Lepingwell, "Soviet Strategic Air Defenses," pp.83-86; Brower, "Targeting Mobile Nuclear Forces," pp.24-31, 33-35; Richardson, "Is Stealth Misleading," pp.968-970; William B. Scott, "UWB Radar Has Potential To Detect Stealth Aircraft," Aviation Week and Space Technology, 4 December 1989, pp.38-41; Jack Anderson and Dale van Atta, "Soviet Radar Might See Stealth Planes," Washington Post, 10 February 1986, p.B-14; "Stealth Aircraft Spur Interest in Space Sensors," Aviation Week and Space Technology, 14 April 1986, p.67; "Defeating Stealth," International Defense Review, vol. 22 (August 1989): p.1103; and David F. Bond, "USAF Believes Impulse Radar Not Feasible For Detecting B-2," Aviation Week and Space Technology, 26 February 1990, p.53.

30. Cited in Mark Thompson, "Foe will be able to detect Stealth Air Force says," Baltimore Sun, 2 November 1989, p.1.

31. See David F. Bond, "USAF Study Asserts That Soviet Defenses Would Be Ineffective Against B-2 Bomber," Aviation Week and Space Technology, 30 October 1989, pp.29-30.

32. Established by the USAF in 1981, this team has evaluated more than 40 unconventional stealth concepts including acoustic systems; ground-based and airborne bistatics; anti-stealth radar waveforms; balloon radar; bistatic reflectors; detection of corona; correlation spectroscopy; cosmic rays; differential absorption, infrared airborne warning and control system; infra-red search and track; land mines; magnetic disturbance; space-based radars, upgrading existing systems; over-the-horizon radar; passive coherent detection; radar shadow detection; hybrid bistatic radar; detection of aircraft emissions; impulse radars; towers and nets; advanced airborne surveillance; radar wake detection; radiometres; ultra-write band radar; polysaturation doppler; and high frequency radars. Ibid, p.29.

- the B-2 can penetrate without allowing adequate vectoring of Soviet fighters;

- fighter sensors cannot detect the B-2 at large enough distances to engage and provide a suitable defence; and

- SAM envelopes have been dramatically reduced so that mission planning and reactive avoidance works under most conditions.[33]

In May 1991 initial results from the low observables testing on the first B-2 (AV-1) indicated that the aircraft's radar cross-section would enable it to penetrate and survive sophisticated air defences with a high degree of reliability.[34] Six months later, however, the USAF's confidence in the B-2s low observability suffered a setback when it was revealed AV-1 had failed to meet desired radar signature measurements. Due to the highly classified nature of this phase of testing, the USAF would only describe the failure as the B-2 "attaining a less than expected radar cross-section at a particular frequency."

Senior Air Force and Defense Department officials admitted the problem was cause for concern but highlighted the fact that the failure had occurred in only one area of a comprehensive low observables testing programme. According to Air Force Secretary Rice the test fell short of predictions partly because the test aircraft was not in precisely the configuration for which the stealth predictions were calculated.[35]

In an effort to downplay the significance of the problem the USAF ruled out any possibility of costly structural or design changes to the B-2. As an alternative it was revealed that relaxation of radar cross-section requirements were being considered. Supported by the Defense Science Board (DSB) B-2 Task Force[36] the USAF began research into how much radar cross-section the B-2 would actually need especially for missions to deliver conventional rather than nuclear weapons. According to DSB Chairman John Foster, the review "will be invaluable in allowing improved tradeoffs to be conducted against signature requirements."[37] In addition to reviewing stealth requirements the USAF is studying ways to compensate for the test anomaly, if necessary, by changing its plans for operating the B-2. As put

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33. Ibid, p.30.

34. The GAO reported that these initial tests measured the radar signature from throughout 360 degrees and at angles above and below the aircraft. Researchers also illuminated surfaces that are normally exposed to ground-based radar. It was noted, however, that only four percent of the test programme had been completed and that the B-2s full capabilities had not been tested in a representative operational environment. "GAO Says Initial Tests Confirm B-2s Ability To Evade Radar," Aviation Week and Space Technology, 6 May 1991. p.66.

35. See David F.Bond, "USAF Resists Changes," p.69.

36. Immediately following the test anomaly of 26 July a panel of stealth experts including the DSB was extablished to review the B-2s stealth requirements. Ibid.

37. Ibid, p.70.

by USAF Chief of Staff, General Merrill McPeak, the USAF will be able to devise "operational workarounds" or "in other words we can stand off a little from suspect radars."[38]

On 1 May the USAF effectively completed its withdrawal from claims the B-2 is potentially radar invisible. In testimony to the House Armed Services Procurement Subcommittee Tactical Air Commander, General Mike Loh, confirmed the bomber has not done as well as expected in stealth testing and is unlikely to meet all the technical specifications established to ensure the planes' ability to evade the full spectrum of radar frequencies. Nonetheless, Loh insisted that a combination of "fixes" now being tested by the USAF coupled with what he described as smart mission planning and tactics, will ensure that the B-2 meets its operational requirements:

> I'm fairly confident that we're going to find a solution [to stealth testing deficiencies] but that is not to say that the B-2 will meet its specifications at every frequency, at every angle and at every elevation... and I don't believe it has to in order to be an operationally effective bomber in either the nuclear or conventional role.[39]

In explaining how the B-2 would meet its operational requirements despite the stealth deficiency Loh said:

> We'll fly the B-2 just like we fly other planes. We will do it smartly; we'll have smart tactics, smart mission planning and we're not going to put it in a situation where the probability of survival is not 100 percent.[40]

Queried by House Armed Services Committee Chairman Les Aspin about the difference in B-2 operational requirements for nuclear and conventional missions, Loh explained that the demands on the aircraft in non-nuclear roles are less severe because conventionally equipped B-2s can operate with other systems for maximum effectiveness:

> The difference is that for the nuclear mission you'll have to take on those [early warning] radars without any support every time. In conventional missions, you're going to have other forces at your disposal. So if you have a deficiency in a specific frequency where radars operate, you can take out that radar by other means.[41]

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38. Ibid.

39. Cited in Barbara Opall, "U.S. Air Force Exposes B-2 Stealth Flaws," Defense News, 4-10 May 1992, p.3.

40. Ibid.

41. Ibid.

While Congressional reaction to the B-2s stealth deficiency has been muted it has made funding for the final four aircraft conditional on Pentagon certification that the aircraft's stealth charateristics work as advertised. Moreover, the prospect of the B-2 not having the capability to evade radar independently, especially on nuclear missions, must be alarming given the mission requirements identified for the bomber.

Cost

The debate over the cost of the B-2 programme is a particularly complex and at times confusing affair. For many years programme costs were hidden in what officials refer to as the "black" side of the defence budget and only became public during 1988 and 1989. Once costs became public, arguments soon developed between the USAF and members of Congress over how procurement costs should be expressed, particularly whether in terms of unit programme cost or flyaway cost. Arguments also broke out over the requirement for, and vast cost of, procuring the full 132 bomber fleet. Congress was convinced that the Pentagon was underestimating the changed strategic circumstances brought about by the quest for democracy in Eastern Europe and a Soviet Union increasingly preoccupied with internal difficulties. In response, Secretary Cheney announced in late April 1990 that the intended purchase of B-2s would be cut from 132 to 75 aircraft and following the abortive August 1991 coup against President Gorbachev and subsequent dissolution of the Soviet Union into the Commonwealth of Independent States, President Bush announced, early this year, that the programme would be capped at 20 aircraft. Notwithstanding these reductions, the B-2 remains an enormously expensive aircraft.

The decision to keep the B-2's costs secret for so long attracted considerable criticism, but sharp disagreement had existed inside the Pentagon over whether the B-2 budget should be declassified. Former USAF Secretary, Vern Orr, recommended declassification in 1984 and 1985 but was blocked by Defense Secretary Weinberger. Orr felt that:

> It [the B-2] had become so big that it distorted the budget. Financially, it was becoming burdensome to hide that much money. And my feeling was that we were not being fair to Congress.[42]

When figures did become available, it was apparent the B-2 programme had been troubled by cost-growth problems caused by a series of decisions to reschedule the "ramp-up" to peak production. During the mid-1980s an eighteen month delay was incurred as a result of the major wing redesign to the B-2. A further two-year delay was ordered in 1987 due to the Gramm-Rudman anti-deficit

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42. Cited in Ralph Vartabedian, "Why Did AF End Stealth on Stealth?," Los Angeles Times, 2 August 1989, p.1.

provisions[43] and in 1989 Secretary Cheney's revised budget added a further 12 month delay to the production phase. The combined result of these decisions was a revised completion time for the programme from 1995 to 1999 and an increase in overall costs.

