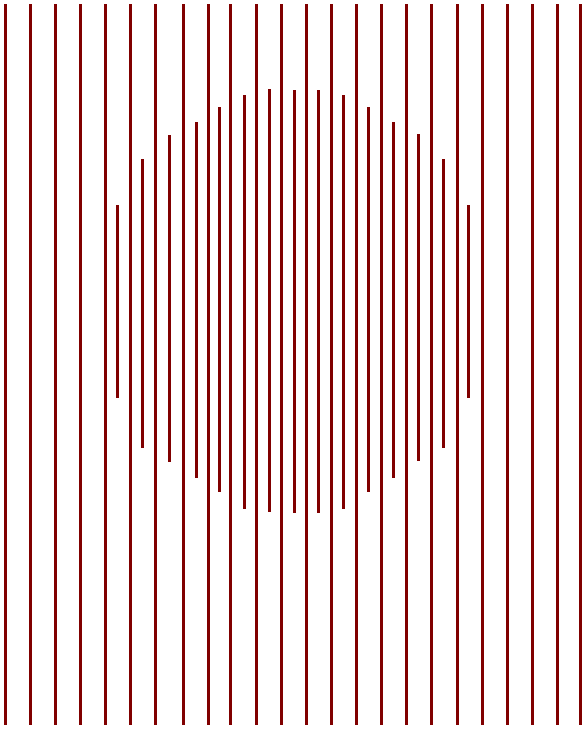
CBO PAPERS

OPTIONS FOR ENHANCING THE BOMBER FORCE

July 1995



CONGRESSIONAL BUDGET OFFICE

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CONGRESSIONAL BUDGET OFFICE
SECOND AND D STREETS, S.W.
WASHINGTON, D.C. 20515

NOTES

Unless otherwise indicated, all years referred to in this paper are fiscal years, and all costs are expressed in constant 1996 dollars of budget authority.

Rounded numbers in text and tables throughout this paper may produce sums that do not correspond to the totals shown.

PREFACE

The United States is in the process of modernizing its heavy bombers and weapons stocks so that they can be more useful in conventional conflicts. With those improvements, bombers could fly combat missions directly from the United States while other forces rushed to the region. That capability makes them attractive to a U.S. military that is smaller and based mostly at home. Debate rages about whether the planned bomber force has adequate capabilities and what, if anything, should be done to improve it.

This Congressional Budget Office (CBO) paper analyzes the costs and capabilities of the Administration's planned bomber force. It also examines four options that would enhance capability in different ways: making the force larger by buying 20 more B-2s or by keeping all 94 B-52Hs, or improving the force by adding weapons and mission-planning systems or by stockpiling spare parts and equipment at bases near the Persian Gulf and Korea. This analysis was requested by the Chairman of the House Budget Committee. In keeping with CBO's mandate to provide objective and nonpartisan analysis, the paper makes no recommendations.

This paper was prepared by David Mosher of CBO's National Security Division under the supervision of Cindy Williams and R. William Thomas. Raymond Hall of CBO's Budget Analysis Division performed the cost analysis under the supervision of Michael Miller. Shaun Black analyzed the capabilities of the options and provided other invaluable assistance. Eric Labs and V. Lane Pierrot thoroughly reviewed the manuscript and provided useful comments. The author would also like to thank Nathan Stacy, Doug Pearson, Barry Pavel, Glen Buchan, David Frelinger, and the numerous people in the Air Force, the Joint Staff, and at the Boeing, Northrop Grumman, and Rockwell Corporations who provided essential information and comments. Of course, all responsibility for the paper lies with the author and CBO.

Sherwood Kohn edited the manuscript and Christian Spoor provided editorial assistance. Cindy Cleveland prepared the paper for publication.

June E. O'Neill
Director

July 1995

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SUMMARY

In the future, according to Pentagon planners, the United States will rely on its bomber force to help respond quickly to unexpected major regional conflicts. From their bases in the United States, bombers will be able to attack targets anywhere in the world within 48 hours. They will continue to attack until the United States is able to deploy enough shorter-range tactical aircraft and ground and naval forces to the theater to prosecute the war.

The goal of these early bomber missions will be to halt the enemy's invasion by attacking armor and supply columns and to disrupt its ability to conduct the war by attacking critical targets as soon as possible. Any tactical aircraft that are in the theater will also contribute to the effort.

But today's bombers are limited in their ability to perform those missions. Designed to fight a nuclear war, they are not properly equipped for conventional conflicts. Only the B-52 can deliver precision weapons, but it is still incapable of delivering the large numbers of inexpensive, accurate armaments that will be key to future success.

The Air Force plans to modify its bombers during the next decade to enable them to wage a conventional war. This effort will make them capable of delivering the new, accurate smart munitions that the Department of Defense (DoD) is currently developing, as well as a variety of existing, unguided weapons. The bomber modernization program will cost more than $12 billion through 2020. (All costs in this paper are in 1996 dollars of budget authority and all years are fiscal years.) Improving the bombers themselves will cost $7 billion; new guided munitions for the bombers, aided by the Global Positioning System (GPS), will probably cost at least $5 billion.

Critics have raised several concerns about the Air Force's plans. Some charge that the planned inventory of bombers will be too small to conduct nearly simultaneously the two major regional conflicts that Pentagon strategists say future U.S. forces must be ready to handle. Others argue that the Air Force needs more B-2 bombers to perform the missions that the national military strategy requires of its bomber force. Still others contend that the Air Force must get more out of its planned force, so that the bombers will be able to fulfill those missions that are expected of them.

Some who support the Air Force's plan argue that the United States will have enough capability to conduct any likely conflicts. Others believe that additional money would be spent more wisely on different programs.

THE USE OF BOMBERS IN FUTURE CONFLICTS

No one knows definitely what future conflicts involving U.S. forces will be like. A large global conflict seems unlikely. A conflict like the recent Persian Gulf War is more probable, one in which a regional power invades an ally or friend or threatens a vital interest of the United States. Pentagon planners believe that for the foreseeable future the United States is most likely to encounter such a conflict in the Persian Gulf or the Korean peninsula.

The United States does not keep large forces permanently deployed in the Persian Gulf region. Most of the units that leaders would call upon are based in the United States. Although the military has stockpiled some equipment for armored brigades and tactical aircraft squadrons on the Arabian peninsula, and maintains a wing of fighters there to enforce the United Nations' no-fly zone in Iraq, it would take the first U.S. troops and combat aircraft several days to deploy. And although the United States has stationed an Army division and a fighter wing in Korea and based an aircraft carrier and a Marine brigade in nearby Japan, those and South Korean forces might need reinforcements to slow a full-scale invasion. The first reinforcements would take several days to arrive from the United States. In both scenarios, bombers flying from the United States could provide combat power while other forces were transported to the theater. They would also be able to swing to a second conflict if it erupted before the first had ended.

ADAPTING BOMBERS FOR CONVENTIONAL WARFARE

The Air Force developed its plan for creating a more capable conventional bomber force in the wake of the Persian Gulf War. The plan, called the Bomber Roadmap, which was completed in June 1992, established conventional roles for each type of bomber, described the new types of munitions that were required, and outlined the modifications required to make the bombers capable of performing their conventional missions. It also established schedules and costs for developing weapons and modifying the bombers. (The B-2 and B-52 will also retain their roles as nuclear bombers.)

The Size of the Bomber Force

The Air Force plans an inventory of 181 bombers by 2001: 20 B-2s, 95 B-1Bs, and 66 B-52Hs. About 154 of those will be funded to fly, including 16 B-2s, 82 B-1Bs, and 56 B-52Hs. The bombers not funded for flying represent an allowance for those in depots or dedicated to testing. In the short term, however, the force will be smaller. Not all of the B-2s have been delivered, and the Air Force plans to operate only 60 B-1s during the next several years until they begin to carry smart weapons.

The Roles Planned for the Bomber Force

According to the Bomber Roadmap and DoD's Bottom-Up Review (BUR), each type of bomber will play different roles in future conflicts; those roles will change as the conflict unfolds. Bombers will be important in achieving all the early goals: halting the enemy's advance; suppressing its air defenses; destroying its air force; attacking its critical command, control, and communications centers; and impairing its ability to assemble or use weapons of mass destruction. In most scenarios, fighters that are deployed in the region will also play a major role in achieving the early goals. The importance of the bomber force would be amplified in a conflict that occurred without warning in a theater where the United States had few forces.

B-2 Missions. The stealth B-2 will be able to attack many targets with short-range (or so-called direct-attack) munitions because it will be better able than other bombers to fly through the enemy's integrated air defenses without being seen. The bombers would probably fly at altitudes greater than 20,000 feet, above the range of shoulder-fired surface-to-air missiles (SAMs) and most antiaircraft guns. At those altitudes they would rely on their stealth characteristics to penetrate defenses and evade enemy fighters. Because the B-2 can be seen by fighter pilots during daylight, it would probably operate mostly at night, much as the F-117 stealth fighters did during the Persian Gulf War. The bomber can attack those targets that are too heavily defended with short- or medium-range standoff weapons (those with ranges of about 50 to 200 kilometers). Alternatively, those targets can be attacked by non-stealth bombers carrying long-range standoff weapons, that is, armaments designed to be launched at the enemy from beyond the range of its defenses.

During the very early stages of a conflict, the B-2 would attack the most heavily defended targets, such as command and control centers and production and storage facilities for weapons of mass destruction. In addition, B-2 pilots would focus at least some of their attention on the task of suppressing enemy air defenses. By attacking such key components of the enemy's integrated air defense as command centers, early-warning and surveillance radars, and surface-to-air missile systems, the

B-2s would enable the more detectable B-1Bs and B-52s to penetrate defenses and use short-range weapons.

B-1B Missions. The B-1B will be able to carry roughly the same payload as the B-2. It will, however, be configured to carry more types of smart weapons. The B-1 has fewer stealth characteristics than the B-2, but after its electronic self-protection system has been improved, the Air Force expects the bomber to be able to penetrate all but the most heavily defended areas and to destroy the bulk of defended, critical targets. The B-1 would probably concentrate on such targets as airfields, key bridges and roads, and advancing armies during the early days of a war. It would use its short-range weapons against moderately and lightly defended targets and its medium-range weapons against targets protected by defenses that were too dangerous for it to penetrate.

B-52H Missions. Because the B-52 is more vulnerable to counterattack by opposing air defenses, for the first few days of a conflict it would probably be restricted to launching long-range cruise missiles at fixed targets in order to keep safely out of the range of long-range SAMs and enemy fighter aircraft. The likely targets of those early attacks would be fixed SAM sites; critical command, control, and communications centers; and sites associated with chemical, biological, or nuclear weapons. As U.S. forces reduced the effectiveness of enemy air defenses during the first days of the conflict, B-52s would begin to deliver medium-range weapons and then direct-attack munitions safely from high altitudes.

Initially, all three types of bombers would fly missions from their bases in the United States (unless they were deployed to a theater in response to an invasion warning). But distances from U.S. bases are great (up to 8,000 miles, or approximately 13,000 kilometers). If they undertake flights up to 36 hours long, bombers cannot be expected to fly more than an average of one mission every two and a half days. Furthermore, after a few weeks of such missions, crews would be exhausted. Thus, although bombers can fly missions directly from the United States, it is difficult to sustain such operations for a long period.

To avoid such long missions, some of the bombers could relocate to bases within a few thousand miles of the theater. There, they would spend less time flying to and from the theater and could increase the number of missions each week. In general, it would be about five days before the bombers could begin flying missions from forward bases; the rapidity with which they would actually be deployed to forward bases and the number that would be deployed would depend on the amount of warning that the United States had before a conflict. The timing of deployment would further hinge on the priority that the theater commander gave to allocating precious airlift assets for transporting people, equipment, and spare parts to support

the bombers. It would also depend on how well prepared the bases were to receive the bombers and provide them with facilities, fuel, and munitions.

Tactical Aircraft. Other assets such as shorter-range Navy and Air Force and allied aircraft would be used in a conflict as soon as they were available--in many cases at the start of the conflict. Some fighters are configured to destroy enemy air defenses. Others provide support for bombers and fighters by jamming the radar of key SAMs or protecting U.S. aircraft from enemy fighters. Still others are more effective than bombers for delivering precise weapons.

How soon tactical aircraft and other assets would be available would depend on where the conflict occurred. In a future Persian Gulf conflict, few U.S. forces might be present at the beginning of a surprise attack, although approximately a wing of U.S. fighters will be on hand until the United Nations stops enforcing its no-fly zone in Iraq. Modern Saudi fighters would also be present. U.S. tactical aircraft and ground and naval forces would be deployed as quickly as possible to the theater. Equipment that the United States has stockpiled near a possible theater would allow those forces to deploy more rapidly than they have in the past, but if a conflict occurred without warning, U.S. forces probably would not start arriving in quantity until the fifth day and the bulk of the force might not be deployed for several weeks.

In a theater like Korea, bombers would be less critical, but still important. South Korea has a large, modern military establishment; the United States also has ground forces and tactical aircraft already deployed there. The mountainous terrain in much of South Korea might make an armored invasion somewhat easier to stop than in the deserts of the Arabian Peninsula. But the terrain could also reduce the effectiveness of U.S. airborne sensors like the Joint Strategic Targeting and Reconnaissance System (JSTARS).

During the later phases of a war, bombers would complement the tactical air, ground, and naval forces that had been deployed to the region. Bombers would also play a very important role if a second conflict broke out while the first was still under way. According to DoD policy, a portion of the bomber force would swing to the second conflict immediately, working to halt the invasion until U.S. forces could be deployed to the theater.

IMPROVING THE EFFECTIVENESS OF THE AIR FORCE'S BOMBERS

The central goal of the Air Force's modernization plan is to improve the bomber force's ability to carry smart and unguided conventional weapons and use them effectively during a regional conflict. When armed with new accurate weapons, the

bomber force is expected to be able to destroy a wide range of target types with unprecedented effectiveness.

The Air Force's Bomber Roadmap lays out a plan for modernizing the bomber force and equipping it with the new munitions that DoD is developing for all of its ground-attack aircraft. It focuses on adding the capability to deliver a variety of unguided and new accurate weapons that use the Global Positioning System to find their way to targets. Those GPS-aided weapons include the short-range Joint Direct Attack Munition (JDAM) unitary bombs for attacking such hard targets as bridges and bunkers and, more recently, the Wind-Corrected Munitions Dispenser (WCMD) cluster bombs for attacking such targets as troops and vehicles. The Roadmap will also add GPS-aided weapons such as the Joint Standoff Weapon (JSOW), which will enable bombers to remain as much as 75 kilometers away from defended targets. In order to allow bombers to remain even farther away--at least 180 kilometers--from long-range defensive weapons, the Air Force plans to develop a replacement for the recently canceled Tri-Service Standoff Attack Missile (TSSAM). Together, those new weapons would allow bombers to attack fixed and moving targets with accurate weapons from a variety of ranges, although the Air Force will have to update the bombers' mission-planning systems in order to take full advantage of the capability of the new weapons.

Improved Weapons and Aircraft

The new generation of accurate weapons that is under development has the potential to improve the effectiveness of high-altitude bombing significantly. Those weapons will be guided to their targets by GPS-aided inertial navigation systems that will enable the weapons to strike within tens of feet of their intended targets. They will also be autonomous after they are launched, which means that the crew will not have to guide them to their targets but can quickly turn its attention to others after each launch. In addition, those weapons will be able to function in adverse weather because they need not rely on sensors to guide them to a target. Moreover, technical advances should make those munitions much less expensive than current accurate weapons. As a result, bombers will be able to deliver relatively large numbers of accurate, inexpensive weapons from high altitudes and in any type of weather, which will greatly increase their combat power.

In addition to developing accurate munitions and modifying the bomber force to carry them, DoD is working to improve the ability of the bomber force to function in a tactical environment. The Air Force plans to remedy deficiencies in the B-1's electronic countermeasures system and modify the system so that the bomber can better protect itself from the threats it is likely to encounter. The service will also

install radios on all the bombers that will allow them to communicate better with command authorities and other forces in the theater. The Administration's modernization plan, however, forgoes most other mission upgrades such as giving bombers the ability to receive intelligence about threats while in flight and to retarget their weapons easily. Such a policy would limit bombers' ability to attack advancing armies, avoid unexpected threats, and change targets.

Costs of the Modernization Plan

The bomber modernization program will cost more than $12 billion in today's dollars through 2020. Improving the bombers themselves would cost about $7 billion through 2020; a missile to replace TSSAM would probably cost in the neighborhood of $4 billion; and the purchases of new munitions that would be allocated to the bombers would probably add at least another $1 billion. (Currently, the Air Force plans to spend $4.8 billion on precision munitions for its fighters and bombers. In addition, it will probably spend at least another $1 billion to improve JDAM and buy a version of JSOW that will carry the Sensor-Fuzed Weapon.)

THE CAPABILITY OF THE MODERNIZED FORCE

When the Air Force completes its modernization program, it will have a total inventory of 181 bombers, all equipped to deliver smart and unguided conventional weapons. Of those, 154 bombers would be operational (the rest would be in depots or designated as test aircraft) and up to 130 would be available for combat (those operational aircraft that were not being used as trainers). If 75 percent of the bombers available for combat were airworthy on any given day, the planned force would provide about 98 bombers capable of flying missions. Operating from the continental United States, as they would be likely to do during the early days of an unexpected conflict, an average of 39 bombers would be able to attack targets each day, assuming that each bomber flies one mission every two and a half days.

But how the number of sorties each day translates into effectiveness on the battlefield depends on many factors. Perhaps most important is the capability of the enemy's air defenses and air force. If defenses are light (not very effective), both stealth and non-stealth aircraft will be able to fly over targets and deliver large numbers of short-range weapons. On the other hand, if defenses are heavy (quite effective), only the B-2s will be able to penetrate them and deliver short-range weapons. The other bombers may have to rely on a mix of long-range weapons, which will reduce their combat effectiveness against some targets but still enable them to deliver a significant quantity of munitions.

The Congressional Budget Office (CBO) chose to illustrate the range of effects that enemy defenses might have on the capability of the planned force, as well as that of alternative forces, by using two simple scenarios: one that assumes that the enemy has light defenses that are vulnerable to attack, and another that assumes that the enemy has effective defenses that are strong enough to survive attack for two weeks. CBO has kept the scenarios deliberately simple to illustrate the effects of defenses without making hundreds of assumptions. Although they may be unrealistic, they present upper and lower bounds of the capability of air defenses; the lightly defended case may understate the capability of possible future adversaries, and the scenario with strong defenses assumes countermeasures that are at once more effective and durable than anything U.S. forces are likely to encounter in the developing world for some time. In reality, the situations that the bomber force will encounter probably lie somewhere between these two boundaries. CBO has also developed a moderate-defense scenario to illustrate the capability of the bomber force and alternatives when some of the boundary conditions are relaxed.

How Would the Planned Bomber Force Fare?

In the lightly defended case, the non-stealth bombers in the planned force would use standoff weapons for three days until the enemy's air defenses and air force were suppressed. During this period, CBO assumes, B-52s would use TSSAM follow-on missiles; B-1Bs would use TSSAM follow-on missiles, JSOWs, and JDAMs each on one-third of their sorties, and B-2s would use only JDAMs. At the end of the third day, the air defenses are assumed to be sufficiently disabled so that all bombers can fly over targets at high altitudes and deliver JDAMs.

To illustrate an upper bound to the effectiveness of enemy defenses, CBO assumed in its strong-defense scenario that the non-stealth bombers must use standoff weapons for 15 days and that only the B-2 is capable of penetrating such defenses. The B-52 uses TSSAM follow-on missiles for the full 15 days, and the B-1B uses TSSAM follow-up on half of its sorties and JSOWs on the other half. The B-2 uses JSOWs on 20 percent of its sorties during that period and JDAMs on the remaining 80 percent. (For the purposes of illustration, CBO assumes that the B-2 can carry JSOWs, although the bomber will not have such a capability, according to current plans.) The scenarios are assumed to occur in 2010, when all of the Air Force's planned modernizations would be complete.

A light defense would pose little challenge to the capabilities of the bomber force. The bombers could deliver a large number of weapons--as many as 9,400 JDAMs, 170 JSOWs, and 500 TSSAM follow-ons. To place those numbers in perspective, the Bomber Roadmap estimates that U.S. and allied forces must strike

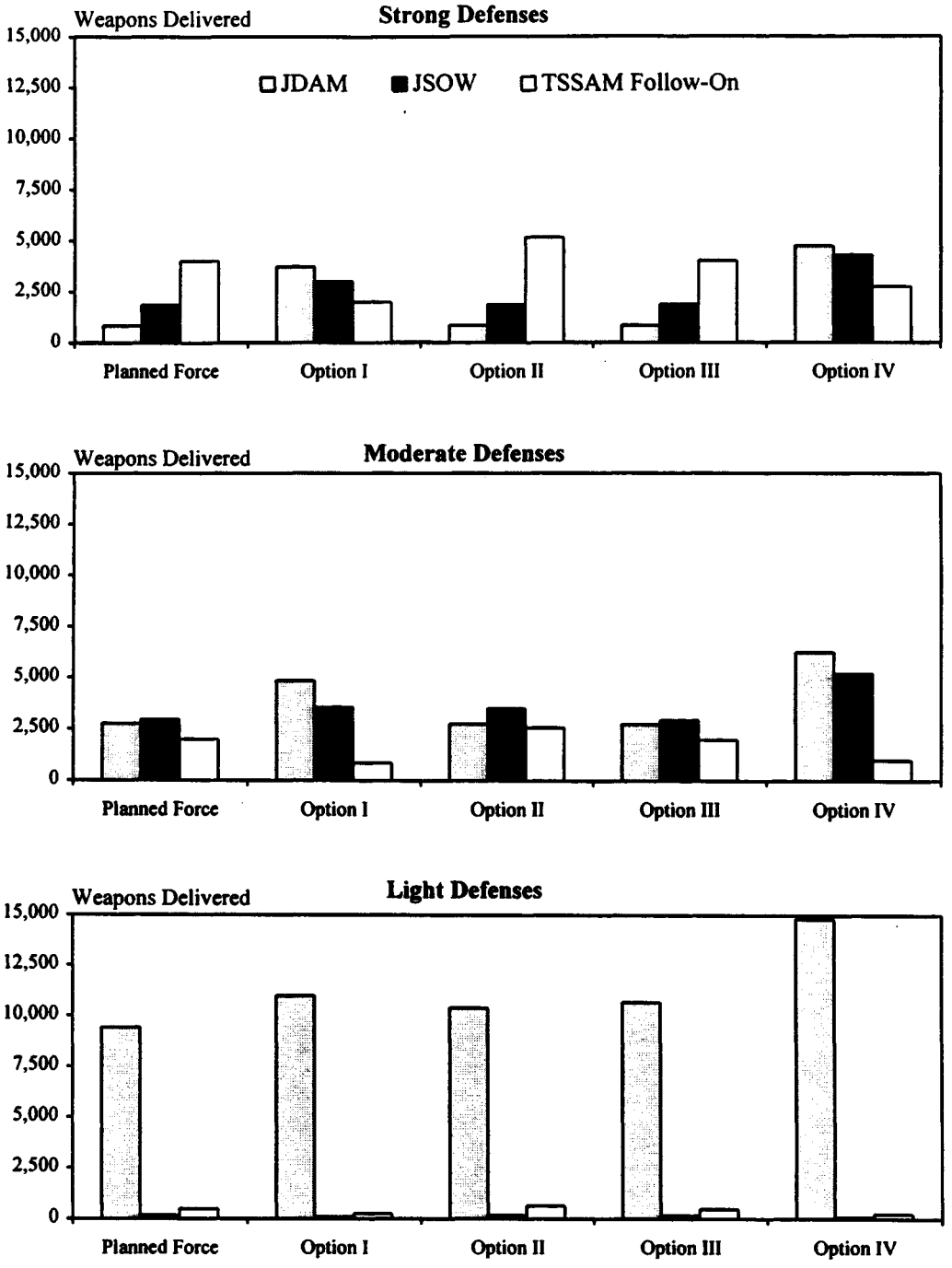
approximately 1,250 high-priority strategic target elements--aimpoints such as corners of a building that must be hit to destroy a target--within the first five days to disrupt an enemy's strategic plan and halt its offensive. Able to deliver some 2,600 weapons over the first five days (an average of more than two weapons per target) and more than 10,000 over 15 days, the planned force should be more than adequate in the light-defense scenario even if other forces are not present (see Summary Figure 1). The capability of the planned force is further indicated by the very large number of short-range weapons that it can deliver; short-range weapons are much cheaper, bombers can carry more of them, and they are more effective than longer-range weapons against such targets as advancing armies.

These results are similar to those of the 1995 Heavy Bomber Force Study--an independent review that DoD commissioned at the request of the Congress. That extensive review concluded that the planned force would be adequate for all reasonable scenarios. The authors of the study used several well-established models to analyze the effectiveness of the bomber force, based on data from actual war plans and the latest intelligence estimates of the future targets and threats in the Persian Gulf and Korea.

That assessment changes, however, when the opponent has effective, durable defenses. If the enemy's defenses were as capable as CBO's strong-defense scenario assumes--an unlikely but conceivable event--the bombers would only be able to deliver about 1,900 weapons within the first five days and 6,700 over the first 15. Furthermore, all but 900 of the weapons delivered in the first two weeks would be munitions fired from a distance, two-thirds of which would be launched from long ranges. In general, that would reduce the number of weapons that bombers could carry on each sortie and reduce their ability to attack advancing forces. Moreover, if there were no tactical aircraft or naval forces in the theater to help attack critical targets, only about half of the target elements prescribed in the Bomber Roadmap could be attacked by more than one weapon. The Heavy Bomber Force Study supports this result. In the unlikely event that tactical aircraft were absent during the first two weeks of the war, the planned force would not fare as well, according to the study (although the United States and its ally would still halt the invasion and win the war).

To illustrate how an air defense with moderate capabilities would affect the planned force, CBO also constructed a moderate-defense scenario. In that more reasonable case, defenses would hold up for seven days against the planned force. During that time the bombers would use the same mix of weapons as they do in the strong-defense scenario. During the second week, the B-52 would deliver JSOWs, the B-1 would devote half of its sorties to JSOWs and half to JDAMs, and the B-2 would deliver JDAMs exclusively. Despite the "moderate" label, these defenses are

SUMMARY FIGURE 1. COMPARISON OF MUNITION EXPENDITURES UNDER VARIOUS OPTIONS



SOURCE: Congressional Budget Office.

NOTES: These results are derived from the scenarios that CBO developed to illustrate the capability of the options against varying defenses. The strong-defense scenario probably overstates the capabilities of stealth and future enemy defenses, and the light-defense scenario may understate the most challenging defenses that the United States may face. Because the scenarios ignore many operational factors that would reduce the numbers of weapons that bombers could deliver in each option, they are best used to compare the relative capability of each option.

JDAM = Joint Direct Attack Munition; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile.

probably more capable than any that are available in the developing world today. Remember that in the Persian Gulf War large sections of the highly regarded Iraqi air defense system were rendered inoperable after the first few days of allied attacks, and B-52s dropped short-range weapons on Iraqi forces on the first day of the war.

In this scenario, the bomber force could deliver some 1,900 weapons over the first five days--more than enough to strike each of the Roadmap aimpoints twice. The planned force would be able to deliver 2,700 JDAMs during the 15-day period, three times what it was capable of in the strong-defense case, but less than one-third of what it could deliver in the light-defense case (see Summary Figure 1).

As mentioned above, CBO's scenarios are designed to illustrate the ways in which different defenses would affect capability and are not intended to be definitive measures of effectiveness. The simplicity of the model, which makes it easier to understand, ignores too many important factors to predict operational capability. For example, it shows how many weapons of each type could be delivered but ignores what targets they may be aimed at or even how many targets need to be destroyed. In addition, the model probably overestimates the number of weapons that could be delivered. It ignores several operational constraints, such as limits on the number of hours that the bomber crews can fly each month, limits on the number of accurate weapons that would be available to the bombers, missions that are aborted because of technical problems or unexpected threats, and missions on which bombers will carry less than their full load of weapons. Nor does the model estimate how the bomber attacks would affect the progress of the enemy's invasion. Also important, it ignores any contribution that Navy and Air Force fighters and other forces would make in the first two weeks.

Bombers Would Not Be a Silver Bullet

The preceding discussion conveys the impression that bombers would be so effective that other forces would not matter. But that is not the case. Bombers would be able to deliver large numbers of weapons from long distances, but they are not omnipotent. For example, none of them would have the ability to act as electronic warfare aircraft and only the B-52 could deliver very accurate weapons. Furthermore, much of the public discussion about how bombers would be used assumes that they would be able to find mobile targets and react quickly to changes in the air defenses. In reality they would have to rely on other sensors to tell them where to look and would have trouble adjusting to rapid changes in threats during a mission. Nor is it certain that the bombers would have the proper information to enable them to launch missions immediately after the start of an unexpected conflict. Unless plans for the first few days had been developed before the conflict occurred

(which is possible when attacking fixed strategic targets), the bombers would have to wait. It might also be difficult to plan in advance in enough detail to orchestrate the complex operations necessary to destroy an enemy's air defenses and strategic plan quickly. Keeping such predetermined war plans current requires that they be updated frequently during peacetime to reflect new intelligence about the location of targets and threats.

ALTERNATIVES THAT WOULD INCREASE THE CAPABILITY OF THE BOMBER FORCE

The Air Force's plans for the bomber force have been criticized from several points of view. CBO analyzed four alternatives that address some of those critiques. If enough money is available, the United States could increase the size of its bomber force as well as improve the capabilities of existing bombers. Or it could improve the existing force and preposition equipment at forward operating bases. Nevertheless, improvements to the bomber force would come at the expense of other programs. By focusing on bombers only, this analysis ignores possible upgrades to tactical aviation and other forces that could well prove more cost-effective than the alternatives examined here. Nor does it provide the information about possible trades between bombers and other forces such as aircraft carriers.

Alternatives That Increase the Size of the Force

Two options would increase the size of the bomber force. Option I would add 20 more B-2s to the force in response to critics who argue that the United States should have more bombers than the 181 planned by DoD and more than 20 bombers with stealth characteristics. Option II would respond to similar concerns by retaining all 94 B-52Hs in the force through at least 2020 rather than just the 66 that DoD plans to keep.

Effects on Capability Options I and II would increase the size of the bomber force available for combat each day by 12 and 16, respectively. Operating from the continental United States, as they are likely to do during the early days of an unexpected conflict, the additional B-2s could add five extra combat missions each day to the Air Force's planned force--an increase of 12 percent (see Summary Table 1). The additional B-52s would add seven extra combat missions each day, an increase of 17 percent. Because the B-2 and B-52 can carry about the same number of smart weapons, the number of weapons that could be delivered under each option would be roughly the same.

If defenses are considered, however, the capability of the force that has more B-2s may increase considerably in comparison with both the planned force and the force with more B-52s, depending on the scenario. But the effect of having more bombers with stealth characteristics or those without is difficult to measure. As one might expect, it depends on many factors, including the capability of an adversary's air defenses and air force and how resistant they are to attack. It also depends on how well stealth works and how well the electronic self-protection systems work on bombers that do not have stealth characteristics.