In dollar terms, the four-year delay to programme completion pushed the total programme cost up from $68.1 billion to $70.2 billion. By early April 1990, the USAF conceded that the price had risen another seven percent to $75.6 billion with each aircraft set to cost around $573 million.[44] Congressional reaction to the huge cost of the B-2 programme was predictably negative.[45]The USAF defended the programme by insisting that the $573 million figure cited by Congress and the media was misleading. To date nearly $27 billion has already been spent or "sunk" on the full-scale development programme. According to the USAF, those funds are non-recurring and should not be applied when costing each aircraft. The correct measure is the "flyaway" cost which excludes research and development. When the flyaway cost is used, each B-2 was said to cost between $285 and $300 million under the 132 bomber plan.[46]

The realities of dramatic changes in Eastern Europe and the Soviet Union, along with an increasing Federal deficit, conspired against this plan. The peak procurement years coincided with Secretary Cheney's request that each service submit budget-cutting plans to meet a $180 billion reduction in military spending during Fiscal Years 1992-94. The USAF was asked to reduce its budget by $9 billion in 1992, $12 billion 1993 and $16 billion in 1994. While proposing to stretch out the B-2 programme, close installations and eliminate several air wings, the USAF still fell eight billion short of the $45 billion target.[47]

On 26 April 1990 and under increasing pressure, Cheney announced the results of a major aircraft review which reduced B-2 numbers to 75 aircraft or two strategic wings. Cheney's revised acquisition plan envisaged the purchase of two B-2s in

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43. Under the Gramm-Rudman deficit reduction law, the Federal budget automatically enters a sequestration process at the start of each fiscal year (October 1) if Congress and the White House have not met pre-arranged deficit reduction goals. Sequestration triggers automatic spending cuts. Half of any deficit overrun would have to be absorbed by the Defense budget with the largest share coming from the procurement accounts. See "Pentagon Budget Expected to Lose About $3 Billion to Gramm-Rudman," Aviation Week and Space Technology, 22 November 1989, p.16; and Bruce A. Smith, "B-2 Peak Production Delays Drive Up Program Costs," Aviation Week and Space Technology, 24 July 1989, p.26.

44. See Richard Halloran, "Air Force Raises Cost Estimate of Stealth Bombers to $68.1 Billion," New York Times, 24 June 1989, p.1; and Mark Thompson, "B-2's cost again rises by 7 percent," Philadelphia Inquirer, 3 April 1990, p.7.

45. Attracting the most criticism was Secretary Cheney's revised production plan which envisaged five B-2s being built in 1991, 10 in 1992, 21 in 1993, 24 in 1994, 30 in 1995, and the remainder being built by 1996. These high annual production rates would have required funding levels approaching $9 billion a year in the mid-1990s. See John D. Morrocco, "Opposition to B-2 Threatens Viability of Strategic Triad," Aviation Week and Space Technology, 19 March 1990, p.49; Andrew Rosenthal, "Stealth Bomber And Its Billions Are Under Fire," New York Times, 24 June 1989, p.1; and Melissa Healy "Cheney Asks Full Production of B-2," Los Angeles Times, 14 December 1989, p.1.

46. For greater detail on costing methods see Bill Sweetman, "B-2 Costs: when a $ is not a $," Janes Defence Weekly, 23 September 1989, p.619; and "One On One," a Defense News interview with Major General Richard Scofield, B-2 Program-Director, Defense News, 4 June 1990, p.44.

47. See John D. Morrocco, "Defense Department Grapples With Massive Spending Cuts," Aviation Week and Space Technology, 27 November 1989, p.18.

1991, eight planes in 1992 and 1993, followed by 12 in 1994. The remaining aircraft would be bought at a rate of 12 per year until the 75 aircraft were delivered to the USAF.[48]

Although the total cost of the B-2 programme had fallen from $75.6 to around $64.7 billion, the unit cost of each aircraft had risen to about $865 million (flyaway cost around $500 million). For FY-92, the Bush Administration requested a total of $3.2 billion for a further four B-2s but was granted $1.8 billion to maintain Northrop's production base for the bomber, $1.6 billion for research and development and the possibility of an extra $1 billion which was dependant on tagon certification that the B-2 meet all of its stealth requirements.[49] Sensing a Congressional impetus toward capping the B-2 programme at the 15 aircraft now authorised, the USAF argued that while the first 15 aircraft would cost around $39.2 billion, the remaining 60 could be purchased for a modest $21.6 billion; that is 35% of the total B-2 budget would purchase 80% of the proposed fleet.[50]

While this figure would appear favourable at first glance, the fact remains that B-2 continues to consume a significant portion of both defence and USAF procurement funding each fiscal year. For the most recent year (FY-92) from a total of $9.024 billion authorised for the DoD's top 10 procurement programmes, the B-2 accounted for $2.8 billion or 31% of the total. From a total of $6.781 billion authorised for the USAF's top six procurement programmes, the B-2s $2.8 billion allocation represents a substantial 41.3%.[51] Although the USAF makes no secret of the fact that the B-2 is its highest strategic priority, critics have regularly charged that in order to sustain and protect B-2 funding lower priority programmes are being cancelled or severely pruned. Cuts to the Short-Range Attack Missile-Tactical (SRAM-T) and the now cancelled rail-mobile Peacekeeper missile have been cited as examples of the USAF's whittling of strategic programmes in favour of the B-2. Although the USAF rejects allegations of favouritism it nonetheless concedes that "if it just so happens that anything we've restructured or cancelled in the past or are considering for the future frees up money [for the B-2] then so be it."[52]

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48. Barbara Amouyal and Philip Finnegan, "Impasse Looms For B-2 Funds," Defense News, 28 May 1990, p. 1, 37.

49. The request and subsequent authorisation were made against the backdrop of a six year defence plan that cuts military buying power 37% every year between 1991 and 1997, atop an 11.3% cut between FY-90 and FY-91. The FY-92 defence budget request of $278.3 billion was the lowest since 1985. By 1996 the Pentagon would spend less of the US GNP on defence (3.6%) than in any year since 1939. See "$278.3 Billion Defense Budget Set to Drop 14% More by 1997," Armed Forces Journal International (March 1991): p.17, and Patricia A Gilmartin, "Bill Reordering U.S. Defense Priorities Leaves B-2 Program Close to Death," Aviation Week and Space Technology, 11 November 1991, p.25.

50. See David F. Bond, "USAF Will Need Another $2.6 Billion to Complete Acquisition of 15 B-2s," Aviation Week and Space Technology, 16/23 December 1991, p.22.

51. These figures are based on data contained in the following articles: James C. Hyde and Glenn W. Woodman Jnr, "Congress Funds Nearly 70% of DoD's Top 25 Programs," Armed Forces Journal International (December 1991): pp.9-12, and Gilmartin, "Bill Reordering Defense Priorities," p.28.

52. Cited in George F. Leopold and Barbara Opall, "B-2 Gains in Air Force Budget Maneuvers," [sic] Defense News, 12 August 1991, p.4, 29.

Not unlike the earlier plan to acquire 132 B-2s the 75 bomber plan has also become a casualty of post-cold war realities. As part of a five year plan announced by President Bush in January to save $50 billion in the defence budget, the B-2 programme has been capped at 20 aircraft which in itself is expected to save $14.7 billion.[53] Confronted with the fact there will be no more than 20 B-2s the USAF has now begun a determined campaign to convince Congress that the full compliment of 20 and not 15 bombers should be authorised.

The opening salvo was fired by Air Force Secretary Rice on 20 February when he informed the House Armed Services Committee that the difference between a 15 bomber force, as proposed by Congress and the 20 B-2s requested by the USAF is only $2.6 billion and the additional cost would yield significant results. Rice explained that a 20 bomber force would provide 15 operational aircraft for extended contingencies from domestic and foreign bases but a 15 bomber force would yield only 10 aircraft which would be sufficient only as a "silver bullet" force for use in one-day raids of the type conducted against Libya in 1986. Echoing Secretary Cheney's remarks more than two years ago when he justified the requirement for a 75 bomber force,[54] Rice concluded that:

> The choice to complete 20 B-2s was carefully weighed. The demands of training, maintenance, and other operational factors convinced us that the force of 15 proposed by some would fall short of the capability we need.[55]

While the operational imperatives for a 20 as opposed to 15 bomber fleet appear credible the unit cost projections are almost the opposite. The most recent USAF calculations put the cost of completing 20 bombers at $44.4 billion which results in a unit cost approaching a staggering 2.26 billion dollars. When using the USAF's preferred flyaway cost measure, however, a 15 bomber force is said to cost $939 million apiece and a 20 bomber force about $450 million apiece. Assistant Secretary of the Air Force for Acquisition, Jack Welsh, attributed the escalating unit cost to overinvestment in facilities, tooling and training along with programme stretch-outs that have nearly doubled the production time for the B-2.[56]

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53. For details of the plan see, Charles Aldinger, "Pentagon Proposes Major Slowdown In Arms Purchases," Reuters Report, Washington D.C., 29 January 1992.

54. Cheney said that two wings or 75 B-2s was the absolute minimum force level required to perform a SIOP mission effectively while capitalising on investments made in logistics, training and infrastucture. See Barbara Amouyal, "After Cheney Proposal, Firms Gird For Even Steeper Aircraft Cuts," Defense News, 30 April 1990, p.11.

55. Donald Rice, Secretary of the Air Force, Reshaping the Future, Testimony to the HASC, 20 February 1992, p.10.

56. The USAF expects to receive 12 B-2s between 1993 and 1995 with the last aircraft reaching the inventory at the turn of the century. See Barbara Opall, "Rice pushes 20 Bomber B-2 Fleet for Extra $2.6 Billion, Defense News, 24 February, p.76; and Barbara Opall, "Welch Says AF Won't Repeat B-2 Excesses," Defense News, 4-10 May 1992, p.3.

The decision to curtail the programme at 20 aircraft has lifted a certain amount of pressure off the B-2s future but given the substantial sum required to complete a 20 bomber plan and the problems in the low observables testing programme, Congress may yet withold funding for completion of the force. Should this occur the problems of cost-effectiveness of a small force and maintenance of a credible strategic bomber force in the longer term will need to be addressed. For the moment, however, the cornerstone of the USAF's case for the B-2 is the identification of a credible mission.

B-2 IN SEARCH OF A MISSION

US Nuclear Targeting Policy

The past decade has witnessed two significant developments in US targeting policy. The first has been a shift from targeting the Soviet Union's means of economic recovery after war to targeting the Soviet capacity to make war. The second development has been a growing US interest in acquiring the capability to wage a prolonged and controlled nuclear war. The genesis of these developments began with a major Nuclear Targeting Policy Review conducted by the Carter Administration in 1977-79 and culminated in a new SIOP, designated 6F, which came into effect on 1 October 1989.[1]

The new targeting policy and SIOP was described by President Reagan in January 1988 as follows:

> Our strategic forces and associated targeting policy must, by any calculation, be perceived as making nuclear warfare a totally unacceptable and unrewarding proposition for the Soviet leadership. Accordingly our targeting policy:
>
> - Denies the Soviets the ability to achieve essential military objectives by holding at risk Soviet war-making capabilities including both the full range of Soviet military forces and the war-supporting industry which provides the foundation for Soviet military power and supports its capability to conduct a protracted conflict: and
>
> - Places at risk those political entities the Soviet leadership values most: the mechanisms for ensuring survival of the Communist Party and its leadership cadres, and for retention of the Party's control over the Soviet and Soviet-bloc peoples.[2]

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1. For a comprehensive and detailed explanation of the major policy documents formulated in this period see Desmond Ball, The Evolution of United States Strategic Policy Since 1945: Doctrine, Military Technical Innovation, And Force Structure. Strategic and Defence Studies Centre (SDSC) Reference Paper no. 164 (The Australian National University, Canberra 1989), pp.21-38.

2. Ibid., p.33.

In essence, the policy states that the Soviet leadership's main objectives in a nuclear war would be preservation of political and military power in order to prosecute a "successful" nuclear war against the US. The notion of the Soviet Union having a war-winning capability has been fuelled by developments in Soviet nuclear forces. Former USAF Chief of Staff, General Welch, has referred to:

> Growing numbers of prompt, accurate offensive systems; steadily increasing hardness of nuclear forces, command, control and leadership facilities; increasing emphasis on redundancy, dispersion, and mobility of forces and command and control assets; and continuing modernization and expansion of an extensive strategic defense system ... [indicate] forces more suited to a war-winning strategy than an assured destruction strategy.[3]

These developments suggest that any Soviet victory would be contingent upon maintenance of significant survivable nuclear forces and C^3.[4] As indicated by President Reagan's statement and SIOP-6F, the key goal for the US is to deny the Soviet Union such reserve forces.

Central to this goal is the capability to locate, track and destroy Soviet strategic-relocatable targets, especially mobile missiles. Since 1982 there has been a substantial increase in the number of Soviet strategic relocatable targets. In 1984 there were about 4,000 relocatable targets in the National Strategic Target List,[5] comprising mobile air defence batteries, submarines, bombers and tank and troop concentrations on manoeuvre. The deployment of the SS-25 (Sickle) road-mobile, single-warhead ICBM in 1985, and SS-24 (Scalpel) rail-mobile, multiple-warhead ICBM in 1987, exacerbated US fears of a more potent and invulnerable Soviet ICBM force. By the end of 1991 analysts estimated that 315 SS-25 and 90 SS-24 had been operationally deployed.[6] By the end of the century the possibility exists that nearly half of all Soviet strategic nuclear targets could be mobile, including two-thirds of their ICBMs.

The US response was to dramatically accelerate its strategic relocatable target research programmes. In 1985, the Central Intelligence Agency (CIA) established a Mobile Missile Task Force Intelligence Requirements and Analysis Group to study

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3. Cited in Michael C. Brower, Targeting Mobile Nuclear Forces: Technical Prospects and Implications, Union of Concerned Scientists. (Massachusetts, 15 February 1988), p.6.

4. Victor Utgoff, "In Defense of Counterforce," International Security, vol. 6, no. 4 (Spring 1982): p.48.

5. Air Force Magazine, vol. 67, no. 12 (December 1984): p.23.

6. The deployment of both missile systems continues, although the former Soviet Union announced that production of the SS-24 ceased on 1 January 1991. At that time 36 launchers had been mounted on 12 trains which were deployed at three sites. It is estimated that about a further 54 SS-24 have been deployed in former SS-19 silos. SS-25 deployment has now probably exceeded 320; the missile was first seen at the October Day Parade on 7 November 1990. It is reliably claimed that follow-ons to both systems are under development. See "International Institute for Strategic Studies (IISS)," The Military Balance 1991-1992, (London 1991), p.88.

the problem of locating and targeting Soviet mobile missiles. Their report, filed on 11 December 1986, drew attention to the fact that new capabilities were required to meet the challenges posed by strategic relocatable targets:

> Our current capability to meet adequately the demands placed upon our limited resources, to address effectively the mobile missile problem, is limited.
>
> A true capability to locate, identify and track mobile missiles for the purposes of targeting is evolutionary.
>
> [It] will require significant enhancement of our present capabilities.[7]

In 1987 the Pentagon formulated a Relocatable Target Master Plan that is keyed to the development of sensors, command, control, communications and intelligence (C^3I) architectures and force structure necessary to put at risk those Soviet targets in the future.[8] The requirements to locate strategic relocatable targets prior to and during a nuclear exchange has led to the development of new sensor systems such as the *Aurora* Mach-5 Stealth reconnaissance aircraft,[9] advanced geostationary signals intelligence (SIGINT) satellites such as *Magnum* and *Mentor*,[10] the KH-12 *Ikon* real-time digital-imaging satellite,[11] and the *Lacrosse* radar satellite system.[12]

The USAF's interest in strategic relocatable target research was given added impetus in that it offered a potentially viable mission for the manned penetrating bomber. In 1986 the USAF argued:

> Because of the increased Soviet emphasis on mobile ICBM delivery systems and command centers, the manned bombers real-time potential for locating and destroying relocatable systems is vital to the maintenance of a viable triad.[13]

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7. Cited in Gregory A. Fossedal, "US said to be unable to verify missile ban," Washington Times, 18 November 1987, p.6; and Rowland Evans and Robert Novak, "What About the Hidden SS-20's?," Washington Post, 18 November 1987, p.26.

8. Edgar Ulsamer, "Missiles and Targets," Air Force Magazine, vol. 70, no. 7 (July 1987): p.69.

9. See Richard Halloran, "US To Build Spy Plane That Radar Can't Spot," International Herald Tribune, 11 January 1988, pp.1, 5.

10. See Desmond Ball, Pine Gap; Australia and the US Geostationary Signals Intelligence Satellite Program, (Sydney 1988).

11. See William E. Burrows, Deep Black: Space Espionage and National Security, (New York 1986), pp.307-309.

12. See Craig Covault, "Atlantis Radar Satellite Payload Opens New Reconnaissance Era," Aviation Week and Space Technology, 12 December 1988, pp.26-28.

13. Cited in James W. Canan, "The Issues That Count," Air Force Magazine, vol. 69, no. 10 (October 1986): p.49.

To support this potential mission the USAF requested $985,000 (FY-87$)[14] for a new programme called Strategic Relocatable Target Capability, the purpose of which was to explore improvements in sensors, electronics and operational procedures that would enable bombers to hunt mobile targets.[15] The bomber's role in threatening Soviet strategic relocatable targets was also increasingly reflected in war plans. According to Lieutenant General Bernard Randolph, then Commander, Air Force Systems Command, "bombers are assigned about half of the SIOP warheads,"[16] of which a large percentage are most likely to be dedicated to the destruction of Soviet strategic relocatable targets.