The Effects of 20 Additional B-2s. To illustrate the gamut of effects from additional B-2s, CBO used the scenarios developed above, after making one adjustment. Those scenarios account for only one aspect of stealth--bombers with stealth characteristics

SUMMARY TABLE 1. CAPABILITY AND COSTS OF THE ALTERNATIVES

Option		Combat Missions Per Day (Percentage increase)	Increases in Weapons Delivered Over 15 Days (Percent)[a] Light Defenses	Moderate Defenses	Strong Defenses	Cost Through 2020 (In billions of 1996 dollars)
I	Add 20 B-2s	12	12	22	35	26.8
II	Keep All 94 B-52s	17	11	17	17	3.2
III	Improve Planned Force	0	13	0	0	1.1
IV	Preposition Equipment, Deploy Bombers Quickly	0/60[b]	0/50[c]	0/67[c]	0/82[c]	1.8

SOURCE: Congressional Budget Office.

a. These numbers are derived from the scenarios that CBO developed to illustrate the capability of the options against defenses with different capabilities. The strong-defense scenario probably overstates the capabilities of stealth and future enemy defenses. The light-defense scenario probably understates the capability of the more challenging defenses that the United States may face.

b. The first number indicates that daily combat missions would not increase for the first three days of the conflict under Option IV. The second number refers to the percentage increase in daily sorties that is possible after the third day by deploying 16 B-2s, 18 B-1s, and 18 B-52s to forward bases.

c. The first number indicates that there would be no increase in weapons delivered during two weeks under this option if the theater commander had enough warning or cargo aircraft to relocate bombers quickly. The second number refers to the percentage increase in weapons delivered over 15 days by deploying 16 B-2s, 18 B-1s, and 18 B-2s to forward bases in those cases in which the theater commander would not otherwise be able to deploy the bombers for at least two weeks.

can penetrate defenses and deliver more short-range weapons. But additional penetrating bombers may also help suppress the defenses more quickly, allowing the non-stealth bombers to intrude more quickly and use their short-range weapons. To illustrate this effect, CBO assumed that doubling the number of B-2s would halve the time that it took to suppress the enemy's air force and defenses. That assumption almost certainly overstates the capability of 20 additional B-2s, but it places an upper bound on the contribution that they can make.

In the case of light defenses, the additional B-2s reduce the time that the B-52s and B-1s must stand off from three days to two. That would have only a modest influence on the capabilities of the bomber force because the effects of stealth are small. It would increase the total number of munitions delivered by only 12 percent (see Summary Table 1). And it would allow the non-stealth bombers to avoid expending only 330 fewer standoff weapons over 15 days (see Summary Figure 1).

By contrast, additional B-2s could have a greater impact in the scenario with strong defenses because CBO has assumed that they would reduce the standoff time from 15 days to eight. As a result, this option would increase the number of weapons that could be delivered over 15 days by 35 percent compared with the planned force, while cutting the number of long-range standoff weapons used by half. It would also quadruple the number of JDAMs that could be delivered. Over the first five days, this option would increase the number of warheads that could be delivered by 14 percent--enough to strike 80 percent of the aimpoints in the Roadmap target set twice. In the moderate-defense case, the effect of adding the B-2s is less dramatic. It would increase the total number of weapons that could be delivered within 15 days by 22 percent and the number of JDAMs by 77 percent.

The results of the scenarios should be used with caution, however. The numbers of weapons shown in Summary Figure 1 represent a potential or maximum capability for the assumptions of each scenario because they neglect many operational factors that would constrain the capability of the bombers, such as limits on the availability of accurate weapons and crew fatigue. Consequently, the results of the scenarios are best used to assess the relative effects of the options in the presence of different defenses and not to indicate accurately the number of weapons that would actually be delivered. For example, it is important that Option I would increase by almost 350 percent the number of JDAMs that could be delivered, compared with the planned force in the strong-defense scenario. Against light defenses, it would deliver only 17 percent more JDAMs than the planned force.

How useful are these analytic results? The above scenarios provide only illustrative boundaries for a conflict and should not be considered predictions of what might actually occur in a major regional conflict. Indeed, as previously mentioned,

this model has significant limitations. The light-defense scenario may understate the ability of future defenses. For instance, although allied air power disabled significant portions of the Iraqi air defenses within the first two days of the 1991 conflict, many combat aircraft were dedicated to that mission and were supported by force packages that provided air cover and electronic weaponry. During the early days of a future conflict, those assets may not be available until the United States has a chance to build up its forces in the region. Furthermore, future adversaries may learn from Iraq's experience and reduce the vulnerability of key command and control centers by placing them underground. They might also use their air force more effectively and force the non-stealth bombers to stand off longer.

Similarly, there are good reasons to believe that the strong-defense scenario overstates the capability of an enemy's air defense and is unrealistically favorable to stealth. By assuming that every square inch of the opponent's country is defended, it understates the ability of the non-stealth bombers, particularly the B-1, to penetrate some sectors of the air defenses and attack targets with JDAMs and WCMDs. According to the Bomber Roadmap, the majority of the targets in a future regional conflict are likely to be lightly or moderately defended. In addition, the scenario neglects the fact that advancing armies would probably be more vulnerable than targets within the territory of the invader because they would be beyond the range of the national air-defense system.

Furthermore, the strong-defense scenario does not take into account suppressing defenses over key targets or creating corridors through the defenses, tactics that are frequently used in combat. It also excludes the contributions of several hundred U.S. and allied shorter-range combat aircraft--many of which will have stealth characteristics in the future--that would be available from the beginning in Korea and even in the Persian Gulf, unless the enemy first destroyed all air bases in the theater and kept them closed with repeated attacks. The strong-defense case also assumes that doubling the number of B-2s will cut in half the time that it takes to destroy air defenses, despite the fact that the majority of the effort against those defenses would come from non-stealth bombers using a variety of standoff weapons or from stealth and non-stealth fighters that were likely to be in the theater. (If CBO had assumed that the impact of additional B-2s was proportional to the bombers' likely share of the attack on the air defenses, doubling the number of B-2s would hasten the demise of those defenses by only about 10 percent.)

The Heavy Bomber Force Study. DoD's recently completed Heavy Bomber Force Study found that purchasing 20 additional B-2s was not cost-effective. The study found that against a wide range of threats the planned force was adequate, additional B-2s were not necessary, and they had little effect on the outcome of a conflict. In a very challenging scenario in which the conflict would happen without warning and

no tactical aircraft would be in the theater for two weeks, the planned force would not fare as well (although the United States and its ally would win the war). But the study found that 20 additional B-2s would make little difference in that scenario; more than 60 would be required, as well as a large number of additional accurate weapons. DoD officials do not seem concerned by those results because they believe such a scenario is very unlikely. Critics of the study do not share that assessment, however, and believe that the results support their argument for more B-2s. Ultimately, the importance one attaches to buying more B-2s depends largely on how likely such a scenario seems.

The Effects of Keeping 28 More B-52s. One of the main advantages of retaining more B-52s is that they would have an immediate impact on the size of the force, whereas buying additional B-2s would not fully affect the size of the force until at least 2008. Against light defenses, a force with 28 more B-52s would be able to deliver 11 percent more weapons than the planned force, slightly less than the force with 20 more B-2s. Against strong defenses, however, the force with more B-52s would deliver 17 percent more weapons, only half the increase associated with more B-2s. Furthermore, all of the additional weapons that this force would provide compared with the planned force would be long-range standoff weapons. Still, the force under this option would be effective against strong defenses, delivering up to 2,300 weapons within the first five days, slightly more than the force that has 20 more B-2s. That would allow the bomber force to attack 80 percent of the target elements in the Roadmap target set with more than one weapon during the first five days of a conflict.

The Effect on Costs. Buying 20 more B-2 bombers would probably cost about $27 billion (in 1996 dollars) through 2020--$18 billion to buy the bombers and another $9 billion to operate and support them for 20 years. That estimate draws heavily on the estimate of acquisition costs that the Institute for Defense Analyses developed for the Heavy Bomber Force Study, but CBO developed its own estimate for operating and support costs. Costs would total about $0.8 billion in 1996 and $13.5 billion through 2001. (Summary Table 2 shows the costs in 1996 dollars, and Summary Table 3 shows the costs of the alternatives through 2020 in current dollars.)

Total costs could be lower--by perhaps $2 billion--if the Defense Department accepts the manufacturer's offer to build the additional aircraft according to the schedule and specifications it offered in a fixed-price contract. That offer is based on efficiencies and other factors that the manufacturer believes will make costs dramatically lower than the initial 20 B-2s; the implication is that if costs were not lowered, the contractor would suffer the consequences and not the government.

CBO uses a higher estimate in this analysis for two reasons. First, a higher estimate is more consistent with the trend of costs for the first 20 B-2s. Second, DoD or the Congress may not want to abide by all of the terms and conditions of the contractor's proposal, which could increase costs substantially. Indeed, such changes could lead to costs that are higher than CBO's estimate.

Keeping all 94 B-52s in the force would increase operating costs by $120 million a year, starting in 1996. In addition, the Air Force would have to pay a one-time cost of roughly $100 million starting in 1996 to modify the 28 additional nuclear bombers so that they could carry conventional munitions. This option would cost $130 million in 1996 and $820 million through 2001. Through 2020 it would cost $3.2 billion, or almost $24 billion less than buying 20 more B-2s. Of course, under some scenarios the force with 94 B-52s would provide much less capability.

Peacetime Versus Wartime Costs. The above discussion focused on the cost of buying and operating the bombers--the costs incurred during peacetime. CBO typically uses that measure for a weapon system because one cannot predict how many or what types of conflicts a weapon will encounter during its life.

SUMMARY TABLE 2. COST OF THE ALTERNATIVES THROUGH 2020
(In millions of 1996 dollars)

Option		1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
I	Add 20 B-2s	790	2,900	1,910	2,710	2,670	2,560	13,540	26,810
II	Keep All 94 B-52s	130	140	150	140	130	130	820	3,230
III	Improve Planned Force	90	260	210	190	170	90	1,010	1,130
IV	Preposition Equipment, Deploy Bombers Quickly	240	250	260	260	260	250	1,530	1,760

SOURCE: Congressional Budget Office.

Some supporters of the B-2 argue, however, that 20 additional stealth bombers will save enough money to pay for themselves because they can penetrate defenses and deliver low-cost, short-range attack weapons rather than expensive standoff armaments. CBO has found that additional B-2s would reduce the cost of the weapons expended during a conflict by the entire bomber force during the first two weeks, when they are most likely to use long-range standoff weapons, by less than $2 billion--a fraction of the $27 billion lifecycle cost for the 20 bombers. That would be true even in a scenario that is very favorable to stealth; one in which the opponent has effective, survivable air defenses and a potent air force that compels all bombers but the B-2s to use standoff weapons against all targets, and 20 additional B-2s help destroy those defenses within half the time that it would take the planned force to destroy them. This estimate uses the strong-defense scenario developed above and assumes that JDAM and JSOW will be bought at their planned average unit procurement price of roughly $40,000 and $180,000, respectively, and that the TSSAM follow-on missile costs $1 million each.

SUMMARY TABLE 3. COST OF THE ALTERNATIVES THROUGH 2020
(In millions of current dollars)

Option		1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
I	Add 20 B-2s	790	2,990	2,020	2,960	2,990	2,950	14,700	35,880
II	Keep All 94 B-52s	130	150	160	150	150	150	890	4,340
III	Improved Planned Force	90	260	230	210	190	100	1,080	1,230
IV	Preposition Equipment, Deploy Bombers Quickly	240	260	280	280	290	290	1,650	1,920

SOURCE: Congressional Budget Office.

NOTE: The numbers in this table reflect inflated dollars, the kind that the Congress will actually authorize and appropriate each year.

Over the life of the bombers, 14 such demanding conflicts, or an average of more than one every two years, would be necessary for the bombers to pay for themselves. In historical perspective, that is a very large number of major regional conflicts; the United States has fought in only three wars against well-equipped adversaries since 1945. Even if the high consumption of standoff weapons lasted for a full month rather than the 15 days assumed here, or long-range weapons cost twice as much, the United States would have to fight at least one war every three years to justify spending the money on the bombers. But there may be other considerations: fewer escort aircraft and fighters capable of suppressing defensive actions might be needed, the number of casualties might be reduced, or the more intense attacks possible with short-range weapons might shorten a conflict; using fewer munitions during conflicts is probably not reason enough by itself.

Improving Capability Without Increasing the Number of Bombers

The second set of alternatives that CBO analyzed would increase the capability of the planned force without increasing the number of bombers. Option III would respond to critics who argue that the Air Force is not equipping bombers properly to conduct the missions expected by the Roadmap and the BUR. It would add JSOW to the B-2 and B-52, WCMD to the B-2, and increase the number of B-1s that can deliver cluster munitions and WCMDs. In addition, it would improve the accuracy of the weapons that the B-1 delivers by improving the resolution of its radar. The third option would also enhance the ability of the planned force to communicate with other forces in the theater. Finally, Option III would improve the mission-planning and communications systems on the bombers so that they could update targets and receive information about new threats during their long flights to the target area.

The fourth option would improve the capability of the bomber force during the critical early days of a conflict by stockpiling spare parts and support equipment at a few key forward bases--an approach known as prepositioning. By doing so, Option IV would make it easier to operate some of the bombers from bases close to the combat theater as quickly as possible, thereby increasing the number of missions that they could fly in the critical early days of the war--without having to pay the costs of increasing the size of the bomber force. That option illustrates the way in which establishing forward bases can markedly increase the capability of a planned force of bombers during the early days of a conflict, particularly a conflict that occurs without warning.

Effects on Capability. Neither the third nor fourth option would increase the size of the bomber force. But they would add capability in other ways. By adding JSOW and WCMD to the B-2, Option III would fill two gaps in the bomber's capabilities.

Because TSSAM was canceled, the B-2 has no standoff weapon, which will limit its ability to attack targets that are too heavily defended by SAMs. (The stealth bomber is not invisible, it is just more difficult for radar to see than other bombers. If it flies close enough to a powerful radar, it can be seen and attacked.) Adding JSOW will give the bomber the capacity to attack almost any soft target protected by SAMs, including the SAMs themselves. Integrating WCMD on the B-2 will give it the ability to attack advancing armor and other soft targets much more effectively.

Fitting the internal bomb racks on the B-52 to carry smart weapons would boost the number of JDAMs and WCMDs that the bomber could carry. Adding JSOW to the B-52 would enable it to deliver an inexpensive, accurate, short-range standoff weapon against soft targets--targets that are vulnerable to relatively small explosions.

By adding the relative targeting system to the B-1, Option III would improve the bomber's ability to attack hard targets by enabling it to deliver JDAMs more accurately and thereby use fewer weapons. It would also enable the bomber to detect, track, and aim at moving targets more effectively. Adding satellite communications equipment would allow the bomber to function more effectively in a conventional war. And adding conventional bomb racks would allow twice as many B-1s (33 rather than 16) to deliver WCMDs, other cluster munitions, and Mk-82 bombs.

Taken together, those modifications would approximately double the capacity of the bomber force to carry JSOWs and WCMDs. They would also increase the capacity for JDAMs by nearly 15 percent and for unguided cluster munitions and Mk-82 bombs by at least 30 percent.

Unlike the other alternatives, however, some of the upgrades in Option III cannot be measured using CBO's illustrative scenarios. Several would not affect the number of munitions that could be carried, but would improve the chances that the bomber could deliver them effectively. Other upgrades--such as adding WCMDs to the B-2 and equipping more B-1s to carry the weapon--are not taken into account by CBO's model because the scenarios assume for the sake of simplicity that JDAM is the only short-range weapon that bombers deliver. Likewise, the scenarios assume that the B-2 can already carry JSOW, which obscures the changes made in this option.

The fourth option would provide insurance against a conflict that occurred without warning, particularly if there were few forces already deployed. In such a case, a theater commander would probably have the bomber force operate from the United States for the first two weeks because he would place greater priority on

rushing tactical aircraft and ground forces to the theater. In that context, Option IV could have a measurable effect on the capability of the bomber force in the early days of a conflict. It would allow the theater commander to deploy 16 B-2s, 18 B-1s, and 18 B-52s to forward operating bases by the end of the third day, which would increase the number of sorties that those bombers could fly by a factor of 2.5 compared with the planned force. Overall, the number of combat missions per day would be 60 percent higher after the third day than under the planned force (see Summary Table 1). Nevertheless, this option would add little, if any, capability to the planned force if the theater commander had enough warning to deploy the bombers before a conflict began. Nor would it have much effect if there were enough combat forces in the theater at the start of a war to allow the commander to allocate sufficient numbers of cargo aircraft for transporting the equipment, parts, and people that support the bombers.

To be consistent with the assumptions used for the larger B-2 force in Option I, the additional B-2 sorties would cut in half the time that it would take to destroy air defenses and allow other bombers to use short-range weapons sooner. Therefore, prepositioning equipment and spare parts near a possible theater would increase by at least 30 percent the weapons that could be delivered by the bomber force during the first five days in all three illustrative scenarios and would increase by one-half to three-quarters the number of weapons that the bomber force could deliver over 15 days (see Summary Figure 1). Prepositioning would also make it easier for a portion of the bomber force to swing to a second conflict if the need arose because much of the necessary parts and equipment would already be there. Perhaps most important, Option IV could provide more B-2 sorties and deliver more weapons than a force with 20 additional B-2s during the critical first five days and during the first 15 days of a conflict (for those cases in which the theater commander would otherwise be unable to deploy bombers quickly). That result holds against light or strong defenses.

There are, however, several problems with prepositioning. First, the United States must obtain permission from host countries to stockpile the equipment, which is not always possible. U.S. leaders discovered that when they tried to place equipment for short-range combat aircraft and ground forces in the Persian Gulf over the last few years. Second, the United States must be able to use the bases as soon as the conflict begins. In some cases, like Guam, which is a U.S. territory, or Diego Garcia, which the United Kingdom allows the U.S. military to use regularly, that is not a problem. But at other bases, such as Kadena in Okinawa and Jiddah in Saudi Arabia, securing permission to use the sites for heavy bombers may be more difficult. Nevertheless, those problems are probably more manageable for bombers than for ground forces and tactical aircraft. Short-range forces must be placed in the theater,

but bombers can be based within several thousand kilometers, thereby opening up a wider range of bases.

The Effect on Costs. Both Option III and Option IV would be significantly less expensive than the ones that would increase the size of the force. CBO estimates that it would cost $1.1 billion to upgrade the bombers as proposed in Option III, or 4 percent of the cost to buy and operate 20 more B-2s and 35 percent of the cost of the force that has more B-52s. It would cost $90 million in 1996, and virtually all of the costs would be incurred by 2001 (see Summary Table 2). Against an opponent with light defenses, the bomber force in Option III would be able to deliver about the same number of weapons as Options I or II. Against a very strong defense, however, Option III would provide much less capability than either of the more expensive options. Nevertheless, the mission-planning upgrades would probably increase the survivability of the bombers.

Option IV would cost $1.8 billion through 2020. Most of those funds ($1.5 billion) would be spent by 2001 to purchase the extra spare parts and equipment that would be stockpiled at the forward bases. The remainder would pay for the small annual cost (roughly $12 million) to maintain the equipment. The strength of this option is that for only one-sixteenth of the cost of buying 20 more B-2s, it could provide 5 percent more B-2 sorties during the critical first 15 days of the war, assuming that the bombers would otherwise have flown their combat missions from the United States. Moreover, it could provide 30 percent more B-1 sorties and nearly 50 percent more B-52 sorties during that period. Those increases would probably last for no more than the first few weeks of a war, however, because even without pre-positioning a theater commander would probably deploy the bombers as soon as he had fielded a sizable force of tactical aircraft. If the United States had enough warning time to deploy bombers before a conflict began, most of the capability added by stockpiling equipment would disappear.

CAN DoD AFFORD THE OPTIONS?

Improvements in the bomber force would come at the expense of other forces such as ground forces or shorter-range tactical aviation. Although the Congress may increase defense spending over the next five years, those extra funds will most likely dry up starting in 2001. Indeed, if the Congress follows through with its plans to balance the budget by 2002, the defense budget will probably be lower than Pentagon projections for 2001 and the years beyond. In that case, any additional money spent on bombers after 2001 would have to be taken from other programs or other accounts such as training.

As mentioned above, this analysis has focused on bombers. But possible upgrades to tactical aviation and other forces could well be more cost-effective than some or all of the alternatives examined here. Moreover, trading capability in those areas to increase the capability of the bomber force may not be wise. Alternatively, bombers could be more cost-effective than other strike assets such as aircraft carriers. CBO intends to analyze the trade-offs in a future study.

CHAPTER I

INTRODUCTION

Without warning, Iraqi tanks roll across the Kuwaiti border. Within hours they have smashed through light resistance, overrun Kuwait city, and begun their advance on Saudi oil fields. Caught by surprise, the United States has few forces deployed in the region to help stop the onslaught. Before the sun rises on the second day of the invasion, however, long-range bombers arrive from the United States and attack the Iraqi invasion force as it moves down the few roads into Saudi Arabia. They drop thousands of small antiarmor munitions on the forward elements of the Iraqi force, inflicting heavy damage and halting the columns. The surviving tanks and armored personnel carriers scatter to avoid the next attack.

Meanwhile, other bombers attack key fixed Iraqi military targets such as military headquarters and air defenses with long-range cruise missiles. Some attack key airfields with a combination of long-range weapons and short-range direct attack munitions. The Saudi air force engages Iraqi fighters while the bombers conduct their strikes.

The bomber attacks continue unabated for the next week as the United States rushes to deploy additional tactical aircraft, warships, and ground forces. Several days after the start of the Iraqi invasion, tactical aircraft and some ground forces begin to arrive from U.S. bases and join the battle.

The above scenario illustrates one of the most challenging types of future conflict that Pentagon planners envision. Unlike Iraq in 1991, they argue, the next opponent may not wait for the United States to build up its forces before engaging it. As a result, U.S. forces must be able to respond rapidly to an attack on an ally or friend, particularly if the enemy invades without warning. Furthermore, the United States will maintain smaller forces that are located mostly at home for the foreseeable future, thus making their ability to respond quickly from U.S. bases more important.

In this new world, bombers armed with accurate conventional munitions would play a key role in any major regional conflict, according to Pentagon plans, particularly during the early days of a conflict when there might be fewer U.S. tactical aircraft or ground forces deployed in a theater than were needed to halt and repel the invader.

Bombers bring two unique features to battle: they are able to attack targets anywhere in the world from bases in the United States within about 24 hours, and

they can carry a large number of weapons. This means that bombers can be attacking targets while tactical aircraft and ground forces based outside the region are still being deployed. In many cases, the United States would have some tactical aircraft and ground forces deployed in the region when the conflict began. Some would be based there, while others might be deployed in anticipation of hostilities. If naval forces were nearby when the conflict erupted, they would also join the fight with cruise missiles and carrier-based aircraft, and even provide fighters and radar-jamming aircraft to help the bombers penetrate enemy defenses.

Furthermore, a new generation of accurate weapons being developed by the Department of Defense (DoD) will increase the effectiveness of each bomber mission, allowing the United States to get the most from its relatively small bomber force.

LIMITATIONS OF TODAY'S BOMBER FORCE

The ability of the bomber force to conduct the early missions assumed in the Pentagon's future war plans, however, is currently limited (see Table 1). Only the B-52Hs can carry precision or standoff weapons--weapons enabling the attacker to remain outside the range of enemy defenses. Other bombers can deliver only unguided gravity bombs. Much of the force will not be properly equipped to conduct strikes with accurate weapons until at least 2000. And large inventories of those weapons will not be available for several years after that.

Those limitations may seem puzzling, but they are strongly rooted in the history of conventional and nuclear bombers. From the beginning of the Cold War until the end of the Persian Gulf War, bombers were regarded primarily as a nuclear asset; their avionics and weapon systems were designed primarily for nuclear missions. Nuclear operations demanded that the bombers fly away from their bases within minutes to escape an enemy's nuclear barrage and then--because communications would be difficult in such an environment--execute their mission without much contact with the outside world. Because they would have been attacking fixed targets and had to start their missions without warning, all of the details of the mission for each bomber, including target locations and flight paths, were preloaded onto magnetic tapes and loaded into the aircraft's computers before takeoff. Consequently, the bombers had no need (and no real ability) to change the targets after they had taken off. The radar, targeting, and mission-planning systems that are on the bombers today were designed primarily to support those predetermined missions against fixed targets.

In future conventional conflicts, however, this type of rigid mission-planning system will limit bombers' ability to perform some of the important tasks that are expected of them. Although a rigid system would allow strikes against fixed targets, attacking mobile targets such as an armored column would be difficult. The column could have moved many miles in the hours before the bombers arrived on the scene. And without the ability to receive new targeting data and program it into their weapons easily, the bombers would not be very effective. Even against fixed targets, a rigid mission-planning system as well as a lack of tactical communications links would make it difficult to adapt to unexpected threats if the tactical situation changed during a bomber's long flight to the target area.

TABLE 1. COMPARISON OF TODAY'S BOMBER FORCE WITH THE PLANNED FORCE

Category	Current Force	Planned Force (Circa 2007)	Future Possibilities
	Weapons Capability		
Short Range (Less than 10 miles)	Unguided (Laser-guided bombs on B-52s only)	Accurate GPS-Aided Munitions (JDAM, WCMD)	Improved Accuracy and More Effective Munitions
Short-to-Medium Range (40 to 100 miles)	Limited (Have Nap on fewer than 20 B-52s)	Accurate GPS-Aided Glide Bomb (JSOW)	Improved Accuracy and More Effective Munitions
Medium Range (100 to 300 miles)	None	Precision Cruise Missile (TSSAM follow-on)	Improved Accuracy and More Effective Munitions
Long Range (More than 300 miles)	CALCM (Limited inventory, B-52s only)	No Change	New Long-Range Missile
	Mission Planning		
In-Flight Route, Mission, and Target Changes	Very Limited Changes	Limited Changes	Real-Time Changes
Tactical Communications	Limited Voice and Data	Some Jam-Resistant Voice and Data	Full Range of Tactical Communications
In-Flight Updates About Threats	None	Limited (Voice only)	Real-Time Data

SOURCE: Congressional Budget Office.

NOTES: GPS = Global Positioning System; JDAM = Joint Direct Attack Munition; WCMD = Wind-Corrected Munitions Dispenser; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile; CALCM = Conventional Air-Launched Cruise Missile.

Moreover, the unguided conventional weapons that have been available to bombers to date are too inaccurate to be effective against many types of targets. And because the utility of the bombers for conventional warfare has been limited, the Air Force has not invested heavily in equipping them for such missions. Unguided bombs are accurate to no more than 400 feet when dropped from high altitude, so it takes many of them to ensure that a building, bridge, or tank is destroyed. In fact, destroying some types of targets with those weapons is almost impossible. During World War II, large numbers of bombers were needed to deliver the hundreds of tons of bombs required to destroy critical targets in Germany. During the Persian Gulf War, aircraft with precision weapons--not bombers--were dispatched to destroy hardened targets. Roughly 40 B-52Gs dropped bombs on relatively soft vulnerable targets such as oil refineries and Iraqi ground forces. They were the only bombers sufficiently equipped to participate in the war.

ELIMINATING THE SHORTCOMINGS OF THE FORCE

The Air Force's Bomber Roadmap, which was completed in 1992, lays out a plan for modernizing the bomber force, developing new munitions, and integrating them with the bombers (see Table 1). It focuses on adding the capability of delivering a variety of unguided and new guided weapons that use the Global Positioning System (GPS) to find their way to their targets. (See Box 1 for a glossary of common terms that are used throughout this paper.) Included are the short-range Joint Direct Attack Munition (JDAM) unitary bombs for attacking "hard" targets such as bridges and bunkers and the Wind-Corrected Munitions Dispenser (WCMD) cluster bombs for attacking "softer" area targets such as troops and vehicles. The Roadmap would also add longer-range GPS-aided arms such as the Joint Standoff Weapon (JSOW). Taken together, these weapons would allow the bombers to attack fixed and moving targets accurately from a variety of distances, although the Air Force must improve the bombers' mission-planning systems in order to take full advantage of the capability that those new weapons offer.

The new generation of accurate weapons under development has the potential to overcome the previous ineffectiveness of high-altitude bombing. The new weapons would be guided to their targets by GPS-aided inertial navigation systems that would enable them to strike within a few tens of feet of their intended targets. They would also be autonomous, meaning that the bomber crew would not have to guide them to the targets but could quickly turn their attention to other targets after launching each weapon. In addition, those weapons would be able to function in adverse weather because they use GPS to navigate and do not rely on sensors to look for the target. Moreover, technical advances should make these weapons relatively inexpensive--a few tens or hundreds of thousands of dollars each, rather than several

BOX 1.
GLOSSARY OF COMMON BOMBER TERMS

AGM:	Air-to-ground missile.
BAT:	Brilliant Anti-Tank Weapon. An antiarmor submunition that searches for the sound of a tank.
BUR:	Bottom-Up Review. The Administration's guide for defense planning.
Bus:	A series of cables for transmitting information from a bomber's computers to its weapons. The point of connection between the cable and a weapon is called an interface.
CALCM:	Conventional Air-Launched Cruise Missile. A conventional version of the nuclear air-launched cruise missile that travels several hundred miles.
CBU:	Cluster bomb unit. Designation for a cluster bomb, a weapon that dispenses bomblets to destroy "soft" targets that are spread out and vulnerable to relatively small explosions.
CEM:	Combined Effects Munition. A cluster bomb for destroying soft targets.
CMUP:	Conventional Munitions Upgrade Program for the B-1 bomber.
ECM:	Electronic countermeasures. Bombers use them to protect themselves against missiles from enemy ground-based air defenses and fighter aircraft.
GAM:	GPS-Aided Munition. A weapon bought in very small quantities to provide an early, accurate weapon for the B-2.
GATS:	GPS-Aided Targeting System on the B-2 bomber.
GPS:	Global Positioning System of 24 satellites providing accurate worldwide navigation in three dimensions.
IADS:	Integrated Air Defense System.
JDAM:	Joint Direct Attack Munition. Adds GPS-aided guidance to 2,000-pound unguided bombs in order to make them accurate to within 40 feet.
JSOW:	Joint Standoff Weapon. An unpowered bomb that glides on small wings for up to 45 miles when launched by a bomber from high altitudes.
JSTARS:	Joint Strategic Targeting and Reconnaissance System. An airborne radar that tracks and targets enemy ground forces.
Mk-82:	Mark 82. A 500-pound unguided bomb.
Mk-84:	Mark 84. A 2,000-pound unguided bomb.
PGM:	Precision-guided munition.
SAM:	Surface-to-air missile. One of the most potent types of air defense.
SLAM:	Standoff Land Attack Missile. A Navy medium-range weapon.
Standoff:	Standoff weapons allow aircraft to attack targets safely out of range of enemy surface-to-air missiles.
TSSAM:	Tri-Service Standoff Attack Missile. A medium-range cruise missile that was canceled in February 1995 before it was fully developed because of technical problems and rising costs.
WCMD:	Wind-Corrected Munitions Dispenser. A guidance kit that will improve the accuracy of cluster bombs to within 100 feet.

hundreds of thousands or even millions. As a result, bombers would be able to deliver relatively large numbers of accurate, inexpensive weapons from high altitudes and in any type of weather, which would greatly increase the aircraft's combat power.

There is an important caveat regarding the effectiveness of GPS-aided weapons. Some critics worry that an opponent could delay the weapons' access to GPS signals in flight by jamming the relatively weak signals coming from the GPS satellites. DoD is examining both the severity of this potential threat and possible countermeasures. In addition, all of the new weapons will have inertial navigation systems that will provide much more accuracy than unguided weapons, although probably not as much as could be provided by an uncluttered GPS signal.

In addition to developing tactical munitions, the Air Force is working to improve the ability of the bomber force to function in a tactical environment. It plans to upgrade the B-1's electronic countermeasures system so that the bomber can protect itself from threats it is likely to encounter in regional conflicts. The service will also install special radios that will allow the bombers to communicate with command authorities and other forces in the theater. The Administration's modernization plan, however, forgoes other upgrades of mission-planning systems, such as giving the bombers the capacity to receive updated intelligence about threats while they are in flight and to retarget their weapons easily. The result is that the bombers' ability to attack advancing armies, avoid unexpected threats, and change targets would be limited.

But improvements in the bomber force cannot be fully exploited if DoD and the intelligence community do not provide the necessary intelligence to theater commanders and decisionmakers about opponents before and during a conflict. Intelligence before the Persian Gulf War about Iraqi forces, tactics, and production facilities for chemical, nuclear and biological weapons was not as good as it could have been. The coalition forces had months to recover after the Iraqi invasion and before the beginning of the air war, but the next conflict may not afford such an opportunity. And after the war started, some important intelligence information reached commanders in Saudi Arabia too slowly for maximum effect.

Obtaining good and timely intelligence about an opponent--what the military calls the intelligence preparation of the battlefield--will be critical if the United States is to use its upgraded bomber force to its full potential during a major conflict. Building up the proper networks of people, collection technologies, and dissemination systems could take years, particularly in situations in which the anticipated opponent has a closed society such as North Korea's. Information about how well those activities are progressing is not publicly available, but correcting any shortfalls could well be more important than most improvements to the bomber force.

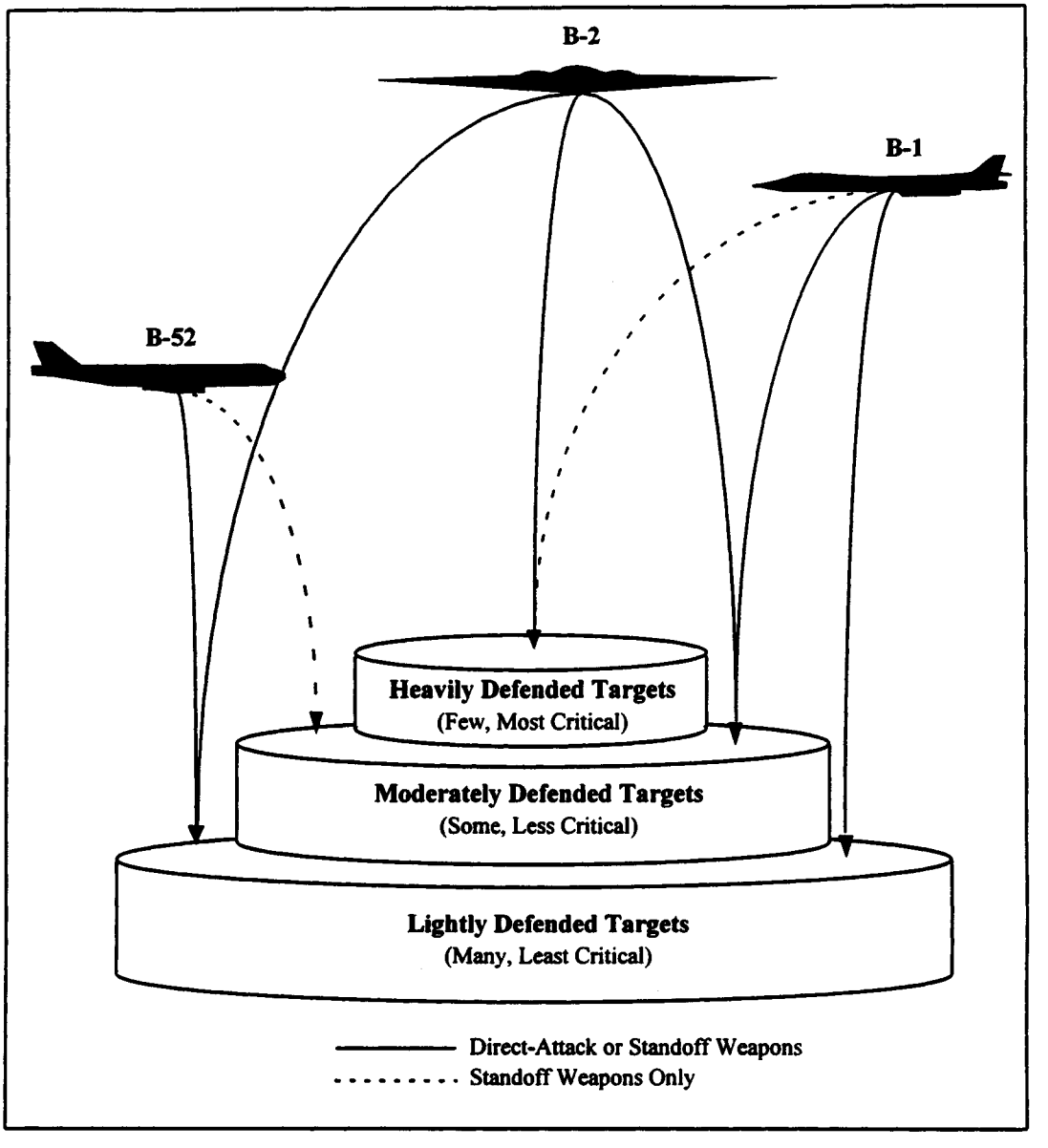
HOW THE BOMBERS WOULD BE USED

Each type of bomber would play somewhat specialized roles in future conflicts, according to Pentagon plans, and those roles would change as the conflict unfolded. According to the Bomber Roadmap and the Bottom-Up Review (BUR)--the Clinton Administration's plan for the military--the bombers would be important in achieving all of the goals of the first phase of the conflict: halting the enemy's advance; suppressing its air defenses; destroying its air force; attacking its critical command, control, and communications centers; and impairing its ability to assemble or use weapons of mass destruction. By closely coordinating the way in which the bombers are employed with tactical aircraft or by themselves if necessary, and using each type to its best advantage, the Air Force can maximize the capability of the entire bomber fleet (see Figure 1).

Initially, the bombers would fly missions from their bases in the United States, unless they were deployed to a theater in response to a warning of an impending conflict. But the distances from U.S. bases are great (up to 8,000 miles, or approximately 12,800 kilometers) and flying time is long (up to 36 hours). Under those conditions, a bomber cannot fly more than one mission every two and a half to three days. Furthermore, such long-range missions are hard on flight crews, and a few weeks of such intense operations would wear out all the available personnel. Thus, although bombers can fly missions directly from the United States, it is difficult to sustain such operations for long periods.

After about five days, some of the bombers could begin to operate out of bases within a few thousand miles of the combat theater. There, they would spend less time flying to and from the targets and could increase their number of daily missions. But how quickly the bombers would actually be deployed to forward bases and how many bombers would be deployed would depend on the priority that the theater commander gave to allocating precious airlift assets to haul the people, equipment, and spare parts necessary to support the aircraft at their forward bases. It would also depend on how well-prepared the bases were to receive the bombers and provide them with the required facilities, fuel, and munitions. For example, in an unexpected conflict in which the United States had no forces in the theater, a commander would probably dedicate his available airlift to transporting short-range (tactical) aircraft and troops. Tactical aircraft can perform many tasks. They can engage enemy fighters, strike fixed and mobile targets on the ground, and impede the operations of or destroy enemy air defenses. Since bombers can fly combat missions from the United States, a commander may opt to use them in that way until he has enough tactical aircraft in place.

FIGURE 1. ROLES ESTABLISHED IN THE BOMBER ROADMAP



SOURCE: Department of the Air Force, *Enhancing the Nation's Conventional Bomber Force: The Bomber Roadmap* (June 1992).

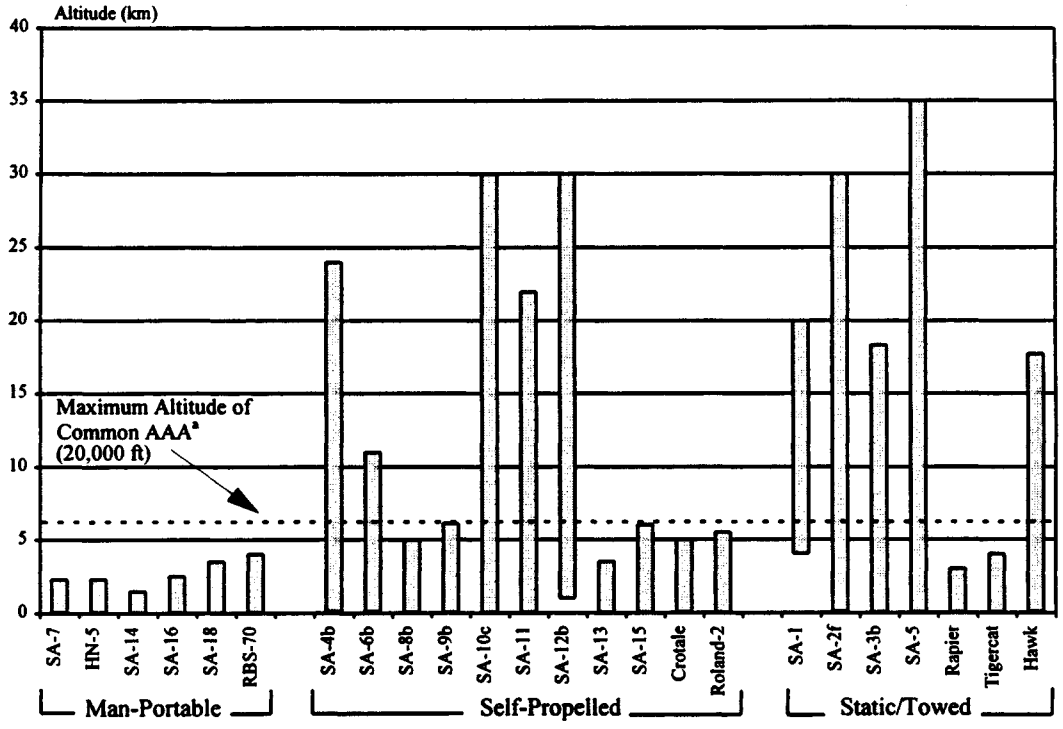
NOTE: After the Air Force has completed its modernization program, it expects each bomber to play specific roles in a regional conflict. The B-2 will be able to attack lightly, moderately, and some heavily defended targets with direct-attack (short-range) weapons such as the Joint Direct Attack Munition. It will use standoff weapons such as the Joint Standoff Weapon (JSOW) and the Tri-Service Standoff Attack Missile (TSSAM) follow-on to attack the most heavily defended targets, including the surface-to-air missiles themselves. The B-1 will attack lightly and most moderately defended targets with direct-attack weapons and use standoff weapons against heavily defended and some moderately defended targets. The B-52 will only be able to attack lightly defended targets with direct-attack weapons. It will attack others with standoff weapons, including JSOW, TSSAM follow-on, and the long-range Conventional Air-Launched Cruise Missile (CALCM).

B-2 Missions

The B-2 stealth bomber is expected to be able to attack many targets with short-range (or so-called direct-attack) munitions because it would be able to thread its way through an enemy's integrated air defenses without being seen. The bombers would probably fly at altitudes greater than 20,000 feet to stay above the range of shoulder-fired surface-to-air missiles (SAMs) and anti-aircraft guns (see Figure 2).

At those altitudes, the B-2s would rely on their stealth characteristics to penetrate the enemy's defenses and evade enemy fighters. Stealth reduces the ranges at which the bomber can be seen by radar and other sensors, thereby opening gaps in defenses through which the bomber can pass (see Figure 3).

FIGURE 2. OPERATING ALTITUDES OF LIKELY ENEMY SAMs

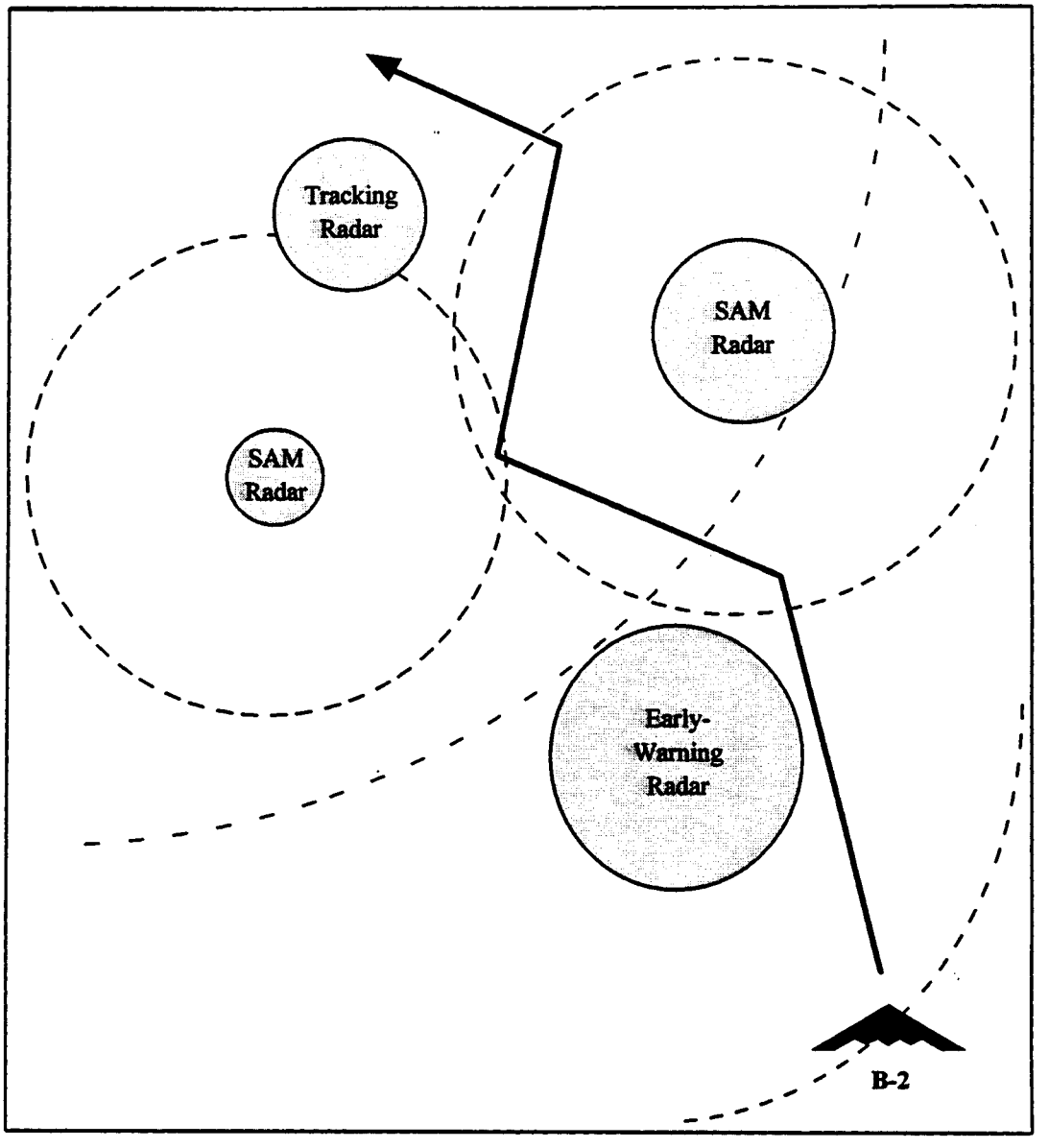


SOURCE: Congressional Budget Office using data from Tony Cullen and Christopher F. Foss, eds., *Jane's Land Based Air Defence* (Surrey, U.K.: Jane's Information Group, 1994).

NOTE: SAM = surface-to-air missile; AAA = antiaircraft artillery; SA = designation used by the United States for surface-to-air missiles built by Russia.

a. There are a few old antiaircraft guns that have maximum altitudes as high as 14 kilometers (45,000 feet). However, they do not pose a significant threat because they fire one shell at a time and are inaccurate at high altitudes.

FIGURE 3. HOW THE B-2 PENETRATES AIR DEFENSES



SOURCE: Congressional Budget Office.

NOTE: The bomber's shape and radar-absorbant coatings reduce the effective ranges of early-warning, tracking, and SAM radars, which create gaps in the integrated air defense system. Good intelligence about the enemy's air defenses and detailed mission planning are necessary for the B-2 to penetrate heavily defended areas. SAM = surface-to-air missile.

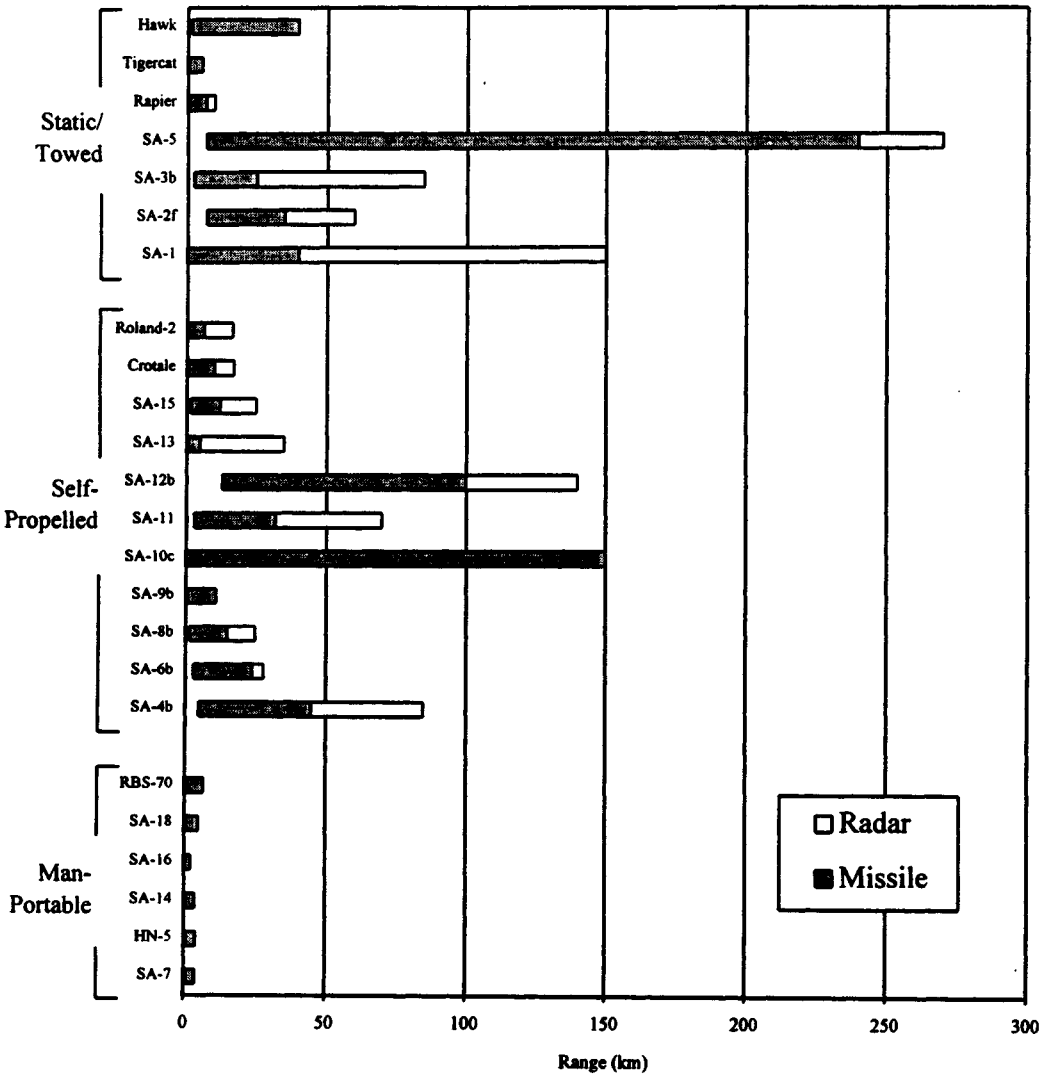
The B-2 would not be invisible, however. It is difficult but not impossible to see. Enemy fighters can see it during daylight in some circumstances, so it will probably operate mostly at night, much like the F-117 stealth fighters did during the Persian Gulf War. The bomber is also more visible from some angles than others. Thus, it relies heavily on mission planning and good intelligence about the locations and capabilities of enemy air defenses to ensure that it keeps its most observable aspects pointed away from enemy radar as much as possible. Finally, enemy radar can detect the B-2 if it comes too close. But those targets can be attacked with medium-range standoff weapons (those with ranges of about 50 to 100 kilometers) or with non-stealth bombers carrying longer-range standoff weapons.

During the very early stages of a conflict, the B-2 would attack the most heavily defended targets, such as command and control centers and production and storage facilities for weapons of mass destruction. In addition, the B-2 would focus at least some of its attention on suppressing enemy air defenses, especially if no other forces capable of doing so were available in the theater. By attacking the key points of the enemy's integrated air defense--such as command centers, early-warning and surveillance radars, and SAM systems--the B-2s would enable the more observable B-1Bs and B-52s to penetrate what was left of the defenses and attack enemy ground forces, airfields, bridges, and other important targets with short-range weapons. The advantage of such munitions is that they are significantly less expensive and smaller than standoff weapons. If a bomber can get close enough to use them (they have ranges of about 10 to 15 kilometers when dropped from high altitudes), it can deliver a large number of weapons. Such an intense attack can be devastating against an airfield, production facility, or armored division advancing down a road. Carrying a large number of weapons--at least three to four times more than most short-range ground-attack fighters can carry--would also allow the bombers to attack several different targets during one mission.

B-1 Missions

The B-1 would be able to carry about the same number of weapons as the B-2, but more types of smart weapons. It is more detectable than the B-2, but after its electronic self-protection system has been improved, the Air Force expects the bomber to be able to penetrate all but the most heavily defended areas and to destroy the bulk of the defended, time-critical targets. The B-1 would probably concentrate on such critical targets as airfields, advancing armies, and points that tend to restrict troop movements--so-called choke points--during the early days of the war. It would use its direct-attack weapons against moderately and lightly defended targets. Against targets protected by defenses that were too strong for it to penetrate, the B-1 would use longer-range weapons (see Figure 4).

FIGURE 4. RANGES OF LIKELY ENEMY SAMs AND THEIR ASSOCIATED ENGAGEMENT RADARS



SOURCE: Congressional Budget Office using data from Tony Cullen and Christopher F. Foss, eds., *Jane's Land Based Air Defence* (Surrey, U.K.: Jane's Information Group, 1994).

NOTE: SAM = surface-to-air missile; SA = designation used by the United States for surface-to-air missiles built by Russia.

B-52 Missions

Because it is more vulnerable to air defenses than the B-1 (it shows up more easily on radar and lacks the B-1's speed), the B-52 probably would be restricted to launching long-range cruise missiles at fixed targets during the initial days of the conflict, safely beyond the reach of long-range SAMs and enemy fighter aircraft. The likely targets of those early attacks would be fixed SAM sites; critical command, control, and communications centers; and storage and production sites for chemical, biological, and nuclear weapons and the missiles that might be used to deliver them. As attacks by tactical aircraft and bombers eroded the effectiveness of enemy air defenses during the first days of the conflict, B-52s would begin to deliver medium-range standoff weapons and then direct-attack munitions safely from high altitudes.

Tactical Aircraft

Other assets such as shorter-range Navy, Air Force, and allied aircraft would be used in a conflict as soon as they were available. Some fighters are configured to destroy enemy air defenses. Others could provide support for bombers and short-range strike aircraft by jamming the radar of key SAMs or protecting U.S. aircraft from enemy fighters. Still others are more effective than bombers for delivering certain types of precise weapons.

The location and timing of the conflict would determine how soon tactical aircraft and other assets would be available. In many cases, some of those aircraft would be available before the bombers because they would already be deployed in the region, either permanently or in anticipation of the conflict. At the beginning of a future surprise attack in the Persian Gulf, few U.S. forces might be present, although approximately one wing of U.S. fighters will be on hand until the United Nations stops enforcing its no-fly zone in Iraq. More than 100 modern Saudi fighters would also be present. Other U.S. tactical aircraft and ground and naval forces would be deployed as quickly as possible to the theater. Equipment that the United States has stockpiled near the theater would allow those forces to deploy more rapidly than they have in the past, but if a conflict occurred without warning, U.S. forces from outside the region probably would not start arriving in quantity until the fifth day, and the bulk of the force might not be deployed for several weeks.

In a theater such as Korea, bombers would be less critical, but still important. South Korea has a large, modern military establishment; the United States also has an Army division and a fighter wing in Korea and has an aircraft carrier and a Marine brigade based in nearby Japan. The mountainous terrain in much of South Korea might make an armored invasion somewhat easier to stop than in the deserts of the

Arabian Peninsula. But U.S. and South Korean forces might need reinforcements to slow a full-scale invasion. The first reinforcements would take several days to arrive from the United States. In both scenarios, bombers flying from the United States could provide combat power while other forces were transported to the theater.

During the later phases of a war, bombers would complement the tactical air, ground, and naval forces that had been deployed to the region. Bombers would also play a very important role if a second conflict broke out while the first was still under way. According to DoD policy, a portion of the bomber force would swing to the second conflict immediately, working to halt the invasion until U.S. forces could be deployed to the theater.

IS DoD'S VISION FOR THE BOMBERS REALISTIC?

Will the modernized bomber force be able to conduct the missions that the BUR and Bomber Roadmap ask of it? Will there be enough bombers to do the job? Will the modernization be completed in time to meet future threats?

There are reasons to believe that the modernized bomber force would be sufficient, both in the short and long term, to perform the mission asked of it by the BUR and the Bomber Roadmap. First, a recent study requested by the Congress and conducted by the Institute for Defense Analyses (IDA) concluded that the planned force would be able to meet the demands of the BUR strategy.[1] The force could fight two nearly simultaneous major regional conflicts over a range of different conditions, provided that the planned upgrades to the bombers and weapons modernization were fully funded. Another study by the STR Corporation came to a similar conclusion.[2]

Second, the BUR may overstate the threats that the United States will face in the future. Some critics argue that two major regional conflicts occurring nearly simultaneously is unrealistic. Very few regional powers have the resources to launch an invasion of the size mounted by Iraq in 1990. And the United States would rise to the defense of few nations in the newly industrialized or developing worlds. Indeed, the United States has fought only three large conflicts since 1945. Thus, these observers contend, there are two realistic threats: a war in the Persian Gulf region and a war on the Korean peninsula. And in Korea, bombers would probably not be as critical as they would be in the deserts of the Arabian Peninsula.

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1. Institute for Defense Analyses, *FY 1995 Heavy Bomber Force Study* (Alexandria, Va.: IDA, May 1995).

2. Testimony of W. Leon Goodson, STR Corporation, titled "Effectiveness of Heavy Bombers in Major Regional Conflict," before the Senate Committee on Armed Services, Subcommittee on Strategic Forces, May 18, 1995.

In addition, some critics contend that the BUR overestimated the forces that the United States would require because a regional power would probably be no match for the military might of the United States. In fact, the total annual economic output of North Korea, Iraq, or Iran is less than the annual budget of the U.S. Air Force. Far more common in the future, as they have been in the past, will be small crises, ethnic conflicts, and peacekeeping operations for which bombers are ill-suited or large numbers of them are unnecessary.

Third, some analysts believe that a large armored invasion may be the wrong type of conflict for which to plan. In their view, potential adversaries have learned from Iraq's experience that it would be foolhardy to engage the U.S. military directly. Future opponents are much more likely to develop strategies that will keep the United States from joining the conflict, these critics argue. The aggressor might coerce the United States' ally not to seek American help by threatening to use nuclear, chemical, or biological weapons against cities. Or it might try to convince the Congress and the President to shy away from involvement by threatening to use those weapons against U.S. troops.

The solutions open to the United States in such situations would be limited. It could try to destroy preemptively the adversary's production and storage facilities for weapons of mass destruction or its ability to deliver them. The United States could also call the aggressor's bluff and build up forces in the region. Since those types of actions would not require a large number of bombers, these critics contend that additional money would be better spent developing the mechanisms to limit proliferation and developing technologies for detecting such weapons programs and, if necessary, destroying the facilities associated with them.

Fourth, the planned bomber force may be adequate in the short term because the threats of a conflict are lower in the two most likely regions than they have been in the past. Iraq is far weaker now than it was in 1990, and Iran is still struggling with a troubled economy. Tensions on the Korean peninsula, while still high, have eased for the moment because the United States and North Korea recently reached an agreement about plutonium production. In several years, after the oil embargo is lifted and Iraq has had time to build up its military establishment again, the challenges for U.S. forces may be greater, but so will the capability of the bomber force. The pace of the planned modernizations may thus be acceptable. Although the last of the upgrades will not be complete until 2007, all three types of bombers will be able to carry at least one type of new GPS-aided weapon by 2001, and the B-2 will carry the JDAM by 1999.

Fifth, there are limits to what bombers can do. Although they offer great potential as quick-response forces, they are not a panacea that would make all other

forces obsolete. For example, bombers would have difficultly finding an advancing army unless they were fed data from off-board sensors about where to look. And unless the United States had some measure of air superiority, it would not bring such airborne sensors as JSTARS close to the conflict. Bombers are not capable of engaging enemy fighters. Moreover, if the bombers operated from the United States, they would not be able to fly many sorties against targets halfway across the world. And even if they operated from bases closer to the conflict, it would still take time to fly to the target area, attack targets, return, and prepare for the next mission. Bombers also lack some of the tools, such as antiradar missiles, jammers, and drones that create false targets, required to suppress enemy air defenses. For all those reasons, spending more on bombers at the expense of other military forces may be unwise.

Nevertheless, critics point to several shortcomings in DoD's plans for the bomber force. First, some argue that the planned force would be smaller than that called for by the BUR. The Air Force plans to keep a total of 181 bombers--of which 154 will be operational--in its inventory beyond 2001. Critics charge, however, that the BUR called for 184 operational bombers. And, although Administration officials have maintained that the BUR number refers to total inventory, at least one military commander has sided with the critics.[3] An opposing force could attack tactical airfields and ports with nuclear, chemical, or biological weapons, thereby forcing the United States to rely more on bombers and naval assets. Although the IDA study supported the Administration's position, it revealed that additional B-2s--albeit a large number of them--would be useful for scenarios in which tactical aviation was unable to deploy to a conflict for several weeks because of enemy attacks on airfields. Some critics have also expressed concerns that there would not be enough bombers to compensate for losses that might occur over the years.