Concurrently, the USAF had been gradually deploying the B-1B and steadily developing the B-2 bomber. While the B-1B was considered a possible candidate for accepting operational tasking against some strategic relocatable targets,[17] it was clear that locating and destroying strategic relocatable targets was a prime objective of the B-2 Stealth bomber. As General Chain noted in July 1987:

> The highly flexible Advanced Technology Bomber, with a low-observable design will penetrate enemy airspace and hold all types of targets, both fixed and relocatable, at risk. This is important given the growing portion of the Soviet target base that will be relocatable in the next decade.[18]

And as USAF officials stated in early 1988, that "With its projected capability to dash into the Soviet Union undetected ... the B-2 [will] be able to roam the strongholds of the mobile Soviet missiles and look for targets."[19]

The complexity of such a mission is readily apparent and to most observers the chances of a lone B-2 successfully penetrating a dense, modern air defence system and then independently detecting, recognising, acquiring and attacking a strategic relocatable target are highly improbable.

Penetrating Soviet Air Defence

The Soviet Air Defense Forces, Voyska Protivovozdushnoy Oborony (VPVO), currently field approximately 8,650 surface-to-air missile (SAM) launchers in some 1,200 sites, more than 2,370 interceptor aircraft and 10,000 air defence

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14. "FY-1988 Air Force RTD&E Conference Budget," Defense Daily, 2 December 1987, p.194.

15. Ulsamer, "Missiles and Targets," p.69.

16. Lieutenant General Bernard P. Randolph, "The B-2 Bomber Technology in Transition;" a speech delivered to the 1989 Aviation Writers Association National News Conference, Phoenix, Arizona, 29 April 1989. Reproduced in Vital Speeches of the Day, 1 June 1989, p.495. As a result of the dissolution of the USSR and subsequent cuts to the US strategic arsenal, the number of SIOP warheads to be allocated to be carried by bombers and accordingly, the percentage allocated to the destruction of relocatable targets is being reviewed.

17. See "Countering Mobile Targets a B-1B Task?," Defense Electronics, vol. 18, no. 3 (March 1986): p.18.

18. General John T. Chain Jr, "Strategic Fundamentals," Air Force Magazine, vol. 70, no. 7 (July 1987): p.67.

19. Cited in R.S. Dudney, "Strategic Forces at the Brink of START," Air Force Magazine, vol. 71, no. 2 (February 1988): p.43.

radars.[20] While many of the surface-to-air missiles deployed are of 1950s and 1960s design, a modernisation programme to upgrade air defences against emerging technologies such as stealth is underway. Soviet strategic SAMS (the SA-2, SA-3, SA-5 and SA-10 Grumble) provide barrier, area and point defence of the Soviet Union. Although the number of strategic SAM sites and launchers has declined as older generation systems are retired, overall capability has increased. Moreover, a trend away from fixed SAM and radar sites to mobile systems is expected to complicate the task of locating and destroying them. The SA-10 Grumble which is replacing older SA-2 and SA-3 SAMS has improved Soviet air defence capabilities against low-altitude aircraft and cruise-missile attacks, and now constitutes approximately one quarter of Soviet strategic SAM launchers.[21]

Given the recent low-observables test results, it is now unlikely that the B-2 could independently penetrate the air defence network of the Soviet Union. An active modernisation programme which includes mobility for both SAM launchers and air defence radars increases the uncertainty. The recent war in the Gulf provided several clues about how a B-2 might fare against a dense, modern air defence system. A stealth "cousin" of the B-2, the F-117A fighter/bomber was highly successful in remaining undetected by Iraqi air defences and conducting surprise raids, but initial penetration had been simplified by F-4 Wild Weasel anti-radar aircraft and AH-64 Apache helicopters working in tandem to suppress early warning air defence radar and SAM batteries. Noting the USAF concession that the B-2 will also require this type of penetration assistance on conventional missions, it is difficult to conceive how the B-2 will penetrate on a nuclear mission where such assistance is not available.

The Soviet reaction to eventual deployment of the B-2 has been muted. Former Chief of Soviet Air Force, Colonel-General Evgeny Shaposhnikov[22] confirmed that his country is developing new air defence systems for "repelling stealth-class weapons" but is awaiting a US decision on B-2 deployment before implementing its "defensive answer."[23] This answer is thought to be in the form of follow-on aircraft to the MIG-29 Fulcrum and SU-27 Flanker fighters along with modernisation of existing SAM defences.[24] The prospective small size of the B-2 force and revelations that the B-2 is not as stealthy as first thought will not have gone unnoticed by the Soviet Union. The B-2, while continuing to pose a considerable technological challenge, is unlikely to generate substantial changes to the Soviet Air Defence modernisation programme.

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20. The Military Balance 1991-1992, p.38. See also John Lepingwell, "Soviet Strategic Air Defense and the Stealth Challenge," International Security, vol. 14, no. 2 (Fall 1989): p.72.

21. 1991 Military Forces In transition, Department of Defense, (Washington, D.C., September 1991), p.38.

22. Following the abortive coup in August 1991 Shaposhnikov was promoted by Boris Yeltsin to Marshall of the Soviet Union and following the dissolution of the USSR appointed Head of the Armed Forces of the CIS. Now his post is in limbo following the establishment of the independent Russian Armed Forces led by Defence Minister General Pavel Grachev.

23. Cited in Nick Cook, "Soviets to Deploy Two New Fighters," Janes Defence Weekly, 27 July 1992, p.132.

24. Ibid.

Attacking Strategic Relocatable Targets

To carry out "hunter-killer" missions against Soviet strategic relocatable targets, including SS-24 and SS-25 mobile ICBMs, the B-2 would be required to combine surveillance, target detection, target recognition, target acquisition and weapon delivery largely independent of distant support forces. This is a considerable tasking assignment for a single aircraft and, not surprisingly, there are many difficulties involved.

The magnitude of the surveillance problem confronting the B-2 over the Soviet Union is daunting. The primary strategic relocatable targets - mobile missiles - can disperse (theoretically) into 22 million square kilometres of territory. Within that area are 550,000 kilometres of sealed, 1 million kilometres of unsealed roads and 230,000 kilometres of railway.[25] While mobile missiles will most likely stay in garrison areas[26] during peacetime and hence be less difficult to locate, their dispersal upon strategic or tactical warning would make the B-2's surveillance and tracking task very difficult. Obviously the bomber would rely on assistance from satellite sensors. The latter's capacity for broad-area surveillance compared with the B-2 is illustrated by the following example:

> Suppose that Soviet SS-25s were to hide in clearings 60 meters wide and surrounded by trees 20 meters tall. Geometry shows ... a stealth bomber flying at 10km altitude would have a clear line of sight to the SS-25 from 15 km away ... This represents a rather small area of coverage - 700 square kilometres - compared to the area in which the SS-25s might be hidden ... A satellite at 500 km altitude, by contrast, could see the SS-25 from a horizontal range of roughly 750 km, allowing it effectively to view close to two million square kilometres at one time.[27]

The capability to locate and track strategic relocatable targets has been built into the KH-12 *Ikon* real-time imaging satellite, the *Lacrosse* radar satellite and the *Magnum/Mentor* geostationary SIGINT satellites. However, as pointed out by Desmond Ball, these systems are poorly configured for real-time war fighting tasks and more suited to the demands of intelligence verification and analysis.[28]

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25. Cited in Brower, "Targeting Mobile Nuclear Forces," p.33

26. As a positive step toward verifying mobile ICBMs both superpowers agreed at the June 1988 Moscow Summit that: both road and rail mobile ICBMs be based in agreed areas of limited size; a percentage of the mobile force would be allowed outside the basing area at all times; dispersals involving up to the entire force would also be allowed for exercise purposes but limited in frequency and duration; dispersals for national emergencies be unrestricted; and deployments and movements be subject to rigorous notification, inspection and other verification measures. Many issues remain unresolved, notably the size of restricted locations. See Robert Einhorn "The Emerging START Agreement," Survival, vol. 30, no.5 (September/October 1988): pp.389-90.

27. Brower, "Targeting Mobile Nuclear Forces," p.32.

28. Private conversation.

Moreover, to maintain continuous tracking of strategic relocatable targets a larger number of those satellites would be required than the anticipated four KH-12s and four Lacrosse to be deployed.[29]

Satellites may also become vulnerable to anti-satellite weapons such as space mines and nuclear warheads delivered by ICBMs. The C^3 links between satellites, ground stations, and bombers may be subject to jamming and/or severely degraded in the initial stages of a nuclear war. Making ground-based C^3 less vulnerable through mobility may be offset by a reduction in size and in capability.[30] In short: "For missions which rely on expensive and complicated satellites in low-earth orbit, the outlook is not good".[31]

Even if the field of search is narrowed to a much smaller area, the B-2 and its sensors still face a number of complex problems. Consider the following example:

> Suppose a B-2 bomber was assigned the task of searching 10,000 square kilometres of Soviet territory. Assuming the bomber's sensor (say, radar) could detect objects at least one metre in size, it would have to examine 10 billion resolution cells [patches of ground equal in size to its resolution] one metre across to search the entire region. Suppose further that for every million cells the radar detected what appeared to be a missile, but was actually a false alarm. The bomber's computer and crew would have to sort through 10,000 false targets to find the dozen or so real ones.[32]

The requirement for automatic target detection, recognition and discrimination is essential. But each of these steps in turn raises further difficulties.