Second, some have expressed concern about the capability of the bomber force in the short term. The modernization program will not be complete until 2007. Neither will large inventories of GPS-aided weapons be realized until then. And the Air Force will have fewer bombers over the next several years because it will operate only 60 B-1s and will not have a force of 20 B-2s until 2001.

Third, critics have raised questions about the capability of the bombers themselves.[4] For example, even though the Air Force will equip the bombers with cluster munitions, it will not perform all of the modifications that would enable the

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3. See the testimony of General John M. Loh, head of the Air Combat Command, before the Senate Committee on Armed Services, Subcommittee on Strategic Forces, May 18, 1995.

4 See, for example, the testimony of Glen C. Buchan and David R. Frelinger, RAND, titled "Providing an Effective Bomber Force for the Future," before the Senate Committee on Armed Services, May 5, 1994.

bombers to find and attack mobile targets. The bombers still will not easily be able to reprogram the weapons for different targets during flight, and the B-1B will not have the ability to use its radar to identify different types of targets. Also, unlike the other two bombers, the B-2 is not scheduled to carry the WCMD, which would make it more effective at halting advancing armies--a mission that the B-2 could be asked to perform in some scenarios. Studies by RAND indicate that upgrades to the bomber force would pay sizeable dividends.[5]

CAN DoD AFFORD TO IMPROVE THE BOMBER FORCE?

The Congressional Budget Office has analyzed the effects on costs and capabilities of several alternatives that would address some of the concerns raised by critics. When considering those alternatives, however, one should be aware that the Air Force believes any extra money would be better spent on tactical aircraft, airlift capabilities, and a replacement for the recently canceled Tri-Service Standoff Attack Missile. Furthermore, the IDA study and most other analyses show that although properly equipped bombers are important, tactical aviation and other forces would contribute significantly to the outcome of a conflict.

In fact, improvements in the bomber force would come at the expense of other things such as ground forces or shorter-range tactical aviation. Although the Congress may increase defense spending over the next five years, those extra funds will most likely dry up starting in 2001. If the Congress follows through with its plans to balance the budget by 2002, the defense budget will probably be lower than Pentagon projections for 2001 and the years beyond. In that case, any additional money spent on bombers after 2001 would have to be taken from other programs or other accounts such as training.

LIMITATIONS OF THIS ANALYSIS

This paper is part of a larger effort that aims to examine the strike assets--forces that can attack critical targets deep inside an enemy's territory--of all the services. It focuses only on enhancements to the bomber force to illustrate that there are a wide range of options. And those options have varying effects on costs and capabilities. Therefore, this study should be used only to compare bomber options with each other and not bombers with other forces.

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5. See Buchan and Frelinger, "Providing an Effective Bomber Force for the Future."

CHAPTER II

BUILDING THE FUTURE CONVENTIONAL BOMBER FORCE: THE ADMINISTRATION'S PLAN

The Administration plans to build a bomber force that will be capable of delivering a wide variety of accurate weapons in future major regional conflicts (MRCs). But today's force is inadequate to perform the missions that would be expected of it in the future. How does the Air Force plan to upgrade its bombers and munitions inventories to meet the demands placed on it by the national military strategy? When will those upgrades be complete and how much will they cost?

BACKGROUND

In the wake of the Persian Gulf War, the Air Force developed a plan for creating a more capable conventional bomber force from an inventory that had been designed for nuclear missions. Called the Bomber Roadmap and completed in June 1992, the plan established roles for each type of bomber, described new types of accurate munitions that were required, and outlined the modifications needed to make the aircraft better able to perform conventional missions. It also established schedules and costs for developing the weapons and modifying the bombers. According to the Roadmap, the modified bombers would provide a critical capability during the early stages of a regional conflict because they would be able to fly from the United States to strike targets before other reinforcements from the United States could arrive in the theater.

The Bottom-Up Review--the Clinton Administration's blueprint for defense--reaffirmed the basic tenets of the Roadmap, but smaller defense budgets have somewhat delayed carrying out the plan. Finally, the Nuclear Posture Review--the Department of Defense's plan for nuclear forces under the second Strategic Arms Reduction Treaty (START II)--established a minimum B-52H force of 66, a reduction from the original Roadmap inventory of 94.

The Size of the Bomber Force

The Air Force plans to have an inventory of 181 bombers by 2001: 20 B-2s, 95 B-1Bs, and 66 B-52Hs (see Table 2). Approximately 154 of those, including 16 B-2s, 82 B-1Bs, and 56 B-52Hs, will be funded to fly--so-called primary authorized

TABLE 2. PLANNED BOMBER INVENTORY, 1995-2001

Bomber	1995	1996	1997	1998	1999	2000	2001 and Beyond
			Total Inventory				
B-2	7	12	13	16	17	20	20
B-1B	95	95	95	95	95	95	95
B-52H	94	66	66	66	66	66	66
Total	196	173	174	177	178	181	181
			Operational Inventory[a]				
B-2	6	8	10	11	13	16	16
B-1B	60	60	60	60	60	60	82
B-52H	74	56	56	56	56	56	56
Total	140	124	126	127	129	132	154

SOURCE: Congressional Budget Office based on data from the Department of Defense and the Northrop Grumman Corporation.

a. Operational inventory refers to aircraft that are funded to fly. These are also called primary authorized aircraft (PAA), which include both aircraft that are combat-capable and those designated for training.

aircraft.[1] The bombers not funded for flying represent an allowance for those in depots or dedicated to testing.

In the short term, however, the force will be smaller. For example, by 1996 only 12 B-2s will have been delivered to the Air Force, eight of which will be operational. In addition, the service plans to fund enough flying hours and flight crews for only 60 B-1Bs. Although it still plans to fly all 82 B-1s, it will fly each of them less so that the total number of flying hours in 1996 will be the same as if 60 aircraft were flown for their full number of hours. The Air Force uses the term "reconstitution reserve" to describe this concept. Twenty-two aircraft will be assigned to that reserve, although all 82 bombers will rotate through it. The measure will allow the Air Force to save money in the short run while the bombers are still being modified for conventional missions and while the new generation of accurate

1. DoD has started to use a slightly different term, primary authorized inventory (PAI), for PAA. The Congressional Budget Office uses PAA because it is more widely recognized.

munitions is being developed. It will also allow the service to reduce the number of flight crews until all 82 bombers are operational again in 2001. In another effort to reduce costs, the Air Force is transferring two squadrons of B-1s (for a total of 18 aircraft) and one squadron of B-52Hs (eight aircraft) to the Air National Guard and Air Force Reserve, respectively.

Some people have criticized the Air Force for its reconstitution reserve concept and for delays in its bomber modernization program. But the service defends them as reasonable approaches to saving money in the current era of tight budgets. In addition, it may be acceptable to operate fewer bombers during the next few years, when Iraq and Iran are still relatively weak.

Others have criticized DoD's plans for modernizing bombers and munitions, arguing that those plans do not adequately address the requirements of the national military strategy. Such critiques take two forms. First, some contend that the number of bombers is inadequate to conduct two nearly simultaneous MRCs as stipulated in the BUR. Proposed solutions range from buying more B-2 bombers to keeping more than 66 B-52s in the force. Some proponents of the bomber force are also concerned that the United States is retiring its B-52s too quickly because Russia is behind the United States in reducing its nuclear forces to levels specified in the first START treaty.

Second, others argue that the modernization program is emphasizing the wrong things. For example, if one role of the bomber force is to halt an armored invasion, why is the B-2 not scheduled to carry GPS-aided cluster munitions?

DEVELOPING SMART WEAPONS

The goal of DoD's plan for modernizing its weapons has been to develop inexpensive, accurate, all-weather munitions that take advantage of the technical revolutions in Global Positioning System navigation and miniaturization. Those technologies will permit DoD to develop inexpensive guidance systems that will significantly improve the accuracy of air-delivered munitions for all ground-attack aircraft, not just bombers.

The need for accurate, all-weather munitions emerged from the U.S. experience during the Persian Gulf War. For much of the war, widely dispersed Iraqi shoulder-fired surface-to-air missiles and antiaircraft artillery forced most coalition aircraft to operate at altitudes above 15,000 feet--beyond the reach of those difficult-to-suppress systems (see Figure 2). But such operation reduced the accuracy of the unguided weapons that the aircraft dropped from those heights, since the long

exposure to winds during freefall significantly degrades the accuracy of the bombs. In addition, poor weather sometimes made it difficult to use precision weapons such as laser- and TV-guided bombs because their sensors do not work well in rain or through clouds. Allied forces had to cancel numerous missions during the Persian Gulf War because the weather would not permit those terminally guided weapons to be used.

Better accuracy will reduce the number of weapons required and thus reduce both the number of aircraft needed for a given task and the air and sealift needed to transport munitions to the theater. More accurate weapons will enable bombers to play an important role in a conflict because they can be delivered effectively from altitudes above the reach of infrared SAMs and air-defense artillery.

Improved accuracy is not guaranteed for all weapons equipped with GPS-aided guidance. The relatively weak signals from GPS satellites make it possible, in theory, for an opponent to deny GPS-aided weapons access to the signal with inexpensive jammers. DoD is examining both the seriousness of this potential threat and possible countermeasures. But all the new weapons will have inertial navigation systems that are immune to jamming and will provide much more accuracy than unguided weapons, but perhaps not as much accuracy as an uncluttered GPS signal.

Furthermore, the new weapons will be autonomous, which means that once they are released, they will guide themselves to the target without any help from crews on the bombers. The bombers thus will be freed to attack other targets and get away quickly. Autonomous weapons also make it possible for a bomber to drop large numbers of weapons quickly over a target--a strength that would be nullified if the crews had to guide each weapon to its target. Autonomous weapons thus reduce a bomber crew's workload, freeing them for such tasks as identifying targets. And autonomous weapons can function in all types of weather, which is not true for most types of precision weapons that were used during the Persian Gulf War.

The Administration's Plan for Modern Munitions

The Administration is actively developing the new generation of smart munitions. It plans to have large inventories of them by the middle of the next decade. Some will be precision weapons equipped with guidance devices that can be accurate within just a few feet. Others will, for a relatively low cost, improve the accuracy of gravity weapons to a few tens of feet with GPS-aided inertial navigation--accurate enough to destroy many types of targets efficiently (see Box 2). During the next 20 years, the Air Force will spend $4.8 billion to buy these new weapons--excluding the cost of buying a more accurate version of the Joint Direct Attack Munition and

developing and procuring the Tri-Service Standoff Attack Missile (TSSAM) follow-on weapon, because DoD has not yet established costs for those programs. The new weapons will join several types of precision air-delivered weapons that are already in the inventory and were used during the Persian Gulf War. (See Table 3 for a summary of the capabilities of the new and existing weapons.)

The ABCs of Precision Munitions

Venturing into the world of air-launched precision munitions requires one to traverse a tangled jungle of acronyms. Two basic guides should make the journey easier:

- There are two general types of conventional warheads: unitary warheads (a single explosive, the classic variety of bomb) and cluster bombs (those that dispense submunitions or bomblets).

BOX 2.
HOW DO SMART WEAPONS FIND THEIR TARGETS?

Smart weapons have computers that steer them to targets using one of two techniques: terminal or inertial guidance. Terminal guidance requires a seeker--a sensor that looks for the target. The seeker uses either a radar or optical image of the target (as with TV-guided bombs) or a spot of laser light that is shined on the target by a laser designator from the aircraft or another source. Weapons that use images must also be able to discriminate the target from other objects. Autonomous seekers use a computer for this purpose; man-in-the-loop seekers rely on a human to identify the target and guide the weapon to it. These weapons usually use inertial guidance to get close enough for the terminal guidance system to find the target.

Inertial guidance does not look for the target at all. Instead, it guides the weapon to a point on the ground where it expects the target to be. This requires that the guidance system know exactly where it is when it is launched and exactly where the target is in relation to the launch point. With the GPS-aided navigation systems that the Air Force is installing, bombers will be able to reduce the uncertainty about their location when they launch weapons. The location of a weapon at the time it is launched will be supplied by its host bomber through a cable connected to the bomb. A short-range weapon that is accurate to within 100 feet of its target need only use an inertial navigation system, provided it receives a GPS position update from the bomber just before it is launched. The Wind-Corrected Munitions Dispenser--a smart cluster bomb--will work this way. Inertial navigation systems, however, tend to drift or lose accuracy over time. Short-range unitary weapons such as the Joint Direct Attack Munition, which are designed to be accurate within 40 feet, must have a GPS receiver on board to receive position updates from satellites during their minute-long flight to the target. The computer on the weapon then adjusts course so that the weapon strikes the correct point.

TABLE 3. CAPABILITY AND COST OF PLANNED AND EXISTING WEAPONS

Weapon Name	Designation	Warhead Type	Warhead Weight (pounds)	Maximum Range[a] (kilometers)	Guidance	Accuracy (meters)	Average Unit Procurement Cost[b] (In thousands of 1996 dollars)
JDAM	GBU-29	HE or Penetrator	2,000[c]	15	GPS/INS	13	40
Improved JDAM	GBU-30	HE or Penetrator	2,000	15	GPS/INS with Terminal Seeker	3	N.A.
WCMD	n.a.	Cluster	1,000	13	INS	30	30
JSOW	AGM-154	Cluster	1,000	75	GPS/INS	27	180
TSSAM Follow-on	N.A.	HE or Penetrator	2,000	180+	GPS/INS with Terminal Seeker	3	d
AGM-130	AGM-130	HE or Penetrator	2,000	65	TV or IIR	<3	700
Have Nap	AGM-142	HE	800	80	TV or IIR	<4	700
CALCM	AGM-86C	HE	1,000	2000	GPS/INS with TERCOM	10	290
Tomahawk (Block III)	AGM-109	HE	1,000	2000	GPS/INS with DSMAC	10	2,000

(Continued)

TABLE 3. CONTINUED

Weapon Name	Designation	Warhead Type	Warhead Weight (pounds)	Maximum Range[a] (kilometers)	Guidance	Accuracy (meters)	Average Unit Procurement Cost[b] (In thousands of 1996 dollars)
Mk-82	Mk-82	HE	500	5-10	n.a.	100[c]	1-2
Mk-84	Mk-84	HE	2,000	5-10	n.a.	100[c]	2-5
CEM	CBU-87	Cluster	1,000	5-10	n.a.	100[c]	15
Gator	CBU-89	Cluster Mine	1,000	5-10	n.a.	100[c]	45
SFW	CBU-97	Cluster (antiarmor)	1,000	5-10	n.a.	100[c]	250

SOURCES: Congressional Budget Office based on Air Force data and Forecast International, *Ordnance and Munitions Forecast* (Newton, Conn.: Forecast International, 1994); Steven J. Zaloga, *World Missiles Briefing* (Fairfax, Va.: Teal Group Corporation, 1994); Duncan Lennox, ed., *Jane's Air-Launched Weapons* (Surrey, U.K.: Jane's Information Group, 1994); and Eliot Cohen, *Gulf War Air Power Survey* (Air Force, 1993), vol. IV, part I, p. 248, and vol. V, part I, p. 550.

NOTE: JDAM = Joint Direct Attack Munition; WCMD = Wind-Corrected Munitions Dispenser; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile; AGM = air-to-ground missile; CALCM = Conventional Air-Launched Cruise Missile; GBU = guided bomb unit (designation for laser-guided bombs); HE = high explosive; GPS = Global Positioning System; INS = inertial navigation system; TV = television; IIR = imaging infrared; TERCOM = Terrain Contour Matching; DSMAC = Digital Scene Mapping and Area Correlation terminal guidance; CEM = Combined Effects Munition; SFW = Sensor-Fuzed Weapon; CBU = cluster bomb unit (designation for cluster munitions); N.A. = not available; n.a = not applicable.

a. Range data assume weapon is released at altitudes of at least 25,000 feet.

b. The average unit procurement cost is the total procurement cost of the program divided by the number of units purchased. It excludes research and development costs.

c. For all aircraft except the F-22. For the F-22, JDAM kits would be attached to Mk-83 1,000-pound bombs because the fighter's bomb bay is too small to accommodate larger bombs.

d. The planned cost of the TSSAM Follow-On missile has not yet been determined. At present, the Air Force is looking at a target price of $600,000.

e. Accuracies for unguided weapons assume that they are released at altitudes of at least 25,000 feet.

- The two types of conventional warheads are carried on three types of weapons--gravity bombs, glide bombs, and cruise missiles--which are distinguished by their ranges.

All precision-guided munitions fall into one of those six categories (see Table 4).

In general, unitary warheads are used for attacking fixed, hard targets such as bridges, aircraft shelters, and buildings. Cluster bombs are used for attacking dispersed soft targets such as troops, marshalling yards, broadcast antennas, vehicles, and tanks. At the proper altitude, the submunitions scatter to increase the lethal area of the weapon. Bombs that carry submunitions are often called tactical munitions dispensers.

TABLE 4. TAXONOMY OF CONVENTIONAL MUNITIONS

Weapon	Warhead Type	
	Unitary	Cluster
Gravity Bombs (Range: less than 10 km)	Mk-82, 84 JDAM Laser-Guided Bombs (GBU-10, 12)	CBU-87, 89, 97 WCMD
Glide Bombs (Range: 40 km to 100 km)	Have Nap SLAM AGM-130	JSOW[a]
Cruise Missiles (Range: greater than 100 km)	TSSAM Follow-On[b] Harpoon CALCM	n.a.

SOURCE: Congressional Budget Office.

NOTE: CBU = cluster bomb unit (designation for cluster munitions); JDAM = Joint Direct Attack Munition; WCMD = Wind-Corrected Munitions Dispenser; GBU = guided bomb unit (designation for laser-guided bombs); JSOW = Joint Standoff Weapon; SLAM = Standoff Land Attack Missile; AGM = air-to-ground missile; TSSAM = Tri-Service Standoff Attack Missile; CALCM = Conventional Air-Launched Cruise Missile; n.a. = not applicable.

a. The Navy is also developing a variant of JSOW that has a unitary warhead.

b. TSSAM was canceled by the Department of Defense in February 1995. DoD will develop another missile to take its place, and although the precise configuration of the replacement missile has not been determined, it will probably have a unitary warhead, since the TSSAM variant with cluster munitions was canceled before the entire program.

Unguided gravity bombs are unpowered and have no wings; they simply fall to the ground under the force of gravity, modified by the effects of air resistance and winds. As a result, their ranges are quite short and they are not very accurate, particularly when released by bombers at high altitudes. If an unguided gravity bomb is released at 30,000 feet by an aircraft traveling 450 miles an hour, it will travel a horizontal distance of several miles before it strikes the ground and be accurate to within only several hundred feet. Virtually all of the gravity bombs in the inventory today (several million of them) are unguided. They are similar in many ways to the bombs that Allied bombers dropped on Germany during World War II.

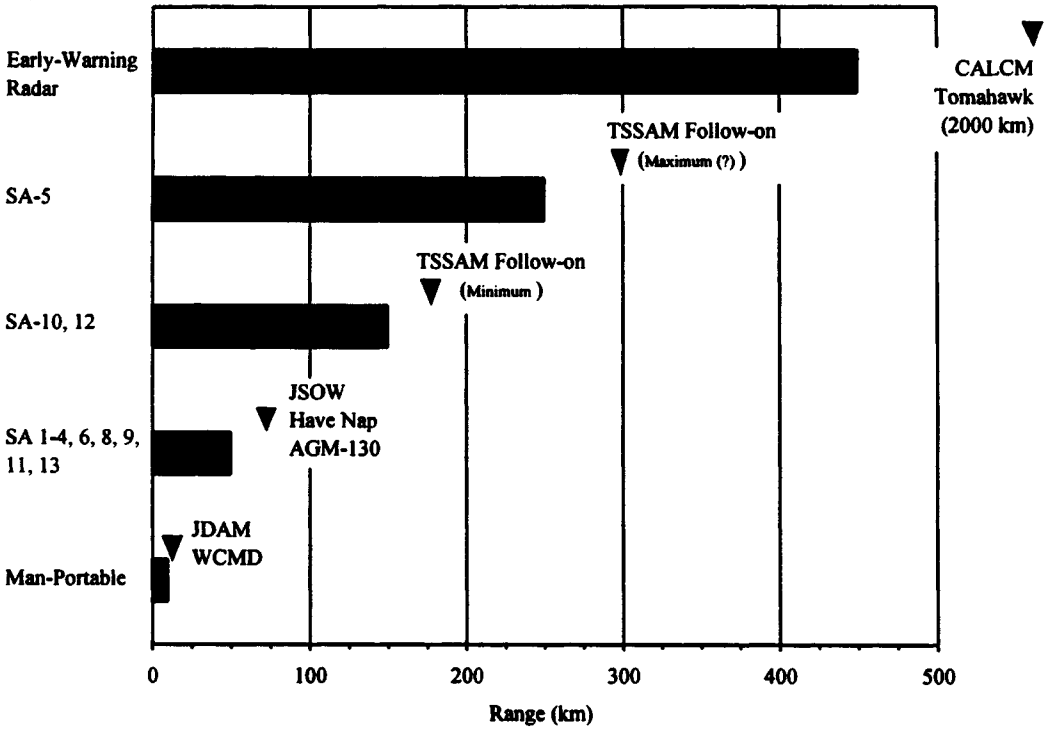
Smart gravity bombs, by contrast, use movable fins to steer themselves to their targets. That allows an increase in the accuracy of a gravity bomb from several hundred feet to a few tens of feet or even a few feet, depending on the capability of its guidance system. The Joint Direct Attack Munition is one example of such a weapon--"direct attack" refers to its short range. The Wind-Corrected Munitions Dispenser is another. Both of those weapons come in kit form and can be applied to existing unguided gravity bombs, thereby keeping costs as low as possible. JDAM kits will be attached to 2,000-pound unitary bombs; WCMD kits will be mounted on cluster bombs.

Glide bombs such as the Joint Standoff Weapon have small wings that allow them to travel much farther than gravity bombs--40 to 75 kilometers compared with 10 kilometers or so when launched at high altitudes. Some glide bombs are powered with small rockets, others are unpowered. They are used when SAMs or enemy fighters make it difficult for a bomber (or fighter) to get close enough to a target to use short-range weapons. The advantage of glide bombs is that they increase the survivability of the host aircraft by keeping it out of harm's way (see Figure 5). Standoff weapons exact a price, however; they are large as well as expensive, which means that each bomber carries fewer of them.

Cruise missiles are designed to fly long ranges (at least several hundred kilometers). At those ranges, bombers can stand off far enough to avoid long-range SAMs and fighters. For example, seven B-52s launched a total of 35 Conventional Air-Launched Cruise Missiles (CALCMs) in the opening hours of the Persian Gulf War, when Iraq's integrated air defenses were still intact. The CALCM's long range (up to 2,000 kilometers) allowed the B-52s to operate at safe distances and to avoid alerting the Iraqis to the impending attack. A cruise missile is essentially a pilotless aircraft powered by a jet engine. Because it has to carry fuel to travel such long distances, it is the largest and most expensive of the three types of conventional weapons that bombers can use, often costing more than $1 million apiece.

JDAM. In many ways the Joint Direct Attack Munition will be the backbone of the Air Force's modern ground-attack munitions inventory. It will be an inexpensive, plentiful, all-weather weapon that will markedly increase the effectiveness of the existing 2,000-pound gravity bombs against hardened fixed targets. JDAM is actually a kit that can be attached to existing Mk-84 general purpose and BLU-109 penetrating 2,000-pound bombs. Using a special adapter, the kit will also be attached to Mk-83 1,000-pound bombs for the F-22 because the bomb bay on that aircraft will be too small to accommodate 2,000-pound bombs. A tail kit will include steerable fins, a GPS receiver and an inertial navigation system. The JDAM kit will also include a set of small, immovable fins called strakelets that attach to the front of the bomb and give the weapon the maneuverability it needs to strike targets from the most effective side or top angle when released from a wide range of altitudes.

FIGURE 5. RANGES OF STANDOFF WEAPONS AND LIKELY ENEMY-HELD SAMs



SOURCE: Congressional Budget Office based on data from the Department of Defense; Tony Cullen and Christopher F. Foss, eds., *Jane's Land Based Air Defence* (Surrey, U.K.: Jane's Information Group, 1994); and Duncan Lennox, ed., *Jane's Air-Launched Weapons* (Surrey, U.K.: Jane's Information Group, 1994).

NOTE: CALCM = Conventional Air-Launched Cruise Missile; TSSAM = Tri-Service Standoff Attack Missile; SA = designation used by the United States for surface-to-air missiles built by Russia; JSOW = Joint Standoff Weapon; AGM = air-to-ground missile; JDAM = Joint Direct Attack Munition; WCMD = Wind-Corrected Munitions Dispenser.

While it is still in the bomber, the weapon can receive GPS position updates from the bomber navigational system through the 1760 interface. When the weapon is released, it will receive the signals from the GPS satellites and glide to its target, using those signals to correct its course. According to the Air Force, JDAM should be accurate to within 13 meters (about 40 feet)--designated as a circular error probable (CEP) of 13 meters--when dropped from high altitudes.[2] That is markedly better than the 100-meter accuracy associated with 2,000-pound gravity bombs released from high altitudes without the kits. Reportedly, JDAM's CEP could be as small as 5 meters if the bomber has an accurate radar, such as the one that will be installed in the B-2, that can eliminate much of the uncertainty about the bomber's position in relation to the target. A similar device is being studied for the B-1B. If the enemy was jamming GPS, however, JDAM would not be as accurate because it would have to rely entirely on its inertial navigation system. According to JDAM specifications, its aim from high altitudes should be off by no more than 30 meters if it was jammed throughout its entire flight to the target.

When released at high altitude (30,000 feet) by a bomber traveling more than 450 miles per hour, JDAM can travel 10 to 15 kilometers (about 5 to 10 miles). The steerable fins allow the weapon to strike a target that is up to several kilometers on either side of the bomber. Thus, the bomber can avoid flying directly toward or over a target where SAMs may be located. The JDAM's maneuverability also allows a bomber to drop weapons in a pattern that is best for each particular target, such as the key points in a large industrial facility or dispersed aircraft shelters and fuel storage tanks on an airfield.

One important feature of JDAM and all of its GPS-aided relations is its ability to function in any weather. Precision weapons such as laser-guided or TV-guided bombs have difficulty operating in clouds or rain. JDAM avoids those problems by not relying on a terminal target seeker. Of course, the penalty for this is that the weapon is less accurate than terminally guided weapons.

The Air Force plans to have 3,200 JDAM kits on hand by 2001 and a total of 62,000 through the end of the program (see Table 5). The first production weapons will be delivered in 1999. The Air Force has budgeted $92 million for JDAM in 1996 and $730 million through 2001 (see Table 6). The total program is expected to cost $2.9 billion. The average cost of procuring each JDAM kit will be about $40,000. The kits will be attached to 2,000-pound gravity bombs shortly before they are loaded onto bombers. Those bombs are already in the inventory and cost nearly $5,000 each, making the total procurement cost of a JDAM weapon about $45,000.

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2. A 13-meter CEP indicates that one-half of the munitions should land within a 13-meter circle around the target.

TABLE 5. THE AIR FORCE'S PLANNED INVENTORIES OF SMART MUNITIONS

Munition	1995	1996	1997	1998	1999	2000	2001	Total Planned Purchase
JDAM[a]	0	0	0	0	430	1,350	3,210	62,000
WCMD	0	0	0	0	216	700	2,560	40,000
JSOW[b]	0	0	0	0	15	75	125	6,000 to 8,000[c]
TSSAM Follow-On	0	0	0	0	N.A.	N.A.	N.A.	1,500 to 5,000[d]
Cluster Bombs								
CBU-97 Sensor-Fuzed Weapon	150	270	620	1,170	1,710	2,550	3,260	5,000
CBU-89 Combined Effects Munition[e]	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
CBU-87 Gator mines[e]	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
CALCM	f	f	f	f	f	f	f	Less than 800[g]
Have Nap	97	111	127	125	123	121	119	149

SOURCE: Congressional Budget Office based on Air Force data.

NOTE: JDAM = Joint Direct Attack Munition; WCMD = Wind-Corrected Munitions Dispenser; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile; CBU = cluster bomb unit (designation for cluster munitions); CALCM = Conventional Air-Launched Cruise Missile; N.A. = not available.

a. Numbers exclude the 12,000 JDAMs that the Navy plans to purchase.

b. Numbers exclude the 8,800 JSOWs that the Navy plans to purchase.

c. The Air Force plans to buy 3,000 baseline JSOWs armed with the Combined Effects Munition and also plans to buy 3,000 to 5,000 missiles armed with the Sensor-Fuzed Weapon.

d. Quantities of the follow-on missile have not yet been determined but will reportedly be between 1,500 and 5,000. The Air Force's planned inventory of TSSAMs was 3,600.

e. Size of the inventory is approximate.

f. The total number of CALCMs available in inventory is classified. An unspecified number of air-launched cruise missiles (ALCMs) were converted before the Persian Gulf War as part of a classified program. During the war, 35 were used. Replacements were purchased in 1993. In 1995, the Congress authorized the Air Force to convert an additional 100 missiles.

g. The Air Force will probably not be able to convert more than 800 ALCMs to conventional missiles unless it reduces its planned arsenal of nuclear cruise missiles under START II.

Improved JDAM. In the 1992 Bomber Roadmap, the Department of Defense discussed plans to develop two more types of JDAM. JDAM II was supposed to be very similar to JDAM I, but affixed to the 500-pound bombs that the Navy uses frequently. The Navy canceled this program for lack of funding. JDAM III--now called the JDAM Product Improvement Program (JDAM PIP)--will use an autonomous terminal seeker to reduce the CEP from 13 meters to 3 meters. Because such accuracy will be required for only a small set of targets and will increase the cost of each weapon, DoD does not intend to buy more than 5,000 of them. Total program costs and quantities are not available. The Air Force intends to start production in 2004.

TABLE 6. FUNDING FOR THE AIR FORCE'S PLANNED WEAPONS PROGRAMS (In millions of 1996 dollars)

	1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
JDAM[a]	90	80	110	90	140	220	730	2,930
WCMD	50	60	30	30	70	70	310	1,250
JSOW[b]	40	20	20	20	20	20	140	640[b]
TSSAM Follow-On	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total	180	160	160	140	230	310	1,180	4,820

SOURCE: Congressional Budget Office.

NOTE: JDAM = Joint Direct Attack Munition; WCMD = Wind-Corrected Munitions Dispenser; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile; N.A. = not available.

a. Includes some development money to improve the accuracy of JDAM, but no money to purchase the more accurate weapon, the costs of which have not yet been determined.

b. Includes roughly $90 million through 2000 to develop a Sensor-Fuzed Weapon (SFW) variant of JSOW but excludes the cost to purchase those missiles because their price has not yet been determined. Because the Air Force plans to purchase some 3,000 to 5,000 JSOWs equipped with SFWs, however, and because those munitions are significantly more expensive than the Combination Effects Munitions on the original 3,000 JSOWs, the total cost of the service's JSOW program will be at least twice and possibly three times as large as the estimates provided in the table.