Detection systems operate most proficiently when the contrast between targets and background is high. On land this contrast is complicated by clutter such as trees, rocks and houses. Should the target move it could be detected through a process known as doppler frequency shift.[33] Stationary targets are much harder to detect and it is expected that mobile ICBMs would be in this category once they had dispersed to a firing location. To exacerbate the detection problem the Soviet Union could employ counter-measures to reduce the thermal and radar visibility of targets. Hot engines and exhausts could be concealed beneath vehicles while thermal insulation, camouflage netting, foliage and low-emissivity paints could further reduce thermal signature.[34]

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29. See Michael C Brower, "Targeting Soviet Mobile Missiles: Prospects and Implications," Survival, vol. 31, no.5 (September/October 1989): p.438; and Brower, "Targeting Mobile Nuclear Forces," pp.36-37.

30. Ibid, p.37.

31. Cited in Brower, "Targeting Soviet Mobile Missiles," p.437.

32. Ibid, p.439.

33. Brower, "Targeting Mobile Nuclear Forces," p.40

34. Ibid, p.41. According to a June 1989 Report prepared by Los Almos National Laboratory Scientists, impulse radar is considered a good candidate for detecting targets in the presence of background clutter. See Scott, "UWB Radar," p.39.

Automatic target recognition and discrimination techniques, that is, the ability to distinguish between real and false targets using computers, are still at an early stage of development and have proved "a difficult and elusive goal, especially for stationary targets."[35] Not unlike target detection, recognition is characterised by probabilities of correct and false target classification. Most methods of target recognition involve extracting several different features from a suspected target (radar cross-section or thermal signature) and comparing them to features of known targets stored in a computer memory. The process operates best when there is clear contrast between the target's features and those of other objects. But these methods entail considerable cost, computational speed and complexity in the number of operations to be performed. The effect of random noise, camouflage, and stealth may blur the contrast between the target's features and those of surrounding clutter, resulting in objects being incorrectly identified as a target. The latter problem would be aggravated if the Soviet Union deployed decoys of their strategic relocatable targets.[36]

The last step in the process of attacking strategic relocatable targets is destroying them once they are located. The B-2 will be armed with AGM-137 Tri-Service Stand Off Attack Missiles (TSSAM) and nuclear gravity bombs such as the B-61 and B-63, but the latter would be used primarily for fixed, hardened targets such as underground C^3 bunkers. With determining the precise location of strategic relocatable targets very much in doubt, the US Department of Energy's nuclear laboratories have been developing a new aerial bomb that would generate high-power microwaves over a wide area and destroy electronic equipment controlling ground-based Soviet mobile missiles.[37] The drawbacks associated with this weapon, however, are that they induce "soft-kill" with no outward sign of damage to weapon systems, making damage assessment difficult. Furthermore, many systems could be protected against microwave pulses. By having electronic components in conducting boxes or Farraday cages, microwaves could be blocked. Also, measures could be taken to guard against voltage and current surge.[38] Nonetheless, it is difficult to assess the effectiveness of these measures short of detonating a nuclear weapon in the atmosphere.

There is no doubt that fundamental problems exist in achieving the task of locating and attacking strategic relocatable targets, particularly mobile missiles. Finding strategic relocatable targets in a large region of the Soviet Union in a short time does not appear practicable for many years, if at all. This view is now increasingly shared by the USAF. General Welch testified in November 1988 that "the whole business of locating mobile missiles, for example, is a very complex task and we're a long way from having decided that we know how to handle that task."[39]

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35. Brower, "Targeting Mobile Nuclear Forces," p.42.

36. Ibid, pp.43-48.

37. Walter Pincus, "DOE Studies New Bomb To Disable Mobile Missiles," Washington Post, 2 February 1990, p.19.

38. Brower, "Targeting Mobile Nuclear Forces," p.42.

39. Cited in Richard Halloran, "General Says Stealth Craft Will Target Soviet Shelters," New York Times, 20 November 1988, p.24.

And in July 1989 the USAF told Congress that "attacking highly mobile targets is [not] likely to be accomplished with great efficiency in the near to mid-term future."[40]

Most recently the Gulf War graphically illustrated the difficulties of locating and attacking mobile missiles. Many of the mobile Iraqi Scud B missiles fired at both Israel and Saudi Arabia during the course of the war proved difficult to locate and attack despite the vast array of surveillance and tracking systems at the allies' disposal. According to SAC Commander, General Lee Butler, the B-2 may help solve the thorny problem of how to find and target mobile missiles but only in that it may have better endurance over hostile territory to search for mobile targets.[41]

While conceding that the strategic relocatable target mission is very difficult, the USAF has by no means abandoned it. Research programs aimed at improving the ability of both the B-1 and B-2 to find mobile targets continue. Defence contractor Martin Marietta has developed the Low-Altitude Navigation and Targeting Infrared System for Night, for installation on a B-1 for 18 months of testing. The programme will include the study of sensor management systems for the critical mobile targeting role. Another SRT programme for the B-1 and B-2 has been underway at Wright-Patterson AFB, Ohio, for two years. Specialists are studying the combination of radar and automatic target recognition algorithms for use against SRTs or conventional theatre ballistic missiles such as Scuds. Despite these developments prospects for the immediate future are not bright. An operational capability for such systems is expected to be at least several years away.[42]

Even if technical obstacles to locating and tracking strategic relocatable targets could be overcome, other operational difficulties remain. In an intra-war environment complex operations would have to be carried out amidst widespread destruction of military facilities and C^3. A good example of this concerns reconstitution of the bomber force. With the bomber's relatively slow speed and restricted altitude only a small percentage of Soviet territory could be covered on a single, several-hour mission. As a result, the aircraft must fly multiple sorties, leaving Soviet airspace periodically for fuel and maintenance. Aerial refuelling, however, depends on precise co-ordination between tanker aircraft and bombers - this could not be guaranteed where C^3 systems are either destroyed or severely degraded. Moreover, the military and civilian bases needed to service the aircraft and assist flight-crew endurance, could suffer attack. Without these facilities sustained bomber operations would be difficult. Adding to this problem

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40. "Industry Generally Upbeat on Management Review," Defense Daily, 13 July 1989, p.66.

41. See John D Morrocco, "Shift in U.S. Military Strategy Calls For Increasing SAC's Conventional Role," Aviation Week and Space Technology, 13 May 1991, p.28.

42. See David A. Fulgham, "Force Drawdowns Limits U.S. Ability to Fight Dual Conflicts," Aviation Week and Space Technology, 6 April 1992, p.20.

is the USAF admission that the B-2 would require "frequent structural and propulsion maintenance in a series of specialised hangars to maintain the bomber's low-observable features."[43] This could be a problematic in a crisis or war. However, maintaining the bomber's stealthy features so it can elude Soviet air defences seems unnecessary given that US SLBMs, ICBMs and cruise missiles would have already destroyed or opened-up large gaps in the air defence network. In fact this operating environment of total nuclear war and degraded air defences would reduce the need for the B-2's sophisticated stealth characteristics and penetrating bomber role.

More important than the technical feasibility of the strategic relocatable target mission is the question of whether or not attacking Soviet mobile nuclear forces adds to or detracts from nuclear stability. If the purpose of having mobile nuclear forces is to provide insurance against a first strike and ensure retaliatory capability, then any concerted attempts to target those forces must be considered destabilising. Similarly, if the US was able to successfully threaten mobile missiles the Soviet Union would be inclined to permanently hide them, and in the process damage hopes for negotiated limits and verification procedures.

Alternative Nuclear Missions

With the strategic relocatable target mission beset by criticism, the Pentagon and USAF have increasingly de-emphasised this role for the B-2. Greater attention is now being drawn to other nuclear and non-nuclear roles. The following USAF statement indicates this shift:

> The B-2 may be at the heart of solving the mobile ICBM problem, but the mobile missile issue is not at the heart of the B-2 requirement. The B-2's primary mission is deterrence across the spectrum of conflict. The B-2 ... can also deliver highly accurate large-yield warheads against high-value fixed targets such as hardened underground command centers and ICBM silos. And ... target other mobile war fighting assets, including armies out of garrison.[44]

In a similar vein, former SAC Commander General Chain stated that "the B-2 may assess targets for damage level prior to striking, thus assuring the required level of damage on the most critical targets and also provid[e] economy of force."[45]

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43. Cited in R. Jeffrey Smith, "Tough B-2 Questions: The Bomber's Task, It's Cost and the Air Forces' Arguments," International Herald Tribune, 28 July 1989, p.7.

44. Cited in Robert Ropelewski, "USAF Back pedaling on B-2 Relocatable Target Mission," Armed Forces Journal International, (July 1989): p.14.

45. US Congress, Senate,"Exon re General Chain's Letter," p.54965.

The alternative nuclear missions have also encountered a significant degree of criticism.

As noted in Chapter One, the bomber's role in attacking fixed, hardened targets may be diminished by deployment of the Trident II D-5 SLBM. Nonetheless, USAF officials maintain there are some very hard, fixed targets which need to be attacked with high-yield weapons of the type carried on penetrating bombers.[46] Targets of this nature, however, are most likely to be defended by heavy point-defences forcing the bomber to carry a larger proportion of short-range attack missiles than high-yield gravity bombs. Cruise missiles are regarded by many commentators as a better all-round weapon for attacking hardened, fixed targets in a follow-on attack. The USAF itself admits that "Air-launched cruise missiles are effective weapons for attacking preplanned, fixed hardened strategic targets."[47] The ALCM can also be fitted with earth-penetrating warheads to increase their effectiveness against very deep, hardened targets. As with threatening mobile missiles, endangering Soviet leadership and C^3 assets can be considered destabilising as it may cause the Soviet Union to act massively and decisively at the onset of a strategic nuclear exchange. Accordingly, any prospects for escalation control and negotiating war-termination would be lost.

The second alternative nuclear mission for the B-2 - providing real-time damage assessment and follow-on coverage to achieve required damage levels would see a bomber arriving at the target area several hours after an initial attack by SLBMs, ICBMs or ALCMs. If the aircraft's sensors and visual observation confirm that the first attack had been unsuccessful, the bomber would then re-attack the target.[48] To many critics this mission appears little more than a "mopping-up" exercise after an initial nuclear exchange. This role was also proposed for the ill-fated B-70 (renamed RS-70 for reconnaissance strike) bomber but then, as now, it was difficult to justify the mission commensurate with the bomber's cost. As put by General Maxwell Taylor when he opposed the RS-70: "Is it worth several billion dollars ... to be able to overfly Soviet targets with a few score of manned bombers looking for residual [targets] after each country ... has already exchanged several thousand megatons of nuclear fire power on their respective target systems?"[49]

Similarly, the costly billion B-2 programme looks a very expensive proposition in order to make "the rubble bounce twice."[50] Other means for establishing whether US missiles had detonated properly within close proximity to their

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46. Cited in Senator William S. Cohen, "The B-2 Bomber: Mission Questionable, Cost Impossible," Arms Control Today, vol.19, no.8 (October 1989): p.5.

47. See Jasper Welch, "Assessing the Value of Stealthy Aircraft and Cruise Missiles," International Security, vol.14, no.2 (Fall 1989): pp.54-56.

48. See Cohen, "The B-2 Bomber," p.5.

49. Cited in Michael C. Brower, "Why the B-2 Will Bomb: The Problems Stealth Can't Hide," Arms Control Today, vol.18, no.7 (September 1988): p.20.

50. Cited in Melissa Healy, "If Stealth Is Nightmare, Critics Wonder Whose," Los Angeles Times, 21 November 1988, p.20.

targets could include the Navstar satellites which are beyond the reach of current anti-satellite capabilities, or the new *Aurora* Mach-5 reconnaissance aircraft. The information provided could be relayed to surviving US SLBMs or ALCMs which would then re-attack.[51] But this scenario also seems implausible considering the likely amount of damage that would be incurred by both sides (military and C^3 assets) in a nuclear exchange.

The B-2 and START

Adding further doubt to the B-2s nuclear utility is the impact of the Strategic Arms Reduction Treaty (START) and the contraction of nuclear targets. The START signed in Moscow in July 1991[52] allows both the US and the former Soviet Union no more than 1600 deployed strategic nuclear delivery vehicles (SNDVs) and 6000 accountable warheads. No more than 4900 warheads can be carried on ballistic missiles and of these no more than 1100 can be deployed on mobile ICBMs. The Treaty, however, allows considerable flexibility to substitute weapons within these limits. In particular, bomber carried weapons are counted more leniently than ballistic missile warheads because they are considered more stabilising and less suitable for use as a first-strike weapon. Under START limits all of the gravity bombs and short-range attack missiles carried by a penetrating bomber count as only one warhead but ten re-entry vehicles (RVs) carried on a ballistic missile count as ten warheads. In addition, each of up to 150 US heavy bombers carrying ALCMs counts for ten warheads (even though each aircraft may carry up to 20 ALCMs), and each of up to 180 former Soviet heavy bombers carrying ALCMs counts for eight warheads (even though each aircraft may carry up to 16 ALCMs). Each heavy bomber over the specified number is accountable for the maximum number of long-range, nuclear-armed ALCMs for which a bomber of that type and variant is actually equipped.[53]

In January President Bush announced in his State of the Union Address that the US would consider cutting the number of actual bomber delivered weapons from 4500 to 1900. In response, President Yeltsin proposed cuts to around 800. At their June Summit meeting the two Presidents agreed that the actual number of warheads retained by each side would fall to between 3000 and 3500 by the year 2003, or as early as 2000 if the US can contribute to dismantling Russian strategic arms.[54] The Summit also agreed to the shifting of 100 US strategic bombers to conventional roles by removing their nuclear weapons and transferring the aircraft to bases where no nuclear weapons are stored. If warhead numbers do fall to around 3000 the number of weapons carried on heavy bombers is likely to be

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51. Brower, "Why the B-2 Will Bomb," p.20.

52. The US Congress began the ratification process on 23 June 1992.

53. See Einhorn, "The Emerging START Agreement," pp.389-90 and Annual Report to the President and Congress, p.60.

54. See Robert S Norris and William Arkin, "Proposed U.S. and C.I.S Strategic Forces," The Bulletin of the Atomic Scientists, vol.48. no.4, (May 1992): pp.48-49 and George Leopold, "Summit Agreement May Lead to Revaluation of US Forces," Defense News, 22-28 June 1992, pp.4,50.

around 865.[55] Although bombers retain their importance for the delivery of nuclear weapons the advantage bestowed by the counting rule will be lost as the size of the bomber force declines. This fact is readily apparent with the progressive scaling back of the B-2 force from 132 to 75 and then to 20 aircraft.

Similarly there has been a contraction in the number of nuclear targets. When deciding on the 20 B-2 fleet, Secretary Cheney observed that "we [the US] were not oblivious to the fact that a number of targets no longer exist."[56] The demise of the Soviet Union and the likelihood of substantial cuts in the nuclear arsenals of both sides has caused the US to consider changing the SIOP. A report commissioned last year by SAC commander and Director of the Joint Strategic Targeting Planning Staff, General Lee Butler, recommends that the US target roughly 5000 nuclear weapons (plus or minus 20 percent) at its potential foes in the next few years. Of particular interest is the Report's suggestion that a new SIOP structure be adopted which includes five categories of plans to deal with varying circumstances and contingencies. These include an option to use only high-precision, non-nuclear weapons in a strategic attack; plans for both "limited" and "major" nuclear attacks against the former Soviet Union; and a plan to hold on to a "strategic reserve force.[57]

In addition, the draft report advocates a controversial option referred to as "SIOP Echo," which would give the President a "nuclear expeditionary force" for attacks against China or targets in the Third World. A "handful of weapons" would be on day-to-day alert to execute these missions including the B-2 bomber.[58] The B-2s utility for such a role may still, however, constrained by the small force size and continuing doubts that the aircraft is capable of conducting a solo nuclear penetration mission in a sophisticated air defence environment.

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55. This assumes the USAF's future bomber force of 217 aircraft will retain no less than 100 nuclear capable aircraft.

56. Cited in Opall, "Rice Pushes 20-Bomber B-2 Fleet," p.76.

57. See Dunbar Lockwood, "Panel Calls For New War Plan," Arms Control Today, vol.48, no.1 (January/February 1992): p.43, and R Jeffrey Smith, "U.S. Urged To Cut 50% Of A-Arms," Washington Post, 6 January 1992, p.6.

58. Ibid.

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CONVENTIONAL ROLES

The Cold War strategic environment has given way to an unfamiliar period of strategic uncertainty. The years ahead are likely to be characterised by increasing regional tensions, leading in many cases to armed conflict, the proliferation and diffusion of weapons of mass destruction and advanced conventional weaponry. To meet the demands of this environment the US has adopted a new defence strategy resting on: an effective strategic deterrent including a diverse mix of survivable, highly capable strategic nuclear weapons; retention of a forward military presence, albeit in reduced numbers; US-based contingency forces to ensure a rapid response to crises affecting US security; and an effective Base Force - the minimum required to ensure US security against a broad array of potential threats.[1] A key element in the evolving US strategy is the conventional role of strategic-nuclear systems.