WCMD. The Wind-Corrected Munitions Dispenser is to cluster munitions what JDAM is to unitary bombs. A kit, it will be mounted on the three modern cluster bombs--CBU-87, CBU-89, and CBU-97, which carry Combined Effects Munitions, Gator mines, and Sensor-Fuzed Weapons (smart antiarmor submunitions), respectively--and will guide them to the proper point to release their submunitions. Guidance is particularly important when cluster munitions are dropped by bombers at high altitudes; the weapons are roughly the size and shape of a hot water heater and are therefore not particularly aerodynamic. WCMD kits will include most of the same elements as the JDAM, namely a tail kit with steerable fins and an inertial navigation system. WCMD's accuracy will reportedly be about 30 meters, which is supposed to be good enough for the Sensor-Fuzed Weapon submunitions on the CBU-97 to find their targets efficiently. Because cluster munitions are designed to attack targets dispersed over large areas, WCMD need not be as accurate as JDAM and therefore will not include a GPS receiver as part of its guidance system. According to current plans, the Air Force does not intend to equip the B-2 or B-52 with WCMDs.

The Air Force expects to spend $310 million on almost 2,600 WCMDs over the next six years and $1.25 billion through the end of the program for a total purchase of 40,000 tail kits. The average unit procurement cost (the total purchase price divided by the number of weapons purchased) for the WCMD is estimated to be $30,000. The cluster bombs to which those tail kits will be attached--CBU 87, 89, and 97--each cost about $15,000, $45,000, and $250,000, respectively.

JSOW. The Joint Standoff Weapon is an unpowered glide bomb that provides a short- to medium-range standoff capability. In its base configuration, JSOW will dispense cluster weapons, specifically the Combined Effects Munition. Later, the Air Force will add a sensor-fuzed weapon capability and the Navy will add a unitary warhead. Like its shorter-range cousin, JDAM, it uses a GPS-aided inertial navigation system. Unlike JDAM, though, it is a complete airframe and not a kit that is added to an existing bomb body. After it is launched, JSOW deploys wings to give it a much longer range--up to 75 kilometers (about 40 nautical miles) when launched at high altitudes. JSOW will carry a smaller payload than the shorter-range weapons--three-quarters of the Combined Effects Munitions of the CBU-87 and 60 percent of the Sensor-Fuzed Weapons of the CBU-97. But the JSOW's range will allow bombers to attack targets when they are forced to stand off to avoid the air defenses that are likely to be most common in the developing world (see Figure 5 and Table 7). The weapon is supposed to have an accuracy of roughly 30 meters without GPS jamming--about the same as WCMD, which is also a cluster weapon. But on the basis of test results, program officials expect accuracy to be significantly better than that.

TABLE 7. INVENTORIES OF SAMs AND AIR DEFENSE ARTILLERY FOR SELECTED COUNTRIES

	North Korea	Iraq (1990)	Iran	Libya
Air Defense Guns	Up to 8,800	Up to 4,000	Up to 1,500	Up to 600
Surface-to-Air Missiles				
SA-1	0	0	0	0
SA-2	240	160	45[a]	108
SA-3	36	140	0	36
SA-4	0	0	0	0
SA-5	24	0	b	48
SA-6	0	180	b	10
SA-7	10,000[c]	b	b	b
SA-8	0	50	0	50
SA-9	0	100	0	b
SA-10	0	0	0	0
SA-11	0	0	0	0
SA-12	0	0	0	0
SA-13	0	60	0	60+
SA-14	0	b	0	0
SA-15	0	0	0	0
SA-16	c	b	0	0
SA-17	0	0	0	0
SA-18	0	0	0	0
SA-19	0	0	0	0
HN-5	b	b	b	0
Roland	0	100	0	0
Hawk	0	0	150	0
Rapier	0	0	30	0
Tigercat	0	0	15	0
Crotale	0	0	0	24
Stinger	0	0	b	0
RBS-70	0	0	b	0

SOURCE: Congressional Budget Office based on data from International Institute for Strategic Studies, *The Military Balance, 1994-1995* (London, U.K.: Brassey's, 1994) and 1990-1991 edition; Tony Cullen and Christopher F. Foss, eds., *Jane's Land-Based Air Defence* (Surrey, U.K.: Jane's Information Group, 1989-1990 and 1994).

NOTE: See Figures 2 and 4 for the capabilities of these systems. SAM = surface-to-air missile; SA = designation used by the United States for surface-to-air missiles built by Russia.

a. Iran actually has 45 HQ-2s, the Chinese version of the SA-2.

b. Country reported to possess this system but the size of the inventory is not available.

c. North Korea is reported to have up to 10,000 SA-7 and SA-16 shoulder-fired SAMs, but most of them are probably the older SA-7s.

The Air Force plans to spend $640 million through 2011 to buy 3,000 of the basic weapons. The Air Force also intends to buy at least 3,000 and perhaps as many as 5,000 Sensor-Fuzed Weapon variants of the missile. The Navy, which is the lead service responsible for developing JSOW, plans to buy 8,800 of the basic weapons. According to current plans, the Air Force will equip only the B-1B with JSOW, although it retains the option to equip the B-52H with it at some point in the future. Plans may change in the next year, however. B-2 program officials believe that JSOW is an excellent candidate to replace the canceled TSSAM. (See Chapter 3 for more details.)

JSOW clearly illustrates the penalties associated with standoff munitions. Each basic weapon will cost $180,000, or six times more than WCMD. In addition, bombers will be able to carry fewer of the large glide bombs than they will short-range cluster munitions. For example, the B-1 will carry only 40 percent as many JSOWs (12) as WCMDs, and--if equipped with JSOW--the B-2 will be able to carry only one-half as many JSOWs (eight) as WCMDs. Nevertheless, JSOW will be much cheaper than long-range cruise missiles.

TSSAM Follow-On. The Secretary of Defense canceled the problem-plagued Tri-Service Standoff Attack Missile program in February. But DoD insists that the need for a medium-range standoff weapon remains, although it need not be as stealthy as TSSAM was supposed to be. The Congressional Budget Office's (CBO's) analysis shows that such a weapon will be crucial to the effectiveness of the bomber force in the future. The non-stealth bombers and in some cases the B-2s will need a weapon that allows them to attack targets from safely outside the areas defended by long-range air defenses such as the SA-5 (a current threat) and the SA-10 and SA-12 (possible future threats), which have ranges in excess of 150 kilometers (see Figure 5). Although the planned shorter-range standoff weapons such as JSOW and Have Nap will allow bombers to stand off safely from the majority of SAMs that they are likely to encounter, they do not have sufficient range to stay clear of long-range SAMs, early-warning radar, and fighters. Long-range weapons such as the Conventional Air-Launched Cruise Missile and Tomahawk have ample range (up to 2,000 kilometers), but are either expensive ($2 million for each Tomahawk) or are in limited supply (air-launched cruise missiles are no longer being produced and DoD could convert at most 800 of them to conventional weapons).

In order to fill that gap quickly and affordably, the Air Force and the Navy will try to develop a replacement missile over the next few years that will need little additional development. In the meantime, the Air Force hopes to buy more of the standoff weapons that are currently in production, including CALCMs and possibly Have Naps and AGM-130 air-to-ground missiles. The Navy will purchase more Standoff Land Attack Missiles (SLAMs), which are variants of the Harpoon missile.

The Air Force and the Navy have not completed the specifics of the TSSAM follow-on program yet, which they are calling the Joint Air-to-Surface Strike Missile (JASSM). But program officials have drafted a requirements document (not yet approved by DoD) that they will use to guide their selection of competing proposals from industry. In order to streamline the acquisition process and keep the cost of the follow-on missile low, the document specifies only two key performance parameters: the range of the missile must exceed 100 nautical miles (180 kilometers), and its effectiveness must exceed a threshold as measured by a formula that takes into account such factors as reliability and the probability that the missile will be capable of destroying various targets and will be able to survive its flight through enemy air defenses. By specifying only general requirements, the Air Force will allow industry to trade factors such as precision, stealth, autonomy, adverse weather capability, guidance technology, and warhead type to develop an affordable missile. In the future, the missile should have the ability to function in adverse weather and be able to operate autonomously after launch, although DoD will consider weapons that do not meet those criteria as long as they can be converted in the future.

Although DoD has not indicated what type of warhead the missile will carry, it will at least have a unitary warhead and may have a cluster bomb version, if TSSAM requirements can serve as a guide. In order to destroy very hard targets, the weapon will probably be accurate to within about 3 meters.

The Air Force says it needs 1,500 to 5,000 missiles. Program officials have not yet established an average unit procurement cost, but their objective is a missile that costs as little as $600,000. The cost of developing the missile has also not been established.

Many candidates are being offered for the follow-on missile, including medium-range weapons such as an extended-range version of the Navy's Standoff Land Attack Missile called SLAM-ER, a low-cost version of TSSAM, turbojet-powered versions of the AGM-130 and JSOW, and long-range missiles such as the CALCM and the Air Hawk, a shortened version of the Navy's Tomahawk sea-launched cruise missile. Pentagon officials are also looking at the British Conventionally Armed Standoff Missile and French Apache missile, which are both in their early development phases.

Long-Range Standoff Weapon. In some scenarios the B-52H will need to carry a long-range standoff weapon--one that has a longer range than the TSSAM follow-on. The requirement for long-range weapons is driven primarily by the need to keep non-stealth bombers away from long-range SAMs and to keep them out of range of early-warning radar during the opening hours of a war so that they can launch a surprise attack. Currently, the conventional version of the ALCM is the only long-range

weapon in the inventory that can be delivered by aircraft. Unfortunately, the United States has a limited supply of those missiles. Developed originally to support the nuclear mission, the last ALCMs were purchased in 1984. Setting aside the missiles that the Air Force needs for nuclear missions to supplement its inventory of Advanced Cruise Missiles leaves only about 800 ALCMs that can be converted to conventional missiles, some of which have already been converted. In addition, converting an ALCM to a conventional missile is surprisingly expensive--currently about $290,000 each. Nevertheless, that is only about 15 percent of the cost of purchasing a new Tomahawk cruise missile.

Existing Types of Precision Weapons. The United States already has several types of accurate ground-attack munitions in its inventory. (See Table 3 on page 24 for information about the range, payload, and accuracy of existing smart weapons.) For example, B-52Gs used CALCMs during the opening hours of the Persian Gulf War. The B-52s can also deliver laser-guided precision bombs and Have Nap medium-range, TV-guided missiles. Other aircraft--particularly the F-117 stealth fighter, the F-15E, and the F-111--used laser-guided bombs extensively during the war, and some Air Force aircraft delivered GBU-15 and Maverick TV-guided bombs. The Navy launched its Tomahawk cruise missiles from surface ships and submarines to attack targets in Baghdad and elsewhere (the weapon was credited with keeping pressure on the Iraqis during daylight when F-117s did not operate). Navy fighter-bombers even launched several developmental SLAM medium-range standoff missiles at Iraqi targets. Those weapons will continue to be important assets in the future. And at least two of them, the conventional ALCM and the Tomahawk, will include GPS-aided navigation.

IMPROVING THE CONVENTIONAL CAPABILITY OF BOMBERS

The central goal of the Department of Defense's modernization plan for its bombers has been to improve their ability to carry conventional weapons--especially inexpensive, accurate munitions that can function in adverse weather--and to use them effectively during a regional conflict.[3] When equipped with the new accurate weapons that DoD is developing, the bomber force will be able to destroy a wide range of target types with an unprecedented effectiveness.

Modernizing the bombers will be expensive, however. It will cost $6.7 billion to complete, $5.8 billion of which will be spent from 1996 through 2001. The

3. Precision-guided munition (PGM) is the term often used to describe all of the smart, guided munitions that DoD is developing. This paper makes a distinction between accurate weapons (those accurate to within 10 meters to 30 meters) and precision weapons (those accurate to within 3 meters or less).

cost of developing and purchasing the new guided munitions is excluded from these estimates.

A variety of modifications will be made to each type of bomber (see Table 8). Because smart weapons require information from the bomber, cabling must be run from the aircraft's avionics (the navigation, weapons management, and sensor systems) to each munition so that it has the information it needs about the location of the bomber and the target when it is launched. The Air Force will use the 1760

TABLE 8. CAPABILITY OF THE PLANNED FORCE TO CARRY WEAPONS

Bomber	Capability in 1995	Weapons Added by the End of 2001	Weapons Added by the End of 2005
B-1	Mk-82	JDAM CBU-87, 89, 97	JSOW WCMD
B-2	Mk-84	JDAM GAM CBU-87, 89, 97 Mk-82, 62, 117	None
B-52H	CALCM Have Nap Harpoon GBU-10, 12 CBU-87, 89 Mk-82, 84, 117 Sea Mines	JDAM WCMD CBU-97	None

SOURCE: Congressional Budget Office using data from the Department of Defense.

NOTES: The ability of a bomber to carry a specific weapon, as indicated, may refer to "limited operational capability," meaning that the weapon has been certified for and integrated with the first bomber. The full operational capability will be achieved when there are enough weapons available for all bombers of that type. See Figure 7 for more information about integration schedules for each bomber and weapon. The recently canceled Tri-Service Standoff Attack Missile (TSSAM) was scheduled to be integrated with the B-2 and the B-52 by 1999 and the B-1 by 2004. The Air Force has not yet identified the missile that will replace TSSAM. Nor has it included funding in its plan for 1996 through 2001 to integrate the missile with the bombers.

JDAM = Joint Direct Attack Munition; JSOW = Joint Standoff Weapon; CBU = cluster bomb unit (designation for cluster munitions); WCMD = Wind-Corrected Munitions Dispenser; GPS = Global Positioning System; GAM = GPS-Aided Munition; CALCM = Conventional Air-Launched Cruise Missile; GBU = guided bomb unit (designation for laser-guided bombs).

data bus (transmission system) to transfer that information to all of the new GPS-aided munitions. Often the bomb racks or pylons must be modified or replaced so that cabling can be run to every weapon station.

The B-2 "modifications" are somewhat different than the others because they are part of a continuing procurement program. That is, all of the improvements required to reach the final production configuration are part of the Air Force's contract with Northrop Grumman to buy the 20 B-2s. Although these are not modifications in the traditional sense, they have been included to show how the conventional capability of the bomber force will change over the next decade.

The B-1B

The Air Force has designated the B-1B as the backbone of its future conventional bomber force. Because it was originally configured for nuclear missions, however, the B-1B must undergo several modifications over the next few years. In addition, the Air Force must address problems that the bomber has experienced over the years, particularly shortfalls in its readiness and its defensive avionics system.

The Conventional Munitions Upgrade Program. In order to modify the B-1B for conventional missions, the Air Force has established the Conventional Munitions Upgrade Program (CMUP). When the program is complete, the B-1B will be able to deliver a large quantity of smart and unguided weapons--24 Joint Direct Attack Munitions, 30 Wind-Corrected Munitions Dispensers or cluster bombs, or 12 Joint Standoff Weapons (see Table 9). Unfortunately, the last of these upgrades will not be fully incorporated into the fleet until 2007. The upgrade program will cost roughly $1.8 billion through 2001 and $2.5 billion to complete (see Table 10). This total excludes most of the cost to upgrade the bomber's electronic self-defense system, which would add several hundred million dollars.

The CMUP has been divided into three phases (see Figure 6). Phase I will improve the B-1's ability to attack area targets with nonprecision weapons by equipping the bomber with the most modern family of cluster munitions in the inventory: CBU-87 (Combined Effects Munition for attacking soft area targets), CBU-89 (Gator antitank and antipersonnel mines), and CBU-97 (Sensor-Fuzed Weapons for attacking armor). All B-1s will be able to carry those weapons by the end of 1997. But the Air Force owns only 100 Conventional Bomb Modules (the B-1's bomb rack), 50 of which can carry cluster munitions. With one module installed in each of a bomber's three bomb bays, only 16 bombers will be able to carry a full load of CBUs at one time. Phase I will also add to the B-1B radar the capability of detecting moving targets.

TABLE 9. THE WEAPONS-CARRYING CAPABILITY OF THE BOMBER FORCE AT THE END OF THE PLANNED MODERNIZATION PROGRAM

Weapon Type	B-52H	B-1B	B-2
	Unguided Bombs, Short Range		
Mk-82	45	84	80
M117	45	0	36
Mk-84	18	0	16
	Accurate Bombs, Short Range		
JDAM	12	24	16
GAM	0	0	16
GBU-10	8 to 10	0	0
GBU-12	10	0	0
	Standoff Weapons		
JSOW	0	12	0
CALCM	20	0	0
Have Nap	4[a]	0	0
Harpoon	8[b]	0	0
	Cluster Bombs		
WCMD	16	30	0
CBU-97 (SFW)	24	30	36
CBU-87 (CEM)	24	30	36
CBU-89 (Gator)	24	30	36
CBU-52,58,71	45	0	0

SOURCE: Congressional Budget Office using data from the Department of Defense.

NOTE: JDAM = Joint Direct Attack Munition; GPS = Global Positioning System; GAM = GPS-Aided Munition; GBU = guided bomb unit (designation for laser-guided bombs); JSOW = Joint Standoff Weapon; CALCM = Conventional Air-Launched Cruise Missile; WCMD = Wind-Corrected Munitions Dispenser; CBU = cluster bomb unit (designation for cluster munitions); SFW = Sensor-Fuzed Weapon; CEM = Combined Effects Munition.

a. Only 10 B-52s will be able to carry Have Nap missiles at any one time.

b. Only 19 B-52s will be able to carry Harpoon antiship missiles at any one time.

Phase II of the CMUP will focus on improving the accuracy of B-1B munitions. It will enable the bomber to carry smart munitions with short ranges (JDAM and WCMD) and to communicate with other forces in a theater. This will require installing Global Positioning System navigation, the 1760 bus (data transmission system), new communications systems, and a more capable offensive avionics computer. For JDAM, the 1760 bus will be added to the multipurpose rotary launcher. The B-1B will be equipped with the JDAM starting in 2001 (see Figure 7). To carry the WCMD starting in 2002, 1760 interfaces will be added to the 50 conventional bomb modules that are configured to carry cluster munitions.

Various elements of the Phase II upgrade will be incorporated into the fleet at different times. The Air Force has stretched the schedule to reduce the annual costs of the program. For example, the computer upgrade will be delayed until the B-1's Block E software modification is complete. Lowering the annual costs, however, has increased total costs somewhat.

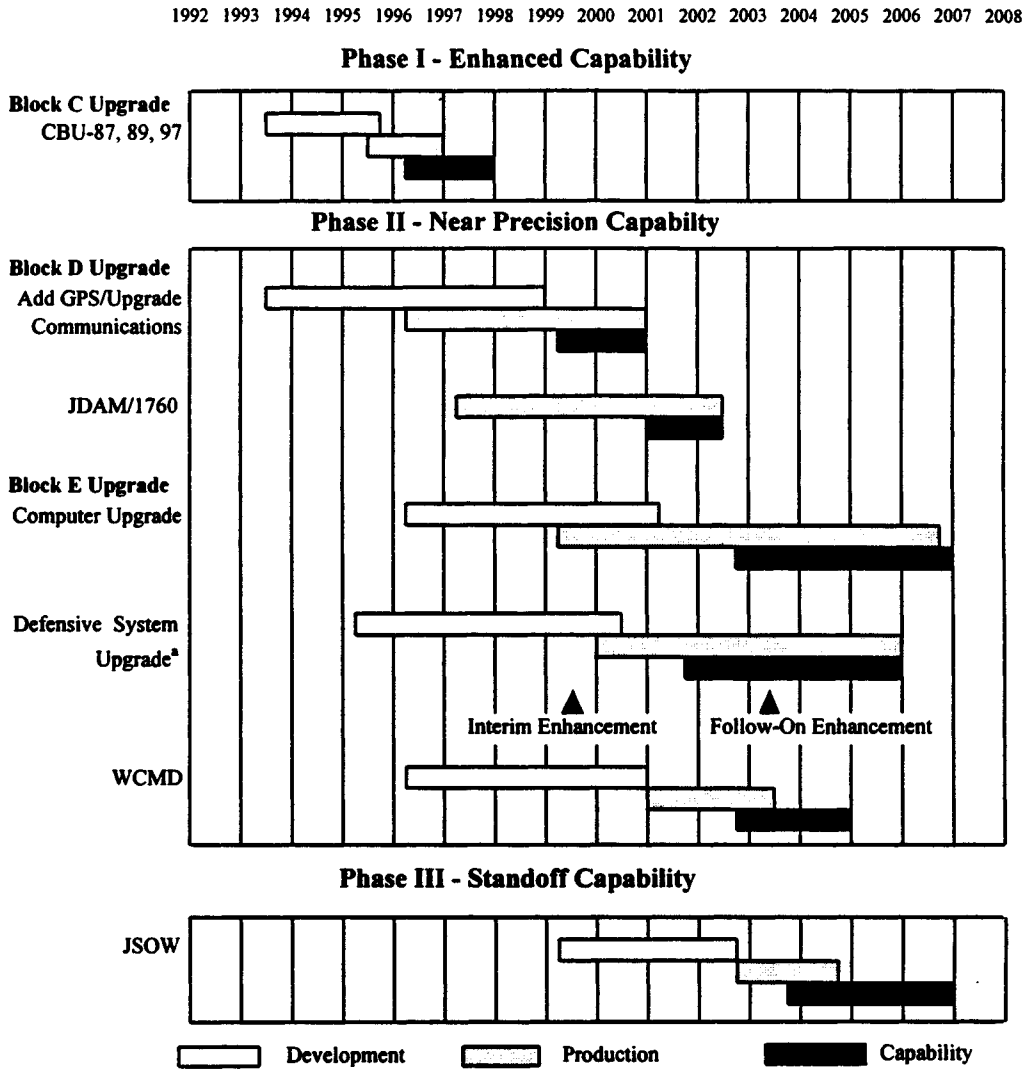
In order to improve the B-1B's ability to survive in a hostile environment, its defensive avionics, or electronic countermeasures (ECM), system will be upgraded. The bomber's original ECM system had technical problems that were never fully corrected. The system was adequate for nuclear missions, which required the bomber to penetrate the air defenses only once and at low altitudes. Today the bomber can operate in low-threat areas, but it needs a better system in order to operate safely in

TABLE 10. FUNDING FOR BOMBER MODIFICATIONS
(In millions of 1996 dollars)

	1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2010
B-1B	310	350	280	350	270	270	1,830	2,490
B-2	1,090	800	840	410	390	200	3,730	3,960
B-52H	20	20	30	60	40	30	200	200
Total	1,420	1,170	1,150	820	700	500	5,760	6,650

SOURCE: Congressional Budget Office based on Department of Defense data.

FIGURE 6. SCHEDULE FOR B-1B CONVENTIONAL MUNITIONS UPGRADE PROGRAM

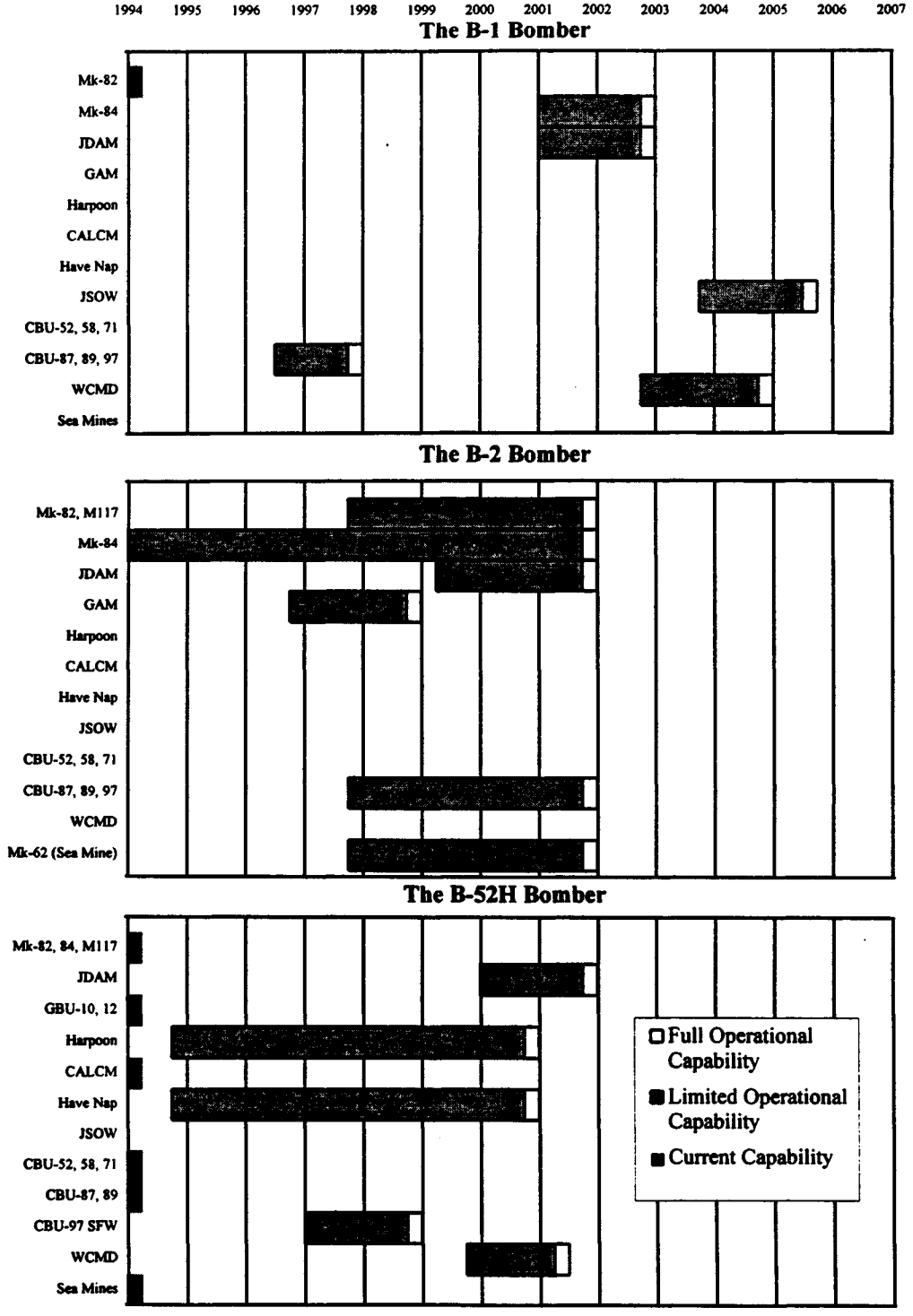


SOURCE: Congressional Budget Office using data from the Department of Defense.

NOTE: CBU = cluster bomb unit (designation for cluster munitions); GPS = Global Positioning System; JDAM = Joint Direct Attack Munition; WCMD = Wind-Corrected Munitions Dispenser; JSOW = Joint Standoff Weapon.

a. The schedule shown for the defensive systems upgrade is for the baseline Tier 1 system. In addition, the Air Force will enhance the capability of the system by adding an interim upgrade starting in 1999 and a follow-on upgrade starting in 2003.

FIGURE 7. CONVENTIONAL WEAPONS AVAILABILITY TIMELINE



SOURCE: Congressional Budget Office using data from the Department of Defense and the Rockwell International, Northrop Grumman, and Boeing Corporations.

NOTE: Mk-82 = 500-pound unitary bomb; Mk-84 = 2,000-pound unitary bomb; JDAM = Joint Direct Attack Munition; GPS = Global Positioning System; GAM = GPS-Aided Munition; CALCM = Conventional Air-Launched Cruise Missile; JSOW = Joint Standoff Weapon; CBU = cluster bomb unit (designation for cluster munitions); WCMD = Wind-Corrected Munitions Dispenser; M117 = 750-pound unitary bomb; Mk-62 = sea mine; GBU = guided bomb unit (designation for laser-guided bombs); SFW = Sensor-Fuzed Weapon.

future conventional conflicts where it will often fly at high altitudes, encounter a wide variety of threats, and may have to operate without the aid of fighter escorts and aircraft specialized for suppressing air defenses.

According to the most recent plan, the bomber's ECM system will be upgraded in phases. Each phase will add the capability to meet the latest anticipated threat. For example, the first (or so-called Tier 1) upgrade would improve the bomber's situational awareness--its ability to detect nearby threats--and its "techniques generator," the part of the ECM system that generates radar signals to confuse incoming missiles. Installed in the first bombers by the end of 2001, the Tier 1 system should be able to deal with most threats that the B-1 is expected to encounter in a regional conflict during that period (see Figure 6). To meet the threats that may develop near the end of the next decade, a second, or Tier 2, upgrade will be installed around 2010.

In addition to the Tier 1 and Tier 2 upgrades, technology from another program will enhance the capability of the B-1 ECM system further. The first of these, the interim upgrade, will be installed starting in 1999 before the Tier 1 upgrade. The second, called the follow-on upgrade, will be added starting in 2003.

By using a combination of equipment that already works well on the B-1 and off-the-shelf components that are deployed on other aircraft, the program office hopes to develop a reasonably priced system (roughly $700 million rather than more than $1 billion for earlier plans) that will be flexible enough to be upgraded to meet future threats.

Phase III of the CMUP will give the B-1B a standoff capability by integrating JSOW. That will enable the bomber to attack heavily defended targets from a distance of up to 75 kilometers. The capability will be essential during the early stages of a conflict when the B-1B could be threatened by an unsuppressed air defense. Funding limitations have compelled the Air Force to delay adding this capability until the end of 2003.

Operational Readiness Improvements. In addition to the CMUP, the Air Force is working to improve the readiness of the B-1B force. The mission-capable rate (the percentage of the operational fleet that can actually fly combat missions on any given day) has been 55 percent, which is low for a bomber.[4] Supporters have argued that the low rate reflected the fact that the Air Force and the Congress had never fully

4. The mission-capable rate is the ratio of flyable bombers to the total number of bombers that are funded to fly (called primary authorized aircraft, or PAA). PAA is a subset of the total number of aircraft in inventory, because some fraction of the total inventory is in the maintenance pipeline or dedicated as test assets.

funded the bomber. Critics have contended that the B-1B was an inherently unreliable system and that more money spent on operations would be wasted.

In 1994, the Congress wanted to see how reliable the bomber could be before it increased spending on bomber operations. It directed the Air Force to run a test to find out if a wing of B-1Bs could be maintained at a mission-capable rate of 75 percent for six months if it was fully manned and had the necessary spare parts. The test was completed in November and, to the surprise of many, 84 percent of the bombers participating in the test remained mission-capable. Moreover, the mission-capable rate of the entire B-1B force during that period rose to 65 percent. Based on its experience during the test, the Air Force believes that it can increase the rate of the entire fleet to 75 percent if it invests $11.2 million to improve the reliability and maintainability of certain parts and systems. This money is not included in the Administration's plan for the 1996-2001 period, but is likely to be included when DoD revises its plans for the 1997-2001 period.