Until the late 1980s US strategy and force planning paid only limited attention to the conventional (or non-nuclear) use of strategic-nuclear systems like heavy bombers. Encouraged by technological advances in the ability of air-breathing systems to elude air defences, developments in reconnaissance systems necessary for rapid targeting and bomb-damage assessment and the increasing accuracy of conventional munitions, the Defense Department initiated in 1987 a DSB study to consider the potential use of conventional weapons to support US strategic objectives. The study's general conclusions were that conventional capabilities could be usefully applied across a wide range of contingencies and constitute an important opportunity that the US ought to exploit.[2] A year later the report of the Commission on Integrated Long-Term Strategy added support for the efficacy of conventional weapons by noting that the prospect of technological innovations one day making it "practical to use conventional weapons to attack many ground targets that currently require nuclear weapons" was seen as the continuation of a broader trend.[3]

The dramatic changes in Eastern Europe and the Soviet Union and subsequent revision of US national security strategy have provided further impetus. For the 1990s and beyond US security planners anticipate the following developments:

- the threat of direct, large-scale, conventional military attack in Europe escalating to a nuclear exchange will be considerably more remote given the demise of the USSR and Warsaw Pact;

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1. Annual Report to the President and Congress, (1 February 1992), ppvi-vii.

2. See Barry D.Watts, "The Conventional Utility of Strategic-Nuclear Forces," The Washington Quarterly, vol.14, no.4, (Autumn 1991): pp.178-79.

3. See Fred C.Ikle and Albert Wohlstetter (co-chairmen), Discriminate Deterrence: Report of the Commission on Integrated Long-Term Strategy, (Washington, D.C., January 1988),p.40.

- without the overt, immediate threat long provided by the USSR, US defence budgets, force-structure, overseas access and military forces overseas will be reduced substantially;

- as the world becomes multi-polar and as traditional ethnic, religious, economic,and political differences formerly overshadowed by US-Soviet rivalry reassert themselves, regional conflicts will grow more likely.

- At the same time, the US as the sole remaining superpower, will remain more engaged abroad than it was prior to World War Two and the increasingly interdependent global economy will be more vulnerable to regional conflict than in the past;

- the worldwide diffusion of advanced weaponry (including weapons of mass destruction) will change the relationship between major and minor powers, making it far riskier and problematic than previously for the US to influence outcomes in regional wars around the globe involving smaller states. Expeditionary intervention overseas by the the US will call for the most sophisticated US weaponry and capabilities.

- in sum, the need will remain for the US to have the advanced military capabilities necessary to deter or defeat aggression at points on the globe much closer to its adversary than to itself.[4]

This anticipated security environment for the 1990s and increasing focus on conventional uses for strategic-nuclear systems correspond closely with the USAF perception of the future. As described in the **White Paper,"The Air Force And U.S. National Security: Global Reach-Global Power:"**

> Conventional capabilities will remain essential to deter and contain local conflicts that could threaten U.S. interests and allies. Addressing these threats by long term occupation of the offending country, or continuous presence in every potential location, is highly unlikely. Instead, our probable response will be to stop or contain the offending behavior and isolate the threat. An ability to maintain constant awareness in potential adversaries that they are always within our reach broadens the spectrum of deterrence. Given this and the unpredictability of the future, our force planning calls for an increased emphasis on force projection capabilities-even more flexible, rapidly responding, precise, lethal forces with global reach.[5]

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4. See The National Security Strategy of the United States, (Washington, D.C., March 1990); The Air Force And U.S. National Security: Global Reach-Global Power, Department of the Air Force, (Washington, D.C., June 1990); National Military Strategy of the United States, (Washington, D.C., January 1992); and Annual Report to the President and the Congress, (February 1992).

5. The Air force And U.S. National Security, p.9.

A central element in this plan is long-range, conventional airpower for which the manned bomber is particularly well suited. According to the White Paper:

> Conventional airpower offers exceptional flexibility across the spectrum of conflict.... The Air Force can deter, deliver a tailored response, or punch hard when required - over great distances - with quick response. We can provide a presence, or put ordnance on a target worldwide in a matter of hours.
>
> Long range bombers armed with conventional weapons can rapidly reach any location on the globe.... The bomber's long range means that the United states can project power and enhance presence in a very short time - and often at lower cost relative to other options - regardless of conflict location.[6]

With conventional rather than nuclear missions becoming increasingly likely, the USAF has quickly seized the opportunity to promote the B-2, as an ideal candidate for conventional roles. Citing the 1986 raid on Libya as an example, Air Force Secretary Rice argues that six B-2s, operating from the US with the support of six tankers could have conducted the same operation which utilized two carrier battle groups, an Air Force F-111 squadron and numerous supporting assets.[7]

A comparison of two raids against an Iraqi nuclear facility during the Gulf War provides a more recent example in favour of the B-2s capabilities. The first mission was carried out with conventional, unguided bombs during daylight by a force of 60 attack, fighter, Wild Weasel and electronic warfare aircraft that required the support of 15 tankers. Due to smokepots around the facility and intense anti-aircraft fire, the attack was unsuccessful. The second raid was conducted at night with eight F-117As carrying laser-guided bombs and supported by two tankers. Three out of four reactors were destroyed the first night and the remaining facilities in the following week. According to Lt General Charles Horner, Commander of the Coalition Air Forces, two B-2s, each with 10 times the range and five times the payload of an F-117A, could have inflicted the same damage in a single mission with no tanker support.[8]

Confirming the importance now attached to conventional missions Secretary Rice testified to the House Armed Services Committee on 20 February that:

> While the B-2 will retain its potential as a nuclear bomber, I have approved a new mission statement for the aircraft that reflects the priority we are placing on its conventional

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6. Ibid, p.8.

7. See Randolf, "The B-2 Bomber," p.496.

8. See David A Fulghum, "F-117 Pilots, Generals Tell Congress About Stealth's Value In Gulf War," Aviation Week and Space Technology, 6 May 1991, p.66.

> role. The B-2 will hold at risk and, if necessary, attack an enemy's warmaking potential, especially those time critical targets which, if not destroyed in the first hours or days of a conflict, would allow unacceptable damage to be inflicted on the friendly side. These targets include emerging capabilities in some states for the production, support and use of weapons of mass destruction. The B-2 will also allow us to deliver a telling blow against massed conventional forces of an adversary threatening or invading a friendly state... This role for the B-2 reflects not just its ability to attack high value targets but also a recognition of the value of time in war. Firepower that is <u>immediately</u> available carries great leveridge (sic). The ability of the B-2 to provide this leveridge (sic) in the face of modern air defenses around the globe reduces both the likelihood and the probability of success of regional aggression.[9]

Although the conventional missions envisaged for the B-2 and the manned bomber force per se, are plausible and now likely to find acceptance with Congress, there are a number of important issues that must be addressed.

Foremost among them is force size and cost effectiveness. Given President Bush's decision to cap the B-2 force at 20 aircraft the question must now be asked as to whether a force of this size, or possibly smaller,is sufficient for more than limited operations. In January, Secretary Rice argued that with 20 B-2s the USAF could deploy two eight-aircraft squadrons with the remaining aircraft used for training and substitutes for aircraft in maintenance. With 15 aircraft, however, the USAF would "struggle" to field as many 10 in a single squadron. Moreover, with 15 aircraft the USAF could mount "only a handful of sorties" - five or six per day at long distance.[10] While accepting that 20 B-2s are operationally more effective than 15, it is doubtful that the addition of 20 bombers, albeit as potentially capable as the B-2, would alleviate the disconnect between the philosophical concept of increased reliance on long range conventional bombers in regional conflicts and the reality of shrinking resources.

Illustrating this quandary is the fact that the USAF is not confident of being able to conduct two major regional conflicts concurrently. According to provisional commander of the Air Combat Command, Major General Stephen Croker, "I think we could well handle one major contingency" with bombers flying from the continental US "for a long enough time to let theatre forces get in place... maybe 15 [to] 20 days."[11] The scenario would require a 0.5 sortie rate, meaning

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9. Honorable Donald B Rice, Secretary of the Air Force, <u>Reshaping For The Future</u>, Testimony to the House Armed Services Committee, 20 February 1992, p.10.

10. Donald Rice, "One On One," Interview with <u>Defense News</u>, 9 March 1992, p.30.

11. See David A. Fulgham, "Force Drawdown Limits U.S. Ability to Fight Dual Conflicts," <u>Aviation Week and Space Technology</u>, 6 April, 1992, p.18.

each bomber would have to fly a long-range mission every other day. The force could undertake one Iraq-type conflict and still conduct "some damage limiting" attacks in a second "but the force structure is not big enough [now] for two [conflicts]."[12]

In an effort to best utilise what will be a small B-2 force and also a declining bomber force generally, the USAF has drawn up the "Bomber Road Map." Based on a force (excluding bombers in overhaul, test and mission spares) comprising 16 B-2s, 84 B-1s, 84 B-52Hs capable of carrying ALCMs and 33 B-52Gs armed with conventional bombs, the "road map" provides an insight as to how the bomber elements will interact for conventional roles. Using a scenario whereby the Iraqi army again invaded Kuwait but continued south into Saudi Arabia, the bomber force would be used in several ways to slow the advance. The B-2s in their limited numbers would lead the air fleet to strike high value targets such as key C^3I nodes and nuclear, biological and chemical weapons plants. Armed with the TSSAM and much shorter range Joint Direct Attack Munition System (JDAMS) B-2 crews would also attempt to destroy key air defence nodes without overflying them and accordingly expand each bomber's area of coverage. The B-1s and B-52s would supplement the B-2s deep attack with additional stand-off munitions such as ALCMs and the Joint Stand-Off Weapon (JSOW). In short, the B-2 would attempt to open gaps for the B-1s and B-52s which would then act as "bomb trucks" to strike ground targets, particularly massed armour or personnel with their substantial payloads.[13]

The use of all the bomber force elements for conventional missions, while a practical response to limited numbers, will only remain feasible for the short term. The progressive retirement of the B-52 force in the late 1990s and early next century, along with real possibility that there will be no new bombers after the B-2 is deployed, indicates a stark future for the bomber force per se. In addition, the costs associated with enhancing the B-1 force for conventional roles and maintaining a small force of "exotic" aircraft such as the B-2 are expected to be substantial.

According to the "Road Map" the 96 B-1s will assume the majority of the strategic bombing roles and as the B-52s retire, become the operational "workhorses" in coming decades. When fully modified for conventional tasks, the B-1 will be used for stand-off attack against high value targets or for direct, precision attacks against medium or low risk threats. The problem, however, is that it will take more than 10 years and cost nearly $2.5 billion for the bomber to achieve its full range of conventional attack capabilities.[14] Similarly there

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12. Ibid.

13. See Ibid p.19 and Fulgham, "Study Details New Conventional Role for B-2 Stealth Bomber," Aviation Week and Space Technology, 8 June 1992, pp.26-27.

14. The USAF plans to spend $240 million next year to correct and enhance the B-1s problem-plagued defensive avionics suite and to commence modifications to the airframe to enable the launching of conventional weapons. In total the USAF intends to spend $1.1 billion to correct, enhance and support the defensive avionics suite and $456 million for conventional enhancements including new radios and computers. A further $912 million is tagged for development and integration of conventional munitions such as TSSAM, JDAMS and JSOW. See Barbara Opall, "USAF Seeks $2 Billion To Enhance B-1B's Role," Defense News, 22-28 June 1992, pp.3,52 and John Boatman, "USAF Looks to Fix B-2 Stealth Hitch," Janes Defence Weekly, 6 June 1992, p.962.

are additional costs associated with the B-2 force. Although the cost of adding conventional weapons carriage and delivery capabilities are included in the total programme cost, the specialised shelters for 16 operational aircraft, as well as fuel cells and heavy maintenance hangars will cost $900 million. Moreover, there is concern that a force of only 20 B-2s will simply prove too expensive to operate. The logistic and maintenance problems experienced with the eight aircraft SR-71 reconnaissance fleet, are a case in point.[15]

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15. According to Major General Croker, who oversaw the SR-71 fleet as SAC's planning officer, the eight aircraft cost more in operations and support costs for a year than three and one half B-52 wings. Cited in David A. Fulgham, "TAC Orders Studies On Uses for 15 B-2s Despite Doubts on Small Fleet's Viability," Aviation Week and Space Technology, 16-23 December 1991, p.21.

CONCLUSION

The fate of the B-2 programme was effectively settled with President Bush's January decision that production would be limited to 20 aircraft. Accordingly, Congressional inclination to withhold funding for the remaining aircraft has dissolved. In the most recent round of House discussion on the fiscal year 1993/94 defence budget, a vote in favour of authorising a further $4.7 billion for the final aircraft was agreed, but conditional on Pentagon certification that the 20 bomber force will not exceed $44.4 billion and that the B-2s stealth characteristics work as advertised.[1]

As with nearly all previous attempts to introduce a new heavy bomber into the US strategic arsenal, the B-2 experience was no less controversial. Thirty years ago President Kennedy stated that the B-70 programme was "unnecessary and unjustifiable," while Defense Secretary McNamara agreed the increase in offensive capability offered by the B-70 was not enough to justify its high cost. For many these arguments remain valid in respect of the B-2, especially given the facts of the programme's vast cost and the small number of aircraft likely to become operational. With cancellation no longer an issue, however, the key question now concerns the adequacy or otherwise of only 20 aircraft.

As discussed in earlier chapters, deployment of the B-2 does not appreciably alter a number of significant drawbacks in the manned bomber's nuclear role. The declining synergy between ICBMs and bombers and the latter's vulnerability to surprise attack are problems unresolved. Similarly, the argument that many hard-target missions designated for bombers could be performed by Trident II D-5 SLBM or ALCM cannot be discounted. The primary mission for which the B-2 was developed - attacking mobile missiles - is technologically too demanding and may also have serious crisis and arms control implications. In short, the now reduced numbers of B-2 would not be adequate to perform their expected role under the previous SIOP.

It would be unrealistic, however, to suggest that the B-2 in its limited numbers now has no nuclear utility. The security environment which is anticipated for the years ahead suggests that a limited nuclear threat cannot be discounted. Should such a threat emanate, for example from one of the newly independent Soviet Republics or a third world state, the small B-2 force could act as a highly capable deterrent. The new SIOP is likely to provide such a role. The B-2 may also provide a degree of insurance against a resurgence, albeit unlikely, of confrontation with a reunited Soviet armed forces. Given the considerable number of nuclear weapons still held in the former Soviet Union the B-2 force would be a valuable asset to maintain until the arms control process is carried much further.

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1. See John D. Morrocco, "House Defense Spending Bill Cuts Funding For Overseas Deployments," Aviation Week and Space Technology, 15 June 1992, p.35.

With regard to the utility of a 20 B-2 force for conventional roles, the new strategic environment provides considerable scope for conventional forces operating from the continental US. A key element of those forces is likely to be long-range airpower in which the B-2 would be a centrepiece. Although the B-2 would be capable of conducting solo operations its limited numbers and high cost will likely see it used only in conjunction with other capabilities. Current USAF tasking policy indicates that this will be the method for using the B-2. A logical corollary, therefore, concerns whether or not the B-2 is too costly and sophisticated for conventional roles. Construction of a less advanced and hence less expensive bomber is an obvious solution but such an aircraft is unlikely to be capable of carrying out both nuclear and conventional missions. Arguably it is the B-2s dual-capability that offsets these disadvantages.

In the present climate of strategic uncertainty a small force of 20 B-2 is adequate to meet the likely security contingencies in the years ahead. The value of the B-2 force lies not only in its ability to meet certain nuclear and conventional contingencies, but also in its contribution to research and development of advanced technologies. Finally, the B-2 will also provide limited cover against the decline in bomber numbers generally. Beyond this, however, the future of the US strategic bomber force may be difficult to sustain.

APPENDIX 1:

B-2 GENERAL CHARACTERISTICS

DIMENSIONS:

Wingspan	52.43 m	(172ft 0 in)
Length overall	21.03 m	(69ft 0 in)
Height overall	5.18 m	(17ft 0 in)
Wheel track	12.20 m	(40ft 0 in)

WEIGHTS:

Weight empty	45,360-49,900kg (100,000-110,0001b)
Max weapon load	22,680 kg (500,000 lb) approximately
Max internal fuel capacity	81,650-90,720 kg (180,000 - 200,000 lb)
Max takeoff weight	158,760 kg (350,00 lb) approximately

ARMAMENT:

Complete internal carriage on two Boeing-Advanced Applications Rotary Launchers with total capacity for 16 Tri-Service Stand Off Attack Missiles (TSSAM) or alternatively B-61 and B-63 nuclear gravity bombs, or 80 conventional 500 lb bombs. Work is being underaken to configure the B-2 for carriage of the short-range Joint Defense Attack Munition Systems (JDAMS). The projected conventional delivery potential of the B-2 is: 16 2000lb bombs; 76 inertially guided 500 lb bombs; 16 precision guided 2000 lb bombs; and eight precision guided deep penetrator weapons.

PERFORMANCE:

Speed	High sub-sonic
Range unrefuelled	6,000 nm (11,120 km; 6,900 miles)
Range with one refuelling	10,000 nm (18,520 km; 11,500 miles)

POWER PLANT:

Four 84.5 KN (19,000 lb st) GE 118-GE-100 non-afterburning turbo fans.

CREW:

Two, with provision for a third seat.

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