The B-52H

Under the Air Force's improvement plan, the B-52H will be the most versatile bomber in the inventory because it will carry a much wider range of weapons than the other bombers (see Table 8 on page 37). Currently, it is the only bomber that can deliver accurate conventional weapons, including conventional variants of the air-launched cruise missile, laser-guided bombs, Have Nap TV-guided bombs, and Harpoon antiship missiles. The Air Force is modifying the B-52H so that it can also carry the GPS-aided munitions that are under development.

Until recently, the Air Force relied on its B-52G fleet for conventional missions. The B-52G was equipped to carry a wide range of conventional munitions, including most types of gravity bombs and sea mines, some laser-guided bombs, and Have Nap and Harpoon standoff weapons. It saw considerable action during the Persian Gulf War, delivering one-third of the total tonnage of weapons dropped by allied aircraft. Last year, however, the Air Force retired its force of B-52Gs because they had became too expensive to maintain. In their place, the newer H models, which are capable of conducting nuclear missions, will assume the conventional role as well. The Air Force will use some of the parts from the B-52G to modify the H model so that it can carry all the conventional weapons formerly carried by the B-52G. In addition, the B-52H will be given the capability to carry most of the new GPS-aided conventional munitions.

As Air Force plans now stand, the service will modify the B-52H so that it will carry all of its smart weapons externally on pylons under each wing. The

exception is the Conventional Air-Launched Cruise Missile, which can be carried both internally and externally (see Table 11). Under the Conventional Enhancement Modification program, the Air Force will upgrade the avionics on all 66 B-52Hs to provide 1760-type interfaces at each pylon, install GPS on the aircraft, and equip it with the Harpoon and Have Nap missiles (which require interfaces that are different than 1760). In addition, a beam must be attached to the pylons on each aircraft so that the bomber can carry weapons other than ALCMs externally. There are four types of beams. The service owns 47 sets of beams that are capable of carrying 1760-compatible munitions, and it is currently negotiating with Boeing to purchase 19 more sets to equip all 66 of its B-52Hs. Because Harpoon and Have Nap missiles use non-1760 interfaces, they require different adapter beams. The Air Force owns 10 sets of beams for Have Nap and 19 sets for Harpoon, but any of the B-52Hs will be able to carry them. Unguided bombs require a fourth type of beam, which the Air Force has in large numbers.

In addition, the Air Force will equip the bomber with JDAMs in 2000 and WCMDs in 1999 (see Figure 7 on page 42). According to its current plans, the Air Force will not add JSOWs to the B-52, although the decision is likely to change in its 1997 budget.

In order to improve the capability of the B-52H to conduct future conventional missions, the Air Force plans to add ARC-210 secure data and voice radios so that the bomber can communicate better with other U.S. forces in the theater. Plans also include making internal bomb racks easier to use by purchasing a universal bomb bay adapter, and improving bombers' defensive avionics systems by adding a third ALQ-172 ECM suite on each aircraft.

The B-2

The B-2 stealth bomber is intended to be the "silver bullet" of the Air Force's future bomber force. Its ability to penetrate air defenses is expected to make it a key asset for attacking critical targets during the early phases of a war, much as the F-117 stealth fighter did during the Persian Gulf War. Unlike the B-1B and the B-52H, the B-2 is still in production. At the end of 1995, seven bombers will have been delivered to the Air Force (see Table 2 on page 20). The 20th and final B-2 will be delivered in 2000. It will be the second aircraft to be delivered in its completed, fully mission-capable, or Block 30, configuration. But the Air Force will not have 20 fully capable B-2 bombers until 2001 because earlier bombers must return to the factory for modifications (see Figure 8).

TABLE 11. CONVENTIONAL WEAPONS CARRIED BY A B-52H BOMBER

Weapon	Quantity		
	Internal	External	Total
Unitary Bombs			
Mk-82	27	18	45
Mk-84	8	10	18
M117	27	18	45
Accurate, Short-Range Bombs			
JDAM	0	12[a]	12[a]
GBU-10 (Paveway I)	0	8	8
GBU-10 (Paveway II)	0	10	10
GBU-12 (Paveway III)	0	10	10
Standoff Munitions			
JSOW	0	b	b
CALCM	8	12	20
Have Nap	0	4	4
Harpoon	0	8	8
Cluster Bombs			
WCMD	0	16[a]	16[a]
CBU-87 CEM	6	18	24
CBU-89 Gator	6	18	24
CBU-97 SFW	6[a]	18[a]	24[a]
CBU-52,58,71	27	18	45
Mk-20 Rockeye	0	18	18
Sea Mines			
Mk-36,62	27	18	45
Mk-40,63	0	18	18
Mk-52	12	18	30
Mk-55,56	8	12	20
Mk-60,64,65	8	10	18

SOURCE: Congressional Budget Office based on data from the Air Force.

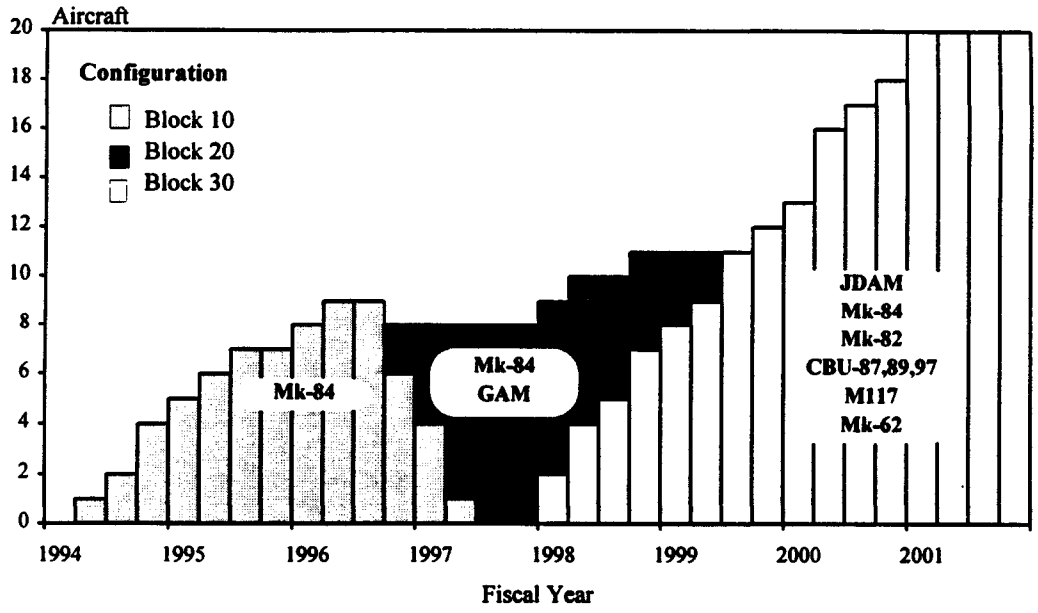
NOTE: JDAM = Joint Direct Attack Munition; GBU = guided bomb unit (designation for laser-guided bombs); JSOW = Joint Standoff Weapon; CALCM = Conventional Air-Launched Cruise Missile; WCMD = Wind-Corrected Munitions Dispenser; CBU = cluster bomb unit (designation for cluster munitions); CEM = Combined Effects Munition; SFW = Sensor-Fuzed Weapon.

a. The Air Force plans to equip the B-52H to carry CBU-97, WCMD, and JDAM weapons in 1997, 1999, and 2000, respectively.

b. According to current plans, the B-52H will not be fitted to carry the JSOW. In theory, each bomber could carry 12 JSOWs.

Like the other bombers, the B-2 was primarily intended to conduct nuclear missions. Therefore, the Bomber Roadmap called for additions to the original B-2 program to improve its ability to conduct a full range of conventional missions. In addition, the aircraft must be altered to improve its stealth characteristics against some types of radar. Because the bomber is still in production, these changes (including a radar modification that will add a GPS-aided targeting system and tactical communications radios) will be incorporated into some of the later bombers during production and retrofitted into earlier ones during the so-called Block 20 and Block 30 modifications. All of those modifications are supposed to be funded within the $44.4 billion program limit (in current dollars) that the Congress imposed in 1993.

FIGURE 8. B-2 AVAILABILITY AND WEAPONS CAPABILITY BY FISCAL YEAR



SOURCE: Congressional Budget Office using data from the Air Force and the Northrop Grumman Corporation.

NOTES: B-2 production started before development had been completed. As a result, the first nine B-2s delivered to the Air Force, designated Block 10, have a very limited capability. The second set of nine bombers delivered to the Air Force, designated Block 20, will be useable in combat, but will only be able to use two types of weapons. The last two B-2s will be delivered fully combat capable in the final Block 30 configuration. The first 18 bombers will then return to the factory to be converted to Block 30 aircraft.

Mk-84 = 2,000-pound unitary bomb; GPS = Global Positioning System; GAM = GPS-Aided Munition; JDAM = Joint Direct Attack Munition; Mk-82 = 500-pound unitary bomb; CBU = cluster bomb unit; M117 = 750-pound unitary bomb; Mk-62 = sea mine.

The B-2's conventional capability will be limited in its original Block 10 configuration. Its only conventional weapon will be the 2,000-pound Mk-84 gravity bomb; it will not have its full low-observability capability or defensive avionics system, and therefore will be able to fly only limited missions. Indeed, the Air Combat Command, which operates the bombers, does not consider the B-2 useable for conventional missions until it is in its Block 20 configuration.

The first Block 20 aircraft will enter the fleet near the end of 1996 (see Figure 8). The modification schedule has been designed so that the Air Force never has more than two types of B-2s in the force at any one time. Block 20 bombers will still have a limited conventional capability. The Air Force will add no more unguided weapons to the bomber. But it will have some capacity for delivering smart munitions. The Block 20 bombers will be equipped with GPS and a GPS-Aided Targeting System that will enable them to carry a 2,000-pound smart weapon called the GPS-Aided Munition (GAM) starting near the end of 1996 (see Figure 7 on page 42). The GAM will make bombers capable of delivering accurate weapons until the B-2 can be equipped with the JDAM.[5] This interim capability is limited, however, by the small number of weapons that the Air Force intends to purchase. Current plans call for only 128 GAMs, which will provide only eight bomber loads of 16 weapons each. That may be an adequate number, however, if the Air Force proceeds with recent (but still unfunded) plans to buy some early-production JDAMs for the B-2 in 1997. Because it will be built largely by hand, GAM is a very expensive weapon--about $200,000 apiece.

Block 20 aircraft were supposed to carry Tri-Service Standoff Attack Missiles, but the development program for the missile has been cancelled. A substitute missile such as JSOW may be used instead, but the Air Force has budgeted no money to equip the B-2 with that missile or other possible TSSAM replacements. Integration will have to be funded outside of the $44.4 billion Congressional cap.

The Block 30 aircraft will have all of the conventional capability that the Air Force currently plans to incorporate into the B-2. The modification will add JDAM, the 500-pound Mk-82, and the modern cluster munitions, CBU-87, 89, and 97. The manufacturer is also supposed to remedy a deficiency in the stealth characteristics of the aircraft during the Block 30 modification. The first Block 30 aircraft will be delivered in 1998 and the final one in 2001.

5. GAM is similar to JDAM in many respects, but it will not have the same maneuverability and therefore will not be as effective against some types of targets.

THE TOTAL COSTS OF THE ADMINISTRATION'S BOMBER MODERNIZATION PROGRAM

When completed, DoD's modernization program will make the bomber force's capability impressive, but it will be expensive. According to the Bomber Roadmap, the force will be able to destroy more than 1,250 elements of the most critical targets during the first five days of a conflict. The bomber modernization program through 2020 will cost more than $12 billion in 1996 dollars. Improving the bombers themselves would cost about $7 billion; a missile to replace TSSAM would probably cost some $4 billion; and the purchases of new munitions that would be allocated to the bombers would probably add at least another $1 billion. (Currently, the Air Force plans to spend $4.8 billion on new GPS munitions for its fighters and bombers. In addition, it will probably spend at least another $1 billion to improve JDAM and buy a version of JSOW that will carry the Sensor-Fuzed Weapon.)

HOW CAPABLE WILL THE MODERNIZED FORCE BE?

When the Air Force completes its modernization program, it will have a total inventory of 181 bombers, all equipped to deliver smart and unguided conventional weapons. Of those, 154 would be operational (the rest would remain in depots or be designated as test aircraft) and 130 would be available for combat (those operational aircraft that were not being used as trainers). Assuming that 75 percent of the bombers available for combat would be ready to fly on any given day, the planned force would provide 98 mission-capable bombers. Operating from the continental United States, as they are likely to do during the early weeks of an unexpected conflict, an average of 39 bombers would be able to attack targets each day. Using maximum loadings for each bomber listed in Table 9, those 39 bombers can deliver up to 740 JDAMs, 840 WCMDs, 1,100 cluster weapons, 250 JSOWs, or 260 CALCMs.

The number of combat missions generated and the number of weapons that can be delivered each day can be useful measures of capability. But they ignore enemy air defenses and fighter aircraft, which would affect how well different types of bombers could deliver weapons against specific targets. And the ways in which enemy air defenses would affect the bombers depend on many factors, including the nature of the conflict, the capability of the adversary and the tactics that it uses, how many forces the United States and its ally have in the region when the conflict begins, and what tactics they use.

Decisionmakers use a variety of models to help determine the relative merit of different options. Complex campaign models allow them to examine in great

detail the interplay of various forces during a simulated war. The results of such models must be used carefully, however, because they require many assumptions about the way a conflict will unfold. Most of these events are unknowable and can only be guessed at. For example, what will be the capability of the enemy's integrated air defense system and its ability to withstand attack? How capable will its air force be? What roles will be assigned to bombers, what targets would they attack, what tactics would they use, and what other allied and U.S. ground, air, and naval forces will be in the region during the early days of the conflict? Results also depend on how well stealth and ECM perform, and how effectively the bombers can be integrated into force packages with fighters that are specialized in suppressing enemy air defenses.

Often, the assumptions that are made in the models can have more impact on the results than the option that is ostensibly being examined. For example, before allied forces began their attack on Iraqi forces in Operation Desert Storm, several military analysts had used models to predict what sort of casualties the United States could expect. Those who assumed a long ground war anticipated high U.S. casualties, and those who predicted an extensive air campaign calculated that casualties would be lower. But all of the models grossly overestimated casualties by underestimating the length and intensity of the allied air campaign. And none of them predicted the "great left hook" that allied ground forces delivered through the western desert to engulf Iraqi forces. Likewise, when modeling different bomber options, much depends on assumptions about the effects of stealth and electronic self-protection systems and the tactics that military commanders will use to exploit them during a conflict.

Simpler models can also be used to illustrate a few important features of a campaign. Such models are less realistic, but can be useful nonetheless. They are often easier to use and their results are easier to understand. Simple models are subject to the same uncertainties about assumptions, but because far fewer factors are involved, it is easier to trace the effects of each assumption.

CBO chose to illustrate the range of effects that enemy defenses might have on the capability of the planned force, as well as that of the alternative forces presented in Chapter 3, by using two simple scenarios: one that assumes that the enemy has light air defenses that are vulnerable to attack, and another that assumes that the enemy has highly effective defenses that can withstand U.S. attacks for two weeks. CBO has kept the scenarios deliberately simple to illustrate the effects of defenses without overwhelming the reader with hundreds of assumptions. Although these scenarios may be unrealistic, they present reasonable upper and lower bounds on the capability of an opponent's air defenses. The lightly defended case may understate the capability of the most challenging defenses that the United States will

face in the future, and the scenario illustrating strong defenses assumes that enemy air defenses are at once more effective and survivable than anything that U.S. forces are likely to encounter in the developing world for some time. In reality, the situations that the bomber force may encounter in the future will probably lie somewhere between these two boundaries. To illustrate such a case, CBO also developed a moderate-defense scenario.

The Basic Scenarios

The scenarios that CBO used are fairly straightforward. In the lightly defended case, the non-stealth bombers in the planned force would stand off for three days until the enemy's integrated air defense system and air force were suppressed and the bombers could conduct operations with relative safety at high altitudes. During this period, CBO assumes that B-52s would use only TSSAM follow-on missiles; the B-1B would use JSOW, JDAM, and TSSAM follow-on, each for one-third of its sorties; and B-2s would use only the short-range JDAMs (see Table 12 for the assumptions used in the scenarios). The light-defense scenario assumes that at the end of the third day, the enemy's defenses are disabled and all bombers will penetrate and devote their sorties to delivering JDAMs until the end of day 15. (The number of each weapon that a bomber can carry is based on the loadings in Table 9.)

In order to illustrate an upper bound to the effectiveness of enemy defenses, CBO assumed in its strong-defense case that the non-stealth bombers must stand off for 15 days and that only the B-2 is capable of penetrating such defenses during this period. The B-52 would use TSSAM follow-on missiles for the full 15 days, and the B-1 would use TSSAMs on half of its sorties and JSOWs on the other half. The B-2 would use JSOWs on 20 percent of its sorties during that period and JDAMs on the remaining 80 percent. (For the purposes of illustration, CBO assumes that the B-2 and the B-52 can carry JSOWs, although according to current plans neither bomber would have such a capability.) The scenarios are assumed to occur in 2010, when all of the Air Force's planned modernizations are expected to be complete.

To illustrate how an air defense with more realistic capabilities than those assumed in the strong-defense scenario would affect the planned force, CBO also constructed a moderate-defense scenario. In that case, CBO assumed that defenses would hold out for seven days against the planned force, and the non-stealth bombers would not be able to penetrate. During this time the bombers would use the same mix of weapons that they do in the strong-defense scenario (see Table 12). During the second week, the B-52 would deliver JSOWs, the B-1 would devote half of its sorties to JSOWs and half to JDAMs, and the B-2 would deliver JDAMs exclusively. Despite the "moderate" label, these defenses are probably more capable than any that

are available in the developing world today. Remember that large sections of the highly regarded Iraqi air defense system were rendered inoperable after the first few days of allied attacks and that B-52s dropped short-range weapons on Iraqi forces on the first day of the war.

TABLE 12. ASSUMPTIONS USED IN CBO'S ILLUSTRATIVE SCENARIOS

Days from Beginning of Conflict	Bomber	Sorties Devoted to Each Weapon
		Strong Defenses
1-15	B-1B	50 percent JSOW, 50 percent TSSAM Follow-On
	B-2	80 percent JDAM, 20 percent JSOW
	B-52H	TSSAM Follow-On
		Moderate Defenses
1-8	B-1B	50 percent JSOW, 50 percent TSSAM Follow-On
	B-2	80 percent JDAM, 20 percent JSOW
	B-52H	TSSAM Follow-On
9-15	B-1B	50 percent JSOW, 50 percent JDAM
	B-2	JDAM
	B-52H	JSOW
		Light Defenses
1-3	B-1B	33.3 percent JDAM, 33.3 percent JSOW, 33.3 percent TSSAM Follow-On
	B-2	JDAM
	B-52H	TSSAM Follow-On
4-15	B-1B	JDAM
	B-2	JDAM
	B-52H	JDAM

SOURCE: Congressional Budget Office.

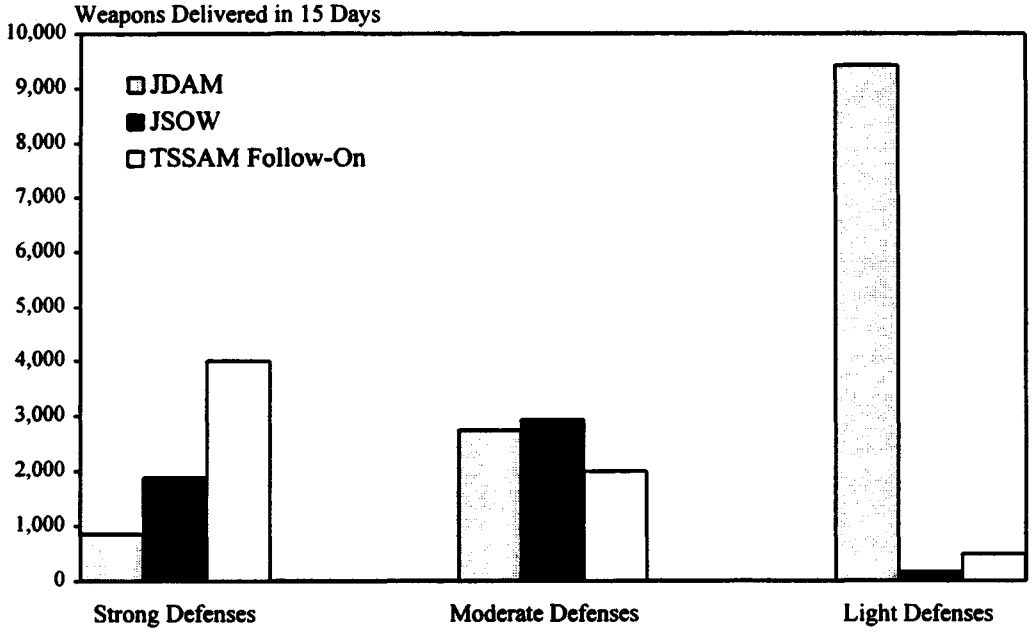
NOTES: CBO developed the scenarios to illustrate the capability of the options against different defenses. The strong-defense scenario probably overstates the capabilities of stealth and future enemy defenses. The light-defense scenario may understate the capability of the most challenging defenses that the United States may face.

JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile; JDAM = Joint Direct Attack Munition.

Light Defenses

A light defense would pose little challenge to the capabilities of the planned force, which could deliver a large number of weapons--as many as 9,400 JDAMs, 170 JSOWs, and 500 TSSAM follow-ons (see Figure 9). All scenarios assume that the bombers would operate from their bases in the United States for the 15 days covered by this model and that they would be capable of generating combat missions at the average rate of one every two and one-half days, or 0.4 per day--the same rate assumed in the Bomber Roadmap. Also like the Roadmap, the scenarios assume that three-quarters of the bombers available for combat would be able to fly missions on any given day.

FIGURE 9. CAPABILITIES OF PLANNED BOMBER FORCE AGAINST DIFFERENT ILLUSTRATIVE DEFENSES



SOURCE: Congressional Budget Office.

NOTES: These results are derived from the scenarios that CBO developed to illustrate the capability of the planned force and alternatives against defenses with different capabilities. The strong-defense scenario probably overstates the capability of stealth and future enemy defenses and the light-defense scenario may understate the capability of the most challenging defenses that the United States might face. Because the scenarios ignore many operational factors that would reduce the numbers of weapons that bombers could deliver in each option, they are best used to compare the relative capability of each option.

JDAM = Joint Direct Attack Munition; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile.

The Bomber Roadmap Target Set. To place those numbers in perspective, the Bomber Roadmap estimates that U.S. and allied forces must destroy 238 high-priority targets within the first five days in a future regional conflict in order to disrupt an enemy's strategic plan and halt its offensive. That translates into roughly 1,250 strategic target elements--aimpoints like corners of a building that must be hit to destroy a target--that would have to be destroyed by bombers and whatever short-range forces would be in the theater during the first five days.

The highest-priority targets would include such critical command and control centers as military headquarters and communications centers; air defenses; enemy air force bases; capabilities for the production, support, and use of chemical, biological, and nuclear weapons; and concentrations of ground forces. The priority given to each type of target would depend on the specifics of the conflict. Some targets, such as bunkers and aircraft shelters, would be difficult to destroy and require accurate unitary bombs. Others, such as radar antennas and ground forces, could be attacked more effectively with cluster munitions.

Those critical target elements account for less than 5 percent of the total expected in a typical major regional conflict, according to the Air Force. And they are more likely to be protected by air defenses and fighters than other elements. But the Air Force argues that striking them quickly would unhinge an enemy's command structure and its ability to conduct combat operations. Practicing this "art of inflicting operational paralysis" would also reduce the damage that the invader could do to U.S. and allied forces and allied civilians.

Because it would be able to deliver some 2,600 accurate weapons during the first five days and more than 10,000 within 15 days, the planned force in the light-defense scenario should be more than adequate. Even without assistance from tactical aircraft, the bombers could deliver more than two weapons to each target element in the first five days. The strength of the force is further indicated by the large quantity of short-range weapons that it could deliver; short-range weapons are much cheaper, bombers can carry more of them, and they are much more effective than standoff weapons, particularly against such moving targets as advancing armies.

The Heavy Bomber Force Study. These results are similar to those of the 1995 Heavy Bomber Force Study--an independent review that DoD commissioned at the request of the Congress. That extensive review concluded that the planned force would be adequate for all reasonable scenarios. The authors of the study used several well-established models to analyze the effectiveness of the bomber force, based on data from actual war plans and the latest intelligence estimates of the future targets and threats in the Persian Gulf and Korea.

Critics have challenged those results, but their differences center on the most challenging and unlikely scenario, in which the invasion occurs without warning and there is no tactical aviation in the theater for the first two weeks of the war.

The Congress intended the Heavy Bomber Force Study to settle the debate over how many B-2s the Air Force should buy. B-2 supporters in the Congress have regarded it as just the opening salvo. The alternatives in Chapter 3 are designed to illustrate the effects on costs and capabilities of a range of approaches to enhancing the capabilities of the bomber force.

Strong Defenses

The assessment of the planned bomber force changes, however, when the opponent has heavy, survivable defenses. If its defenses were as capable as CBO assumed in its strong-defense scenario--an unlikely but conceivable event--the bombers would only be able to deliver about 1,900 accurate weapons within the first five days and 6,700 within the first 15. Furthermore, all but 900 of the weapons expended over the first two weeks would be standoff munitions, two-thirds of which would be launched from long ranges. In general, that would reduce the number of weapons that bombers can carry on each sortie and lessen their ability to attack advancing forces. The ability to penetrate defenses not only would reduce the number of bombers needed to conduct the mission, but would increase the intensity of the attack--a quality that is particularly effective against an army. In addition, long-range standoff weapons are of limited value against moving targets because their flight times are so long. Moreover, if there were no tactical aircraft or naval forces in the theater to help attack critical targets, only about one-half of the time-critical target elements prescribed in the Bomber Roadmap could be attacked by more than one weapon. Nevertheless, the number of target elements that could be attacked in the first five days would be within the range prescribed by the Bomber Roadmap.

The Heavy Bomber Force Study arrived at a similar result. In the unlikely event that tactical aircraft were absent during the first two weeks of the war, the planned force would not fare as well, according to the study (although the United States and its ally would still halt the invasion and win the war). Several other studies that focus on this type of severe threat have come to similar conclusions. It is this type of scenario that critics worry about, although DoD officials believe that it would be quite unlikely.

Moderate Defenses

In the more reasonable moderate-defense scenario, the bomber force could deliver some 1,900 weapons during the first five days--more than enough to strike each of the Roadmap targets twice. In the first 15 days, the bombers could deliver some 7,700 weapons (see Figure 9). Although that would be only 14 percent more weapons than the bombers could deliver against strong defenses, the mix of weapons would shift sharply towards short-range munitions (three times more) and away from long-range weapons (only half as many).

Limitations of CBO's Model

As mentioned above, CBO's scenarios are designed to illustrate how different defenses would affect capability and are not intended to be definitive measures of effectiveness. The simplicity of the model makes it easier to understand but ignores too many important factors to predict operational capability. Perhaps most important, it ignores any contribution that Navy and Air Force fighters and other forces would make in the first two weeks, which in many cases could exceed that of the bombers. It also shows how many weapons of each type could be delivered by the bombers but ignores what targets they may be aimed at or even how many targets must be destroyed. In addition, the model probably overestimates the number of weapons that could be delivered. It ignores several operational constraints, such as limits on the number of hours that the bomber crews could fly each month, limits on the number of accurate weapons that would be available to the bombers, missions that were aborted because of technical problems or unexpected threats, and missions on which bombers would carry less than their full load of weapons. Nor does the model estimate how the bomber attacks would affect the progress of the enemy's invasion.

Bombers Will Not Be a Panacea

The preceding discussion conveys the impression that bombers would be so effective that other forces would not matter. But that is not the case. Bombers would be able to deliver large numbers of weapons from long distances, but there would be many tasks that they could not do. For example, none of them would have the ability to act as electronic warfare aircraft or engage enemy air forces. Although much of the public discussion about how bombers would be used assumes that they would be able to find mobile targets and react quickly to changes in the air defenses, in reality they would have to rely on other sensors to tell them where to look and would have some trouble adjusting to rapid changes in threats during a mission. Nor is it certain that

bombers would have the proper information to enable them to launch missions immediately after the start of an unexpected conflict. Unless plans for the first few days had been developed before the conflict occurred (which is possible when attacking fixed strategic targets), the bombers would have to wait. It may also be difficult to plan in enough detail to orchestrate the complex operations needed to destroy an enemy's air defenses and strategic plan quickly. Keeping such predetermined war plans current requires that they be updated frequently during peacetime to reflect new intelligence about the location of targets and threats.

CHAPTER III

ALTERNATIVES FOR IMPROVING THE CAPABILITY OF THE BOMBER FORCE

The Air Force's plans for modernizing its bomber force have drawn criticism from several quarters. Some people have charged that the planned bomber force would be inadequate to execute successfully the Bottom-Up Review strategy of two nearly simultaneous major regional conflicts (MRCs). Consequently, there have been calls for buying more B-2 bombers. Others have argued for keeping more B-52Hs. Still others contend that the number of bombers would be adequate, but only if their capability was improved in ways not included in the Bomber Roadmap. For example, more could be done to optimize bombers and munitions for the conventional missions expected of them in the BUR strategy. Alternatively, resources could be devoted to deploying the bombers more rapidly to forward bases. That would reduce the number of missions that must be flown from the United States.

Nevertheless, supporters of the Administration's plan contend that no significant changes will be needed. By the end of the planned conventional modernization program, they argue, the bomber force will be far more capable than it was during the Persian Gulf War. Furthermore, extra resources may be better spent modernizing other forces to improve the United States' ability to respond to a major regional conflict, such as buying new ground-attack fighters, attack helicopters, or carriers, or stockpiling more supplies and equipment near volatile areas.

The Congressional Budget Office has developed four alternatives to the Administration's plan in order to illustrate the costs and effects of carrying out some of the solutions proposed by critics. The first two would improve capability by increasing the size of the force; the second two would improve the capability of the force without making it larger. These options are not mutually exclusive; depending on the amount of money that could be made available for improvements to the bomber force, the Congress could pursue more than one of them.

Unless budgets increase, however, spending more on the bomber force may require that other programs receive less. Even if the Congress over the next few years adopts larger defense budgets than those proposed by the Administration, there is an opportunity cost associated with funding the alternatives in this chapter: the additional funds will not be available for other programs. And those additional funds are likely to dry up beyond 2000 if the Congress follows through with its plan to balance the budget by 2002. Indeed, defense budgets would be lower than those proposed by the Administration.

This analysis is not meant to be a comprehensive study of the capabilities of the alternatives in war, but rather a comparison that relies on basic measures. The reader should also be warned that, by focusing on bombers only, this analysis presents only some of the possible options for improving the United States' ability to conduct its national military strategy. Clearly, there may be other areas in which investments would prove more cost-effective than some of the options for the bomber force presented here. There may also be trades that could make some of the options more cost-effective than maintaining the current force structure. CBO intends to provide a more thorough analysis of a full range of conventional strike options in the future.

OPTION I: BUY 20 MORE B-2 BOMBERS

Some of the most vocal critics of the Bomber Roadmap advocate buying more B-2s. These critics see a fundamental mismatch between the requirements laid out in the BUR and the force proposed by the Administration. According to the BUR, the United States needs 100 bombers to grapple with one MRC and up to 184 bombers for two. The BUR is unclear, however, whether these figures refer to the total number of bombers in the inventory or the number of operational bombers--those that are not in depots for maintenance or designated as test aircraft. It is also silent about how many bombers would be needed for nuclear missions and how many could be diverted to conventional missions.

Administration officials maintain that 184 refers to the total bomber inventory. Advocates of increasing the bomber force argue that the number refers to operational bombers. In testimony before the House Committee on National Security in April, General John M. Loh, commander of the Air Combat Command, stated that he thinks operational bombers are the correct measure for the BUR force. Keeping 184 bombers operational would require a total inventory of at least 210 bombers, which would mean adding 30 more bombers--by buying more B-2s, retaining more B-52s in the force, or some combination of the two.

This option would buy 20 more B-2 bombers, the increment that is most commonly discussed. They would be produced at a rate of about three a year over the next seven years. All of them would be made in the same Block 30--fully mission-capable--configuration as the last of the original 20 B-2s. The first of the new bombers would be delivered in 2001. When the last of them was delivered in 2008, the Air Force would have a total of 201 bombers (see Table 13). The number of operational bombers would increase by 16 to 170 under this option, and the bombers available for combat--operational bombers less trainers--would increase

from 130 to 146, assuming that none of the 32 operational B-2s were designated as trainers, which is consistent with the Air Force's plans for the first 20 bombers.

Effect on Capability

This option would measurably increase the capability of the bomber force in relation to the Administration's plan, provided no other bombers were retired and planned bomber modernization programs were not curtailed to help pay for more B-2s. The larger combat force proposed in this option would not only increase the number of bombers that could be allocated to an MRC but also allow U.S. commanders to swing more bombers from a first to a second MRC. The size and flexibility of the

TABLE 13. SIZE OF THE BOMBER FORCE BY 2010 UNDER PROPOSED OPTIONS

	Total Inventory	Operational Bombers	Bombers Available for Combat	Bombers Available Each Day (Mission-Capable)	Bombers Attacking Targets in Theater Each Day[a]
Administration's Plan	181	154	130	98	39
Option I	201	170	146	110	44
Option II	209	176	152	114	46
Option III	181	154	130	98	39
Option IV	181	154	130	98	39/62

SOURCE: Congressional Budget Office estimates based on Department of Defense and Air Force data.

NOTE: Operational bombers--the total inventory less the number scheduled for depot maintenance or designated for testing--are the bombers that are funded to fly. They are also called primary authorized aircraft. Bombers available for combat are all those operational bombers that are not designated as trainers. Numbers of mission-capable aircraft assume that 75 percent of the bombers available for combat are able to fly on any given day.

a. For the Administration's plan and Options I through III, this assumes that each mission-capable bomber can fly no more than four missions every 10 days. For Option IV, this assumes an average of four missions in 10 days for the first three days and, after that, one mission each day for the 12 B-2s, 18 B-1s, and 18 B-52s that are deployed forward.

force under this option might reduce some of the risks associated with the so-called swing strategy, about which General Loh expressed concern in recent testimony.

Increasing the size of the B-2 force would also free it from its silver-bullet role and allow it to take over missions that would pose greater risk to the non-stealth bombers. It would also make the B-2 force less sensitive to combat and peacetime attrition, an important consideration for such a small force, since each aircraft of a 20-bomber force that was lost would reduce the size of the force by 5 percent.

The Effect on Simple Measures. It is difficult, using any single measure, to assess the capability that this option would add. But it is possible to use the number of additional bombers that would be available for combat, the number of additional combat missions (sorties) that the bombers could fly each day, and the additional weapons that the bombers could carry each day. Using the first of these three commonly used measures, adding 20 B-2s to the force would increase the number of bombers that are available for combat by only about 12 percent (see Table 13). Using the second measure, the additional B-2s could add five extra combat missions each day--also an increase of 12 percent--if they operate from the continental United States, as they are likely to do during the early weeks of an unexpected conflict (see Table 14). Similarly, this option would increase the capability of the bomber force to carry JDAM and Mk-84 2,000-pound bombs by only 10 percent, would have no effect on its capacity to carry WCMD or JSOW, and would increase its capacity to carry unguided cluster and 500-pound bombs by 25 percent (see Figure 10).

The Effects Against Different Air Defenses. But those measures ignore the effect of defenses on capability. Nor do they provide any way to measure the effect of additional bombers on the outcome of a war. The real question is, how many weapons can the bomber force deliver when confronted with air defenses and fighters? Furthermore, what effect would this have on the progress of the invasion?

The strength of this option is that it would double the number of stealth bombers. Although it increases the number of weapons that can be carried by the bomber force modestly, those weapons will be carried on the bomber that will be best able to penetrate enemy defenses and deliver short-range standoff and direct-attack munitions. As a result, Option I will improve the ability of the bomber force to fight against an adversary who has a strong integrated air defense by doubling the number of sorties that can be flown and weapons that can be delivered by stealth bombers.

Unfortunately, it is difficult to measure the effect of stealth against enemy air defenses in a definitive way. As one might expect, that effect depends on the capability of the enemy's air defenses and air force and how resistant they are to attack by bombers and other systems. It also depends on how well stealth and the electronic

countermeasures systems that protect non-stealth bombers perform. If the defenses are strong and can survive repeated attacks, additional B-2s will add significant capability. If the defenses are light, however, the additional B-2s will not add much capability; other bombers will be able to fly close to most targets.

To illustrate the effects of this option in 2010 over a range of possible defenses, CBO used the scenarios described in Chapter 2 and the Roadmap goal of destroying 1,250 high-priority target elements within five days. CBO made one adjustment, however. So far, those scenarios account for only one aspect of stealth: stealth bombers can penetrate defenses and deliver more short-range weapons. But

TABLE 14. CAPABILITY AND COSTS OF THE ALTERNATIVES

Option		Combat Missions Per Day (Percentage increase)	Increases in Weapons Delivered Over 15 Days (Percent)[a]			Cost Through 2020 (In billions of 1996 dollars)
			Light Defenses	Moderate Defenses	Strong Defenses	
I	Add 20 B-2s	12	12	22	35	26.8
II	Keep All 94 B-52s	17	11	17	17	3.2
III	Improve Planned Force	0	13	0	0	1.1
IV	Preposition Equipment, Deploy Bombers Quickly	0/60[b]	0/50[c]	0/67[c]	0/82[c]	1.8

SOURCE: Congressional Budget Office.

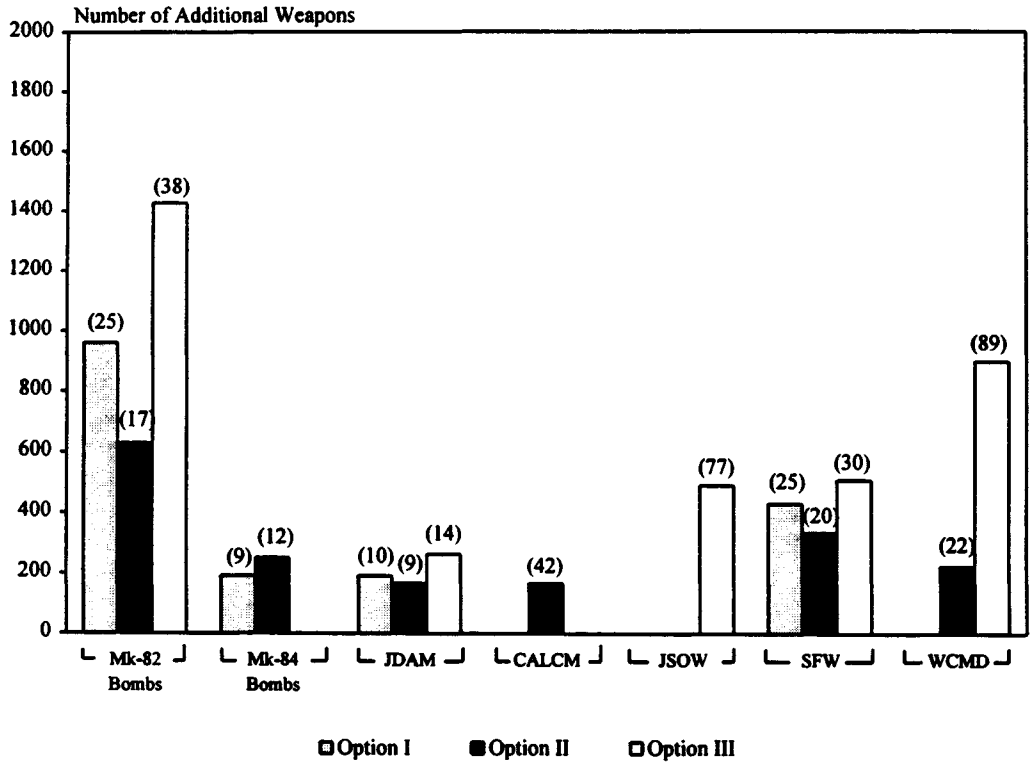
a. These numbers are derived from the scenarios that CBO developed to illustrate the capability of the options against defenses with different capabilities. The strong-defense scenario probably overstates the capabilities of stealth and future enemy defenses. The light-defense scenario probably understates the capability of the most challenging defenses that the United States may face.

b. The first number indicates that daily combat missions would not increase for the first three days of the conflict under Option IV. The second number refers to the percentage increase in daily sorties that is possible after the third day by deploying 16 B-2s, 18 B-1s, and 18 B-52s to forward bases.

c. The first number indicates that there would be no increase in weapons delivered during two weeks under this option if the theater commander had enough warning or cargo aircraft to relocate bombers quickly. The second number refers to the percentage increase in weapons delivered over 15 days by deploying 16 B-2s, 18 B-1s, and 18 B-52s to forward bases in those cases in which the theater commander would not otherwise be able to deploy the bombers for at least two weeks.

additional penetrating bombers may also help suppress the enemy's defenses and air force more quickly, allowing the non-stealth bombers to move in and use their short-range weapons sooner. To illustrate this effect, CBO assumed that doubling the number of B-2s would cut in half the time that it took to suppress the enemy's integrated air defense and air force. That assumption--which almost certainly

FIGURE 10. WEAPONS-CARRYING CAPACITY ADDED UNDER EACH OPTION



SOURCE: Congressional Budget Office using data from the Department of Defense and the Rockwell International, Northrop Grumman, and Boeing Corporations.

NOTES: The number of weapons in this figure reflects the capacity added to the bomber force under each option to carry a single type of weapon if each mission-capable bomber flies one mission. (The mission-capable portion of the force is assumed to be 75 percent of those bombers that are designated for combat.) The number at the top of each bar indicates the extent to which an option would increase (in percent) the capacity of the bomber force to carry that weapon compared with the planned force. This illustration does not include any effects of enemy defenses.

Mk-82 = 500-pound unitary bomb; Mk-84 = 2,000-pound unitary bomb; JDAM = Joint Direct Attack Munition; CALCM = Conventional Air-Launched Cruise Missile; JSOW = Joint Standoff Weapon; SFW = Sensor-Fuzed Weapon; WCMD = Wind-Corrected Munitions Dispenser.

overstates the capability of the B-2 because it ignores the fact that much of the effort against the air defenses would come from non-stealth bombers using standoff weapons--places an upper limit on the contribution that the extra B-2s can make.

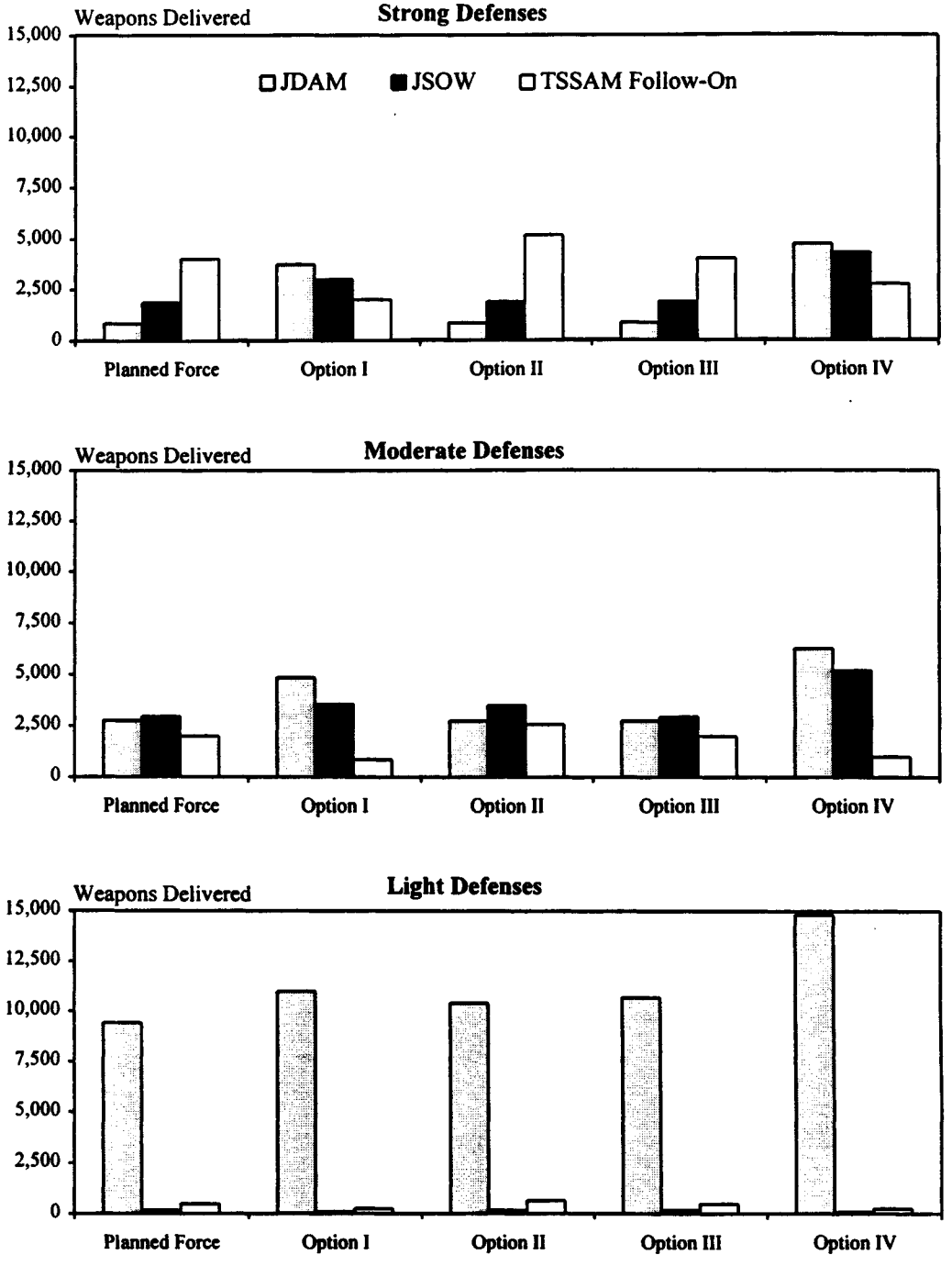
In the case of light defenses, the additional B-2s reduce the time that the B-52s and B-1s must stand off from three days to two. That would have a modest effect on the capabilities of the bomber force because the effects of stealth are small. It would increase the total number of munitions delivered over the first 15 days by only 12 percent (to 11,300) and the number of short-range weapons delivered by only 17 percent. It would allow the non-stealth bombers to expend only 330 fewer standoff weapons over 15 days than with the planned force (see Figure 11). Because the planned force can deliver a significant number of direct-attack weapons against light defenses, this option would not add significantly to its ability to meet the Roadmap goal of striking 1,250 target elements in the first five days.

By contrast, in the less likely scenario involving strong defenses, additional B-2s could have a significant impact because CBO assumed that those bombers would reduce the standoff time from 15 days to eight. As a result, Option I would increase the total number of weapons that could be delivered in 15 days by 35 percent compared with the planned force. Simultaneously, the number of long-range standoff weapons used would be cut by one-half. The option would also quadruple the number of JDAMs that could be delivered. Over the first five days, this option would increase the number of warheads that could be delivered by 14 percent--enough to strike 80 percent of the aimpoints in the Roadmap target set twice.

In the more reasonable moderate-defense case, in which the additional B-2s would help destroy the enemy's air defenses within four days rather than eight, the effect of adding the B-2s would be less dramatic. It would increase the total number of weapons that could be delivered within 15 days by 22 percent and the number of JDAMs by 77 percent.

The results of those scenarios should be viewed with caution, however. The numbers of weapons shown in Figure 11 represent a potential or maximum capability for the assumptions of each scenario because they neglect many operational factors that would limit the capability of the bombers. For example, they assume that bombers can fly one sortie every two and one-half days for two weeks without wearing out their crews. They also assume that no mission-capable bombers would be withheld in reserve other than those dedicated to training. In addition, each bomber would be fully loaded with weapons, there would be no aborted missions or targets that cannot be attacked because of unexpected threats or poor weather, only accurate weapons would be used, and the supply of those weapons would be unlimited. Indeed, some scenarios show that the bombers would use almost 10,000

FIGURE 11. COMPARISON OF MUNITION EXPENDITURES UNDER VARIOUS OPTIONS



SOURCE: Congressional Budget Office.

NOTES: These results are derived from the scenarios that CBO developed to illustrate the capability of the options against varying defenses. The strong-defense scenario probably overstates the capabilities of stealth and future enemy defenses, and the light-defense scenario may understate the most challenging defenses that the United States may face. Because the scenarios ignore many operational factors that would reduce the numbers of weapons that bombers could deliver in each option, they are best used to compare the relative capability of each option.

JDAM = Joint Direct Attack Munition; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile.

JDAMs (one-sixth of the planned inventory) during the first two weeks of a single major conflict. Such heavy use would require all of those weapons to be pre-positioned at bomber bases. Other scenarios show that the bomber force would consume more than 5,000 TSSAM follow-on missiles within the two-week period--probably more missiles than DoD expects to purchase.

Consequently, the results of the scenarios are best used to assess the relative effects of the options in the presence of varying defenses and not to indicate accurately the number of weapons that would actually be delivered. For example, it is important that compared with the planned force, Option I would increase by almost 350 percent the number of JDAMs that could be delivered in the unlikely case that enemy defenses were as effective and resistant to attack as assumed in the strong-defense scenario. And against light defenses, it would deliver only 17 percent more JDAMs than would the planned force.

How Useful Are These Results? The above scenarios provide illustrative boundaries for a potential conflict and should not be considered predictions of what might actually occur. The light-defense scenario may understate the ability of future defenses. For instance, although allied air power disabled significant portions of the Iraqi integrated air defense system (IADS) within two days, many combat aircraft were dedicated to that mission and were supported by forces that provided air cover and jammed Iraqi radar. During the early days of a future conflict, those assets may not be available until the United States has a chance to build up its forces in the region. Furthermore, future adversaries may learn from Iraq's experience and reduce the vulnerability of key command and control centers by placing them underground. They might also use their air forces more effectively and force the non-stealth bombers to stand off longer.

Similarly, there are good reasons to believe that the strong-defense scenario overstates the potential capability of enemy air defenses and is unrealistically favorable to stealth. By assuming that every square inch of the opponent's country is heavily defended, it significantly understates the ability of the non-stealth bombers, particularly the B-1, to penetrate some sectors of the integrated air defense and attack targets with JDAMs and WCMDs. Indeed, according to the Bomber Roadmap, the majority of the target set in a future regional conflict is likely to be lightly or moderately defended, although a greater proportion of the target set for the first days of a conflict will be highly defended.

For example, large sectors of Iraq were not defended by radar-guided SAMs, including the areas along the Saudi border where some Iraqi troops were deployed (see Figure 12). This means that bombers could fly through those areas at high

altitudes--above the range of the most numerous threat, the shoulder-fired SAM--provided Iraqi fighters could be kept at bay.

In addition, the strong-defense scenario neglects the fact that advancing armies would probably be more vulnerable than targets within the territory of the invader because they would be outside the national integrated air defense system. Although many of Iraq's radar-guided SAMs were mobile and designed to protect invading forces, many were kept in Iraq to defend critical fixed targets around Baghdad, other major cities, and military production facilities. Moreover, the scenario does not allow for selective suppression over key targets or for creating corridors through the IADS, tactics that are frequently used in combat. Nor does it allow for the fact that the B-52H's electronic self-protection system is very good and that of the B-1B should be when it is upgraded. It also excludes the contributions of

FIGURE 12. AREAS COVERED BY IRAQI RADAR-GUIDED SAMs BEFORE DESERT STORM

SOURCE: Eliot Cohen, *Gulf War Air Power Survey* (Air Force, 1993), vol. 2, part II, p. 134.

several hundred U.S. and allied shorter-range combat aircraft--many of which will have stealth characteristics in the future--that would be available from the beginning in Korea and even in the Persian Gulf, unless the enemy first destroyed all air bases in the theater and kept them closed with repeated attacks.

The strong-defense case also assumes that doubling the number of B-2s will cut in half the time that it takes to destroy the IADS, despite the fact that much of the effort against those defenses would come from other bombers. In addition, B-2s will devote a significant portion of their effort to striking key command and control and leadership targets, according to the Bomber Roadmap. If CBO had assumed that the impact of additional B-2s was proportional to the bombers' likely share of the attack on the air defenses, doubling the number of B-2s would hasten the demise of the air defense system by at most 10 percent.

Furthermore, if the experience with Iraq during the Persian Gulf War proves typical of future conflicts, it would be reasonable to expect that integrated air defenses might collapse within a few days--sooner than the eighth and fifteenth days assumed in the moderate- and strong-defense cases, respectively. Before the allied assault began, Iraq's air defense was characterized as one of the best in the world, and the Iraqis--rich by the standards of other developing nations--spent a lot to build it. The system featured modern SAMs and radar and was integrated by an advanced computer system developed by the French. Nevertheless, a clever allied war plan allowed the coalition to destroy the system quickly; by the end of the second day of the air war, allied aircraft were able to fly over large sectors of Iraq at medium and high altitudes with relative impunity. Similarly, other regional powers in the developing world may not be able to afford an IADS that will withstand a coordinated attack.

Of course, the proliferation of advanced systems from Russia could change the picture somewhat. But a lack of resources would probably limit the number of those systems that developing nations could buy. And mastering the complexity of those systems might be difficult for nations that devote few resources to training. The fact of the matter is that without an effective air force to keep U.S. warplanes at bay--a capability that few, if any, countries in the developing world are likely to have--an enemy's air defenses would find it difficult to survive for long periods.

A more crucial limitation of this analysis, and one that makes stealth bombers appear more attractive, is that CBO ignores the contributions of other U.S. and allied air, naval, and ground forces. That includes forces that would be in the theater at the start of the conflict and those that would begin to arrive from outside the region after the first few days. The United States keeps at least a wing of Air Force fighters in Korea and another in the Persian Gulf region to enforce the U.N. no-fly zone in Iraq.

And the Navy has a carrier based in Japan and keeps one near the Persian Gulf. Not only would those aircraft have an impact on the battle by themselves, but they could help the bombers penetrate defenses more easily by suppressing air defenses and engaging enemy fighters. Cruise missiles launched by Navy surface ships and submarines could also help to suppress air defenses.

The Heavy Bomber Force Study. As discussed in Chapter 2, the Institute for Defense Analyses' recently completed study of the bomber force concluded that purchasing 20 additional B-2s was not cost-effective. The study found that against a wide range of threats the planned force was adequate, the additional B-2s were not necessary, and they had little effect on the outcome of a conflict. In a very challenging scenario in which the conflict would happen without warning and no tactical aircraft would be in the theater for two weeks, the planned force would not fare as well (although the United States and its ally would win the war). But the study found that 20 additional B-2s would make little difference in that scenario; more than 60 would be required, as well as a large number of additional accurate weapons. Department of Defense officials do not seem concerned by those results because they believe such a scenario is very unlikely. Critics of the study do not share that assessment, however, and believe that the results support their argument for more B-2s. Ultimately, the importance one attaches to buying more B-2s depends largely on how likely such a scenario seems.

Effect on Costs

As the preceding analysis shows, there is no doubt that adding more B-2s would increase the capability of the force. The question is, how many of these bombers does the United States need and how many can it afford? Buying 20 new bombers would be expensive (and, of course, would require the Congress to rescind legislation capping the B-2 program at 20). Furthermore, the costs would not end after the bombers had been purchased; the aircraft would have to be supported and maintained throughout their service lives. In addition, more pilots and maintenance crews would have to be trained and added to the payroll. Several Administration officials, including General John M. Loh, head of the Air Combat Command, have expressed concern about the effects on other programs of funding more B-2s--particularly planned bomber modifications and weapons development programs--if the Air Force is required to buy new bombers but has no additional money in its budget to buy and operate them. Neither would this option address the gaps that some have identified in the weapons with which the B-2 would be equipped. Furthermore, the Air Force has not yet verified the ability of the contractor to deliver the bombers at their advertised price.

Even if the Air Force obtains additional money over the next five years, more B-2s are not at the top of its priority list. General Loh and the Chief of Staff of the Air Force, General Ronald Fogelman, have stated that restoring the funding taken from the F-22 program last December, buying more F-16s and F-15Es, and ensuring that the B-1B readiness and modernization programs are properly funded are more pressing priorities.

Costs of 20 More B-2s. CBO estimates that adding 20 B-2 bombers to the force will cost $26.8 billion in 1996 dollars through 2020--$18.0 billion to purchase the 20 bombers, and $8.8 billion to operate and support them through 2020 (see Table 15). That estimate draws heavily on the estimate of the recurring costs to build the additional bombers that the Institute for Defense Analyses developed for the Heavy Bomber Force Study, but CBO developed its own estimate for other acquisition costs and the costs to operate and support the bombers.

This option would cost $790 million in 1996, $2.9 billion in 1997, and $13.5 billion through 2001--an average of about $2.3 billion per year. (Those figures are in constant 1996 dollars; Table A-2 in the Appendix shows the costs in current dollars.)

TABLE 15: PROCUREMENT SCHEDULE AND ESTIMATED COSTS OF BUYING 20 MORE B-2 BOMBERS (In millions of 1996 dollars)

	1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
				Number of Aircraft				
Purchased	0	2	2	3	3	3	13	20
Delivered	0	0	0	0	0	2	2	20
				Cost				
Acquisition Costs	790	2,900	1,910	2,710	2,640	2,440	13,390	18,030
Operating and Support Costs	0	0	0	0	30	120	150	8,780
Total	790	2,900	1,910	2,710	2,670	2,560	13,540	26,810

SOURCE: Congressional Budget Office based on data from the Department of Defense and the Institute for Defense Analyses.

Total costs could be lower--by perhaps $2 billion--if the Defense Department accepts the manufacturer's offer to build the additional aircraft according to the schedule and specifications it offered in a fixed-price contract. That offer is based on efficiencies and other factors that the manufacturer believes will make costs dramatically lower than those of the initial 20 B-2s; the implication is that if costs were not lowered, the contractor and not the government would suffer the consequences.

CBO uses a higher estimate in this analysis for two reasons. First, a higher estimate is more consistent with the trend of costs for the first 20 B-2s. Second, DoD or the Congress may not want to abide by all of the terms and conditions of the contractor's proposal, which could increase costs substantially. Indeed, such changes could lead to costs that are higher than those in CBO's estimate.

Several estimates of the costs of purchasing additional B-2s have been made, and they vary over a range of several billion dollars. The reason for the variance involves the unique nature of the B-2 program and the difficulty of extrapolating the cost of additional bombers using data from the first 20. Only 20 bombers are being built--a very small quantity by manufacturing standards--which makes it difficult to estimate what the next unit will cost. Estimating the cost of additional units is much easier when hundreds or thousands of an item have already been made because the manufacturer has better data about its production costs. Adding to the difficulty for B-2 estimates, the first 20 B-2s were built before the development program was completed. As problems were discovered during development, the changes were incorporated into only those bombers that were in the early phases of production. Bombers that were too close to completion or had already been delivered to the Air Force will be retrofitted later. As a result, the development and production funds are tightly intertwined and difficult to separate.

Adding to the confusion is the fact that Northrop Grumman presented its offer as a firm, fixed-price contract. Three subsequent estimates of procurement costs have adjusted its estimate upward. In the lowest estimate, the Air Force accepted that the manufacturer could provide 20 bombers at the offered recurring price for the airframes, but added $2.3 billion to account for costs that the service believed it would end up having to pay if it purchased the bombers. Two groups--IDA in its Heavy Bomber Force Study and the Pentagon in its cost analysis--derived their own numbers for the recurring cost of the bombers by using data about the manufacturing process supplied by Northrop Grumman. Those two estimates are roughly $1.5 billion higher than the Air Force's estimate. Overall, the two groups estimated that total acquisition costs would be roughly $2.5 billion higher than the Air Force's number.

CBO's findings do not imply that Northrop Grumman cannot deliver bombers at its new proposed price. Indeed, if the company signs a firm, fixed-price contract at the proposed price with the Air Force, it will be bound to produce those 20 bombers at that price.

But a firm, fixed-price contract has several pitfalls. One is that if the contractor has underestimated the costs, it may be unable to deliver. Another is that any changes that the Air Force wants to make in the program after letting the contract can become a vehicle for recouping anticipated losses. Perhaps most important, DoD does not usually let contracts for the entire duration of a production program. Rather, it usually buys weapons in lots and negotiates a contract for each lot. Those negotiations can also become a means for the contractor and the service to increase the price to cover higher-than-expected costs.

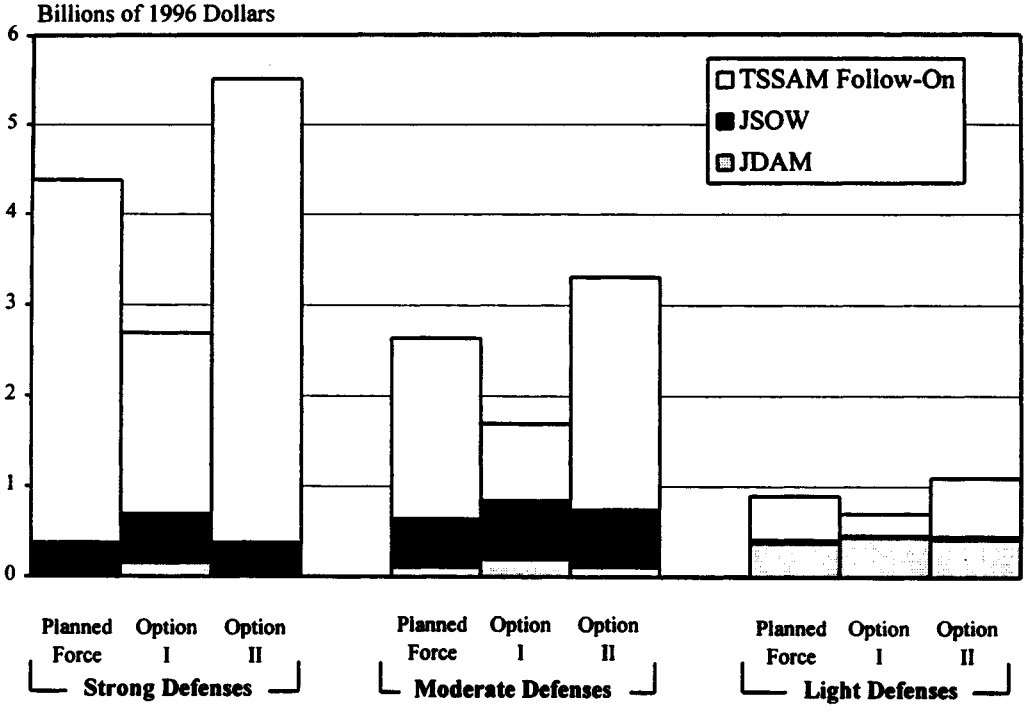
Peacetime Versus Wartime Costs. The above discussion focused on the cost of buying and operating the bombers--the costs incurred during peacetime. CBO typically uses that measure for a weapon system because one cannot predict how many or what types of conflicts a weapon will encounter during its life.

But some supporters of the B-2 argue that 20 additional stealth bombers will save enough money to pay for themselves because they can penetrate defenses and deliver low-cost, short-range attack weapons rather than use expensive standoff weapons. CBO has found that additional B-2s could only reduce the cost of the weapons expended by the entire bomber force by less than $2 billion during the first two weeks of a conflict--the period when bombers would most likely use long-range standoff weapons because portions of the enemy air defenses might still be operational. Those lower costs represent a fraction of the $27 billion lifecycle cost for the 20 bombers. Furthermore, this result is derived from a scenario that is very favorable to stealth: one in which the opponent has very effective, survivable air defenses and an effective air force that forces all bombers but the B-2s to use standoff weapons against all targets for the first 15 days, and 20 additional B-2s help destroy those defenses within half the time it would take the planned force to destroy them (see Figure 13). This estimate uses the strong-defense scenario developed above and assumes that JDAM and JSOW would be bought at their planned average unit procurement price of roughly $40,000 and $180,000, respectively, and that each TSSAM follow-on missile would cost $1 million. (The Air Force anticipates an average procurement price of $600,000 for the follow-on missile. CBO uses the higher cost to be conservative.)

Over the life of the bombers, 14 major conflicts, an average of more than one every two years, would be necessary to amortize the costs of the bombers in this manner. By historical standards, that is a very large number of major regional

conflicts; the United States has engaged in only three large conflicts since 1945. Even if the high consumption of standoff weapons lasted for a full month rather than the 15 days assumed here, or long-range weapons cost twice as much, the United States would have to fight at least one such challenging war every three years to justify spending the money on the bombers. There may be other reasons to justify spending the money on the bombers: fewer escort and defense suppression fighters may be needed, the number of casualties might be reduced, or the more intense attacks possible with short-range weapons might shorten a conflict, but using fewer munitions during conflicts is not reason enough by itself.

FIGURE 13. COST OF MUNITIONS FOR THE PLANNED FORCE AND OPTIONS I AND II FOR ILLUSTRATIVE SCENARIOS



SOURCE: Congressional Budget Office.

NOTES: These results are derived from the scenarios that CBO developed to illustrate the capability of the options against defenses with different capabilities. CBO assumes that JDAM, JSOW, and the TSSAM Follow-On missile cost $40,000, $180,000, and $1 million, respectively. The strong-defense scenario probably overstates the capability of stealth and future enemy defenses, and the light-defense scenario probably understates the capability of the most challenging defenses that the United States may face. Because the scenarios ignore many operational factors that would reduce the numbers of weapons that bombers could deliver in each option, they are best used to compare the relative capability of each option.

JDAM = Joint Direct Attack Munition; JSOW = Joint Standoff Weapon; TSSAM = Tri-Service Standoff Attack Missile.

Effect on the Industrial Base

Stopping B-2 production would halt bomber production entirely, making later startup more difficult. This analysis does not delve into that issue. The Congress has directed DoD to study the industrial base because the recently released Heavy Bomber Force Study did not indicate a need for more bombers. People concerned about the industrial base worry about losing the skilled workers necessary to build large stealth bombers. They also worry about the time it would take the United States to design and build a new bomber if required by a change in geopolitics, large losses of bombers in combat, the need to replace an aging fleet, or a marked increase in the capabilities of air defenses by potential adversaries in the developing world.

Nevertheless, there are several reasons that preserving the industrial base may not be a compelling argument. There will be other programs--notably the F-22, the Joint Advanced Strike Technology aircraft, and the Tier 3-minus unmanned air vehicle--that will continue to develop and refine stealth technology, engine technology, and avionics. Also, the three types of heavy bombers in the force today were built by three different contractors, and there have been long gaps between bomber production in the past. Finally, preserving a production line may tie the United States to old technology. The B-2 may be the wrong bomber for the future. In addition, a future bomber could benefit from years of technical innovations from other stealth systems that were not available to the B-2 program.

Other Issues

Increasing the number of B-2s may force the United States to decrease the loadings of nuclear weapons on the B-52s in order to stay within the limits of the START II treaty. The United States will probably not be willing to reduce the number of weapons that can be carried on the B-2's rotary launchers because the bomber will also use those launchers to carry smart conventional munitions. (See the discussion about B-52H loadings under START II below.)

OPTION II: KEEP ALL 94 B-52H BOMBERS IN THE FORCE

Advocates of this option have been motivated by one of the concerns voiced by supporters of buying more B-2s: namely, that the planned bomber force is too small to meet Bottom-Up Review requirements and those articulated by some military commanders. Option II would keep all 94 B-52Hs in the force through at least 2020--28 more than are currently planned. All of them would be upgraded to carry the same conventional munitions as the first 66 (see Chapter 2). Although these

bombers are old--the newest was built in 1962--they have been upgraded extensively already and their airframes have enough structural life left to fly for at least another 30 years, according to the Air Force.

Option II illustrates a significantly less expensive way to increase the size of the bomber force. It makes use of existing assets rather than buying new ones; it also provides a larger force sooner. In addition, it would cost less to operate the extra B-52s each year than 20 additional B-2s. But there is a tradeoff: the older aircraft will be less capable of penetrating air defenses and, as a result, will have to rely more on expensive standoff weapons during the days before enemy air defenses have been suppressed.

Effect on Capability

With the inventory of 209 bombers that this option would provide, the United States could increase the size of its force of operational bombers in 2001 from 154 to about 176 without having to buy new aircraft. The number of bombers that would be available for combat (operational bombers less trainers) in 2001 would increase from 130 to about 152 under this option (see Table 13 on page 61). That would increase the capacity of the bomber force to carry CALCMs by 170 (40 percent), WCMDs by 20 percent, and JDAMs by 10 percent (see Figure 10 on page 64). In relation to the force that incorporates more B-2s, this option would be able to carry more CALCMs and WCMDs, about the same number of JDAMs and unguided 2,000-pound bombs, and slightly fewer unguided cluster and 500-pound bombs.

But which type of munitions would the B-52H be able to deliver safely during a war, when defenses cannot be ignored? The capability that the additional B-52Hs bring to a conflict depends on what one assumes about future scenarios. The B-52 will have to stand off from modern long-range air defenses during the opening days of a conflict unless there are sufficient tactical aircraft already in the theater. But if the enemy's air defenses and fighters can be beaten down quickly by U.S. forces--much as Iraq's defenses disintegrated in the opening days of the Persian Gulf War--the additional B-52s can deliver large numbers of smart and unguided direct-attack munitions from high altitudes.

CBO's illustrative scenarios show the possible effects of a larger B-52H force (see Figure 11 on page 66). Against light defenses, a force with 28 more B-52s would be able to deliver 11 percent more weapons and 10 percent more JDAMs over 15 days than the planned force and almost the same number as the force with 20 more B-2s. Against strong defenses that can withstand the pounding of a U.S. attack for several weeks, however, the force with more B-52s could deliver 17 percent more

weapons in 15 days than the planned force, although all of that increase would be TSSAM follow-on missiles. Although this increase in weapons delivered over two weeks is only about half that associated with 20 more B-2s, it comes at a significantly lower price. Still, the force under this option would be able to deliver up to 2,300 weapons during the first five days, slightly more than the force that has 20 more B-2s. That would allow the bomber force to attack 80 percent of the target elements in the Roadmap target set with more than one weapon during the first five days of a conflict.

Option II offers advantages other than its low cost. One of the main advantages of keeping more B-52s is that it would have an immediate impact on the size of the force, whereas buying additional B-2s would not have its full impact on the size of the force until 2008. In addition, the larger combat force proposed in this option would increase the number of bombers that could be allocated to a major regional conflict in relation to the planned force and allow U.S. commanders to swing more bombers from a first to a second major regional conflict. A larger B-52H fleet would also make it easier to keep more bombers available for nuclear missions. Finally, this option would provide more aircraft to carry WCMD--expected to be the Air Force's most effective antiarmor weapon--than would Option I because under current plans the B-2s would not be equipped with that accurate cluster weapon.

Effect on Costs

Keeping all 94 B-52s in the force would increase operating costs by $120 million a year, starting in 1996. In addition, the Air Force would have to pay a one-time cost of roughly $100 million starting in 1996 to modify the 28 additional nuclear bombers so that they could carry conventional munitions. This option would cost $130 million in 1996 and $820 million through 2001 (see Table 16). Through 2020 it would cost $3.2 billion, or almost $24 billion less than buying 20 more B-2s.

Wartime Costs. Although increasing the size of the bomber force by adding B-52s is much less expensive in peacetime than buying more B-2s, under some circumstances the costs of conducting a war could be higher under this option. The key factor is the number of long-range munitions required, which depends on the capability of the enemy's air defenses and air force.

Borrowing from the above analyses of capability and B-2 costs, it is possible to project the ways in which different scenarios can change the relative wartime costs of these two options. In the light-defense scenario, the extra B-52s would expend only about 400 more long-range standoff weapons and 90 more JSOWs in a conflict than Option I with more B-2s. Thus, the wartime cost of Option II would be about

$430 million higher over two weeks than the first option (see Figure 13 on page 74). In sum, the force with 20 additional B-2s would cost less in wartime than the force with extra B-52s, but the magnitude of those savings would be small compared with the $27 billion cost of the new bombers.

In the strong-defense case, the force with more B-52s would expend munitions worth $5.5 billion during the first 15 days, or $2.8 billion more than the force with 20 additional B-2s. If the bombers can reasonably be expected to fight in at least nine of these challenging conflicts against extremely well-armed foes through 2020, buying more B-2s could be the more cost-effective option. Of course, that would require the United States to engage in an average of at least one major regional war every three years, a rate that has heretofore been unprecedented. The real wartime costs of Options I and II probably lie somewhere in between the boundaries established in those two scenarios.

Other Issues Raised by Option II

Option II raises an issue under the START II treaty, although it should not be viewed as a significant problem. The B-52H has been identified by the United States as a

TABLE 16. COST OF THE ALTERNATIVES THROUGH 2020
(In millions of 1996 dollars)

Option		1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
I	Add 20 B-2s	790	2,900	1,910	2,710	2,670	2,560	13,540	26,810
II	Keep All 94 B-52s	130	140	150	140	130	130	820	3,230
III	Improve Planned Force	90	260	210	190	170	90	1,010	1,130
IV	Preposition Equipment, Deploy Bombers Quickly	240	250	260	260	260	250	1,530	1,760

SOURCE: Congressional Budget Office.

nuclear bomber, and under the treaty, increasing the number of bombers will affect the number of nuclear weapons that each B-52H is allowed to carry. The Administration plans to deploy 66 B-52Hs under the treaty, allocating 1,000 warheads to this force. Preliminary information by the Air Force indicates that those warheads will probably be allocated by deploying the maximum load of 20 nuclear cruise missiles (12 under the wings and eight inside the bomb bay) on some bombers and modifying the other bombers so that they can only carry missiles under the wings. For example, the Air Force might distribute its 1,000 warheads on 66 bombers by modifying 40 to carry cruise missiles externally and keeping only 26 bombers with the ability to carry missiles both internally and externally. The Air Force would have to change its allocation, however, if it retained a force of 94 bombers.

OPTION III: FURTHER IMPROVE THE CAPABILITY OF THE ROADMAP FORCE

The modernization that the Air Force plans for the bomber force will greatly improve its ability to conduct conventional missions. Nevertheless, there are modifications that could be made to all three bombers that would improve their capability even further and would be relatively inexpensive. This option focuses on the question, "How does the United States get the most out of the Air Force's planned bomber force?" It also responds to some extent to the criticism made by some analysts that the Air Force has not matched its upgrades with the roles that each bomber is expected to play.

Option III would make several improvements to each of the three bombers (see Table 17). It would allow the B-1 to deliver weapons more accurately by installing the relative targeting system (making it similar in capability to the one on the B-2), improve its ability to communicate with other forces in the theater, and buy more bomb racks for cluster munitions and unguided 500-pound bombs. On the B-52, this option would add JSOW and provide smart bomb racks that would boost the number of JDAMs and WCMDs that the bomber could carry. And for the B-2, this option would integrate the JSOW and WCMD smart weapons that will be essential for exploiting the capabilities of this stealth bomber.

A second round of modifications consistent with this alternative's philosophy of making the most of existing resources would improve the mission-planning and communications systems on the bombers so that they could change their missions and targets while in flight. The modifications would allow them to cope more effectively with the rapidly changing environment of the battlefield, particularly during attacks on advancing armies. By allowing the bombers to have access to the latest information about the disposition of air defenses, this option would also reduce

TABLE 17. COST TO MODIFY THE BOMBERS UNDER OPTION III
(In millions of 1996 dollars)

	1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
Core Modifications Included in Option III								
B-1								
Relative targeting system	20	20	30	40	40	20	170	170
Communications upgrade	a	a	a	a	a	a	a	a
More conventional bomb racks[b]	40	100	70	40	30	0	270	270
B-2								
Add JSOW	0	20	60	20	10	10	110	120
Add WCMD	0	10	20	20	20	a	70	70
B-52								
Add JSOW	10	10	a	a	0	0	10	10
Add smart weapon capability to internal bomb racks	0	80	20	0	0	0	100	100
Total	70	230	190	110	100	30	730	740
Additional Mission-Planning Upgrades								
B-1								
Real-time information in cockpit[b]	10	10	10	10	a	a	40	40
In-flight retargeting[b]	a	10	10	10	10	10	40	40
B-2								
Mission-planning upgrades[b]	0	0	0	60	50	50	160	260
B-52								
Mission-planning system[b]	10	10	10	10	10	0	40	40
Total	20	20	20	80	70	70	280	380
Core Modifications Plus Upgrades								
Total	90	260	220	190	170	90	1,010	1,130

SOURCE: Congressional Budget Office based on data from the Department of Defense, Boeing, Rockwell International, and Northrop Grumman.

NOTES: Numbers may not add to totals because of rounding. JSOW = Joint Standoff Weapon; WCMD = Wind-Corrected Munitions Dispenser.

a. Less than $5 million.

b. Based on contractor estimate. Because this cost has not been verified by the Air Force, it should be treated as an illustration of the approximate order of magnitude of likely costs.

the chances that they would be shot down. Without those upgrades, it would be difficult for the bomber force to attack invading armies--a key mission, according to the Bottom-Up Review and the Bomber Roadmap.

The B-1B

Installing the relative targeting system on the B-1 would offer several advantages. First, by improving the resolution of the B-1's radar from about 10 meters to 2 or 3 meters, it would improve the accuracy of such GPS-aided munitions as JDAM and JSOW. By using its more accurate radar the bomber can eliminate much of the uncertainty about the relationship between its location and that of the target and improve the accuracy of JDAM from 13 meters to as little as 5 meters. Analysis has shown that improving JDAM accuracies to 8 meters or better can significantly increase the probability of destroying hardened targets. This upgrade would make the resolution of the B-1B radar comparable to that of the B-2 with its GPS-aided target system. It would also improve the bomber's ability to detect, track, and target moving vehicles. The Air Force is currently funding some development and testing of the upgrade, but is awaiting the outcome of tests before committing itself to buying the system. This upgrade will cost a total of $170 million, according to the Air Force, and could be installed in all 94 bombers by 2003 (see Table 17).

Adding the satellite communications upgrade to the B-1 will allow the bomber to communicate more easily with other U.S. forces in the theater by giving it access to the full range of data and voice satellite systems. This upgrade would cost almost $5 million and would be fully installed by the end of 2003.

Option III would also purchase 100 additional conventional bomb modules: 50 equipped for both unguided cluster munitions and WCMDs and 50 equipped for Mk-82 500-pound bombs. Those extra modules would increase the number of bombers in the force that could carry each of these weapons from 16 to 33 (each bomber can carry three conventional bomb modules, one in each of its three bays). The portion of the B-1 force that can attack armies and softer fixed targets, both of which constitute large portions of the targets expected in a regional conflict, would increase. For example, the capacity of the bomber force to carry Mk-82s would increase by almost 40 percent (see Figure 14). And its capacity to carry WCMDs and cluster bombs would increase by nearly 90 percent and 30 percent, respectively. The Air Combat Command has recommended buying 51 more bomb modules equipped for cluster munitions for the B-1. This option goes further by equipping them to carry WCMD and buying additional racks for the Mk-82. One hundred extra bomb modules would increase costs by a total of $270 million.

The B-52H

Adding JSOW to the B-52 would give it the ability to deliver an inexpensive, accurate, medium-range standoff weapon against soft targets and armor. That would fill a gap in the bomber's armaments because under the Air Force's plans it can currently attack only hardened targets from medium ranges using Have Nap missiles.

Adding JSOW could cost as much as $25 million. But to minimize costs, this option would equip the bomber with JSOW, WCMD, and JDAM at the same time. (Under current plans, JDAM and WCMD are scheduled to be added separately.) By making the required software changes all at once, adding JSOW would only increase costs by about $10 million--$15 million less than if all three weapons were added separately.

The types of munitions that the B-52 can carry internally are limited. Converting the existing internal bomb racks to smart racks would increase the B-52's ability to deliver GPS-aided munitions like JDAM and WCMD by two-thirds and one-third, respectively. It would boost the bomber's capacity for JDAM from 12 to 20 and WCMD from 18 to 24 (see Table 18). Compared with the planned force, adding GPS weapons to the B-52's internal racks would expand the capacity of the bomber force to carry JDAM and WCMD by 14 percent and 89 percent, respectively (see Figure 14). Because the option would make no other changes to the internal racks, it would have no effect on the bomber's ability to carry such unguided weapons as Mk-82s, Mk-84s, and cluster bombs or such standoff weapons as JSOW and the TSSAM follow-on missile.

Adding 1760-type interfaces to the internal racks of the B-52 will cost about $100 million (see Table 17). If the program were started in 1997, all of the bombers would be converted by the end of 2000.

The B-2

By adding JSOW and WCMD to the B-2, Option III would fill two gaps in the bomber's capabilities. Because TSSAM was canceled, the B-2 has no standoff weapon. B-2 program officials believe that need can be filled by JSOW. According to Northrop Grumman officials, JSOW should have enough range to allow the B-2 to stand off safely from the air defenses that such a weapon would be used to destroy. Furthermore, they believe that the short flight time of the weapon, combined with a shape that makes it difficult to detect from the front, will make it survivable enough to attack modern air defenses that have the ability to protect themselves against non-stealth cruise missiles.

It may seem odd that a stealth bomber would need a standoff weapon. If the bomber cannot be seen by radar, why could it not just fly close enough to the targets to use direct-attack weapons? The reason is that the bomber is not invisible, it is only difficult to see. For example, a black car with its lights off can be hard to see at night even if you are looking right at it. With a spotlight you could see it if it came close enough, but you would see a white (non-stealth) car in the dark at a greater distance. The same is true for the B-2. If it comes close enough to powerful radar, it can be seen. Therefore, in order for the B-2 to attack targets that are located close to a powerful radar or to attack the radar itself, it needs a standoff weapon that will allow it to stay out of harm's way. That was the role that TSSAM would have played for the B-2, and it is a role that the program office thinks that JSOW can play.

Northrop Grumman analysts conclude that JSOW will be able to perform 85 percent of the standoff missions that the B-2 would have been assigned to with TSSAM. The remaining 15 percent could be accomplished with long-range standoff weapons from other bombers. Although that analysis has not been independently verified, it does illustrate that JSOW could be a low-cost substitute for the TSSAM follow-on missile in many situations.

TABLE 18. OPTION III'S EFFECTS ON THE ABILITY OF BOMBERS TO CARRY MUNITIONS

Bomber	Effects
B-1	Double the portion of the fleet that can carry WCMDs and CBUs to 33
B-52	Add JSOWs (12 per bomber)
	Increase numbers of JDAMs carried from 12 to 20 and WCMDs from 18 to 24
B-2	Add JSOWs (8 per bomber) and WCMDs (16 per bomber)

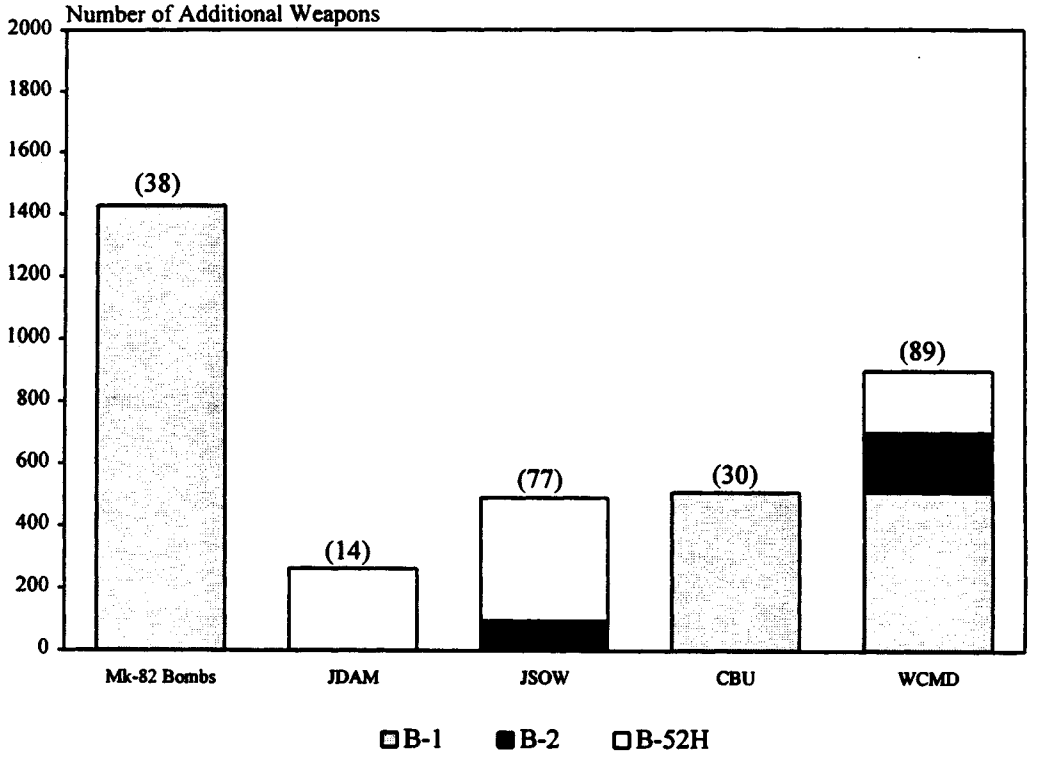
SOURCE: Congressional Budget Office.

NOTE: WCMD = Wind-Corrected Munitions Dispenser; CBU = cluster bomb unit; JSOW = Joint Standoff Weapon; JDAM = Joint Direct Attack Munition.

Option III would equip the B-2 with JSOW by 1999 at a cost of $120 million (see Table 17). That total includes missiles for testing and for a modest inventory of 128 missiles for the bomber, according to Air Force data.

Equipping the B-2 with WCMD would give it the ability to attack columns of vehicles and armor more effectively. Some authors erroneously assume that the Air Force already plans to equip the B-2 with WCMD. Currently, there are no plans

FIGURE 14. WEAPONS-CARRYING CAPACITY ADDED UNDER OPTION III



SOURCE: Congressional Budget Office using data from the Department of Defense and the Rockwell International, Northrop Grumman, and Boeing Corporations.

NOTES: The numbers in this figure reflect the capacity added to the bomber force under Option III to carry a single type of weapon if each mission-capable bomber flies one mission. (The mission-capable portion of the force is assumed to be 75 percent of those bombers that are designated for combat.) The number at the top of each bar indicates the extent to which Option III would increase (in percent) the capacity to carry that weapon compared with the planned force. This illustration does not include any effects of enemy defenses.

Mk-82 = 500-pound unitary bomb; JDAM = Joint Direct Attack Munition; JSOW = Joint Standoff Weapon; CBU = cluster bomb unit; WCMD = Wind-Corrected Munitions Dispenser.

to fit the B-2 with accurate antitank weapons. It will have the ability to carry 16 WCMDs (eight per rotary launcher and one launcher in each bomb bay), but the integration costs have not been included in the Administration's plan. Equipping the bombers would cost $70 million; WCMDs could be installed on the first B-2 by the end of 2000. Because the Air Force is already planning to buy 40,000 WCMDs, funding for additional WCMD kits is not included in this option.

Northrop Grumman has said that the radar and cockpit displays must be improved for the B-2 to make efficient use of the WCMD--an upgrade that might increase the costs of this option by at least $250 million, according to the company. Northrop Grumman has made an alternative proposal to the Air Force that would outfit the B-2s with tactical munitions dispensers (the same casing that the modern cluster bombs use) that would each carry four of the Brilliant Anti-Tank weapons (BATs) that the company developed for the Army. Because those weapons can search a wider area than the Sensor-Fuzed Weapon, the contractor argues that the improved accuracy provided by the Wind-Corrected Munitions Dispenser is not necessary. CBO did not analyze this tradeoff.

The net result of these modifications is that the B-2 force would be far better equipped to perform its missions than it would be under the current plan. JSOW would give the bombers the necessary standoff capability and WCMD would give them the ability to slow an invasion by enabling them to attack armor more effectively. Compared with the planned force, the modifications to the B-2 would increase the capacity of the bomber force to carry JSOW by 15 percent and WCMD by 19 percent.

Improving the Mission-Planning Systems

A second round of upgrades would improve the ability of the bombers to change their missions and targets onboard during flight. That would allow them to cope more effectively with the rapidly changing environment of the battlefield, particularly to avoid unexpected threats and to attack advancing armies. It would eliminate the last vestige of old-style nuclear planning that remains under the Administration's plan: bombers flying missions that have been planned for hours before they take off and are many hours out of date before the bombers arrive in theater. If left uncorrected, those mission-planning delays would make it difficult to attack advancing armies--one of the primary missions for bombers, according to the Bottom-Up Review--because the targeted forces would be miles away before the bombers arrived on the scene.

On the B-1, mission-planning upgrades would include adding the systems that crews would need to obtain real-time intelligence information about unexpected threats and to retarget weapons in flight using coordinates sent by off-board sensors. Developing and installing the Real-Time Information in the Cockpit (RTIC) system on all B-1s would cost about $40 million, according to contractor estimates (see Table 17). Adding in-flight retargeting to the B-1 fleet would cost about $40 million.

This option would also install the Mission-Planning System on the B-52. Like the B-1 upgrades, that system would provide B-52 crews with real-time information and the ability to retarget weapons in flight. This modification would cost at least $40 million.

Mission-planning systems on the B-2 would also be upgraded under Option III. Most important, an upgrade to the mission-management system would allow the bomber to replan its routes, and to some degree its mission, based on new information about either the threats or targets. As mentioned in Chapter 2, the B-2 relies heavily on mission planning to penetrate air defenses. To ensure that it is not detected, the B-2 must know where the enemy surveillance radars, SAMs, and fighters are located so that it can keep its least visible aspects facing their radar. If those threats change during the B-2's long flight to the target area, the bomber may have to change its plan and route to maintain its low visibility. This upgrade would provide some capability to do that. It would also add the secure radios that would be needed for the bombers to get information about new threats and targets. Those changes would cost about $260 million over five years.

Such modifications to the B-2 stop well short of some proposals, however. A group of analysts at RAND have argued for extensive changes in the B-2's mission-planning systems that would enable the bomber to act as a quarterback for other bombers.[1] Taking advantage of its low visibility, the B-2 could loiter over the battle area, use its stealth radar to find targets, and direct other stealth and non-stealth bombers to them. It could also use its passive sensors to identify threats and warn other bombers to avoid them. One change that the RAND group has proposed would add a third crew member to the B-2, a change that would require an expensive modification but is necessary, they argue, to reduce the load on the crew, to get the most information out of the B-2's sensors, and to allow the bomber to play the quarterback role.

Upgrading the mission-planning capability aboard all three bombers would increase the costs of this option by $380 million (see Table 17). It is included here to illustrate the effects of optimizing the bomber force for conventional missions. If

1. Dave Frelinger and others, "Bomber Flexibility Study: A Progress Report" (Santa Monica, Calif.: RAND, 1994).

bombers are to play a truly critical role in the early phases of an MRC--especially attacking armored columns--these upgrades (and perhaps more extensive ones as well) may be worthwhile. For example, under the Administration's plan, it would be difficult for bombers flying over key roads to launch more than a few cluster munitions if they encountered a column of vehicles because they would have to program the target coordinates for each weapon by hand. With better mission-planning systems, they could identify the location and length of the column by radar and the computer would drop a string of cluster weapons, properly spaced for maximum effect. Several studies have shown that bombers should be able to conduct such missions in order for the United States to be able to halt an invasion during a major regional conflict.[2]

Nevertheless, improving mission planning may not be cost-effective. Attacking such moving targets as an armored column is tricky because the targets must be found first. That may have been easy during the Persian Gulf War when the Joint Strategic Targeting and Reconnaissance System was on-station, but this sensor platform may not be available during the early days of a conflict if no air-superiority fighters are available. For one thing, it will be vulnerable to enemy fighters unless it has a protective escort. Thus, the bombers will either have to rely on other assets such as satellites, unmanned air vehicles, or special forces to locate the targets or use their own radars.

Using its own radar to conduct broad area searches, however, makes a bomber--even the B-2, with its difficult-to-detect radar--more vulnerable to detection. One of the techniques of using radar on a stealth aircraft is to keep it turned off as much as possible. When it is on, however, it sends out narrow beams and keeps its energy as low as possible. If cued to the proper general location, though, the bomber can use its radar to find the target, even if it has moved somewhat. Another reason that improved mission-planning software may not be a good investment is that such systems may not be required in order to seed choke points on suspected advance routes with mines to slow down an advancing army. That would probably be a more effective tactic in the mountainous terrain of Korea than in the open desert of Kuwait or Saudi Arabia.

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2. See, for example, Glen C. Buchan and David R. Frelinger, "Providing an Effective Bomber Force for the Future," testimony before the Senate Committee on Armed Services, May 5, 1994 (Santa Monica, Calif.: RAND, 1994); and Jasper Welch, "Bomber Forces for 'Cold Start' Conflict," *Air Force Magazine* (December 1994).

The Effect on Capability

Taken together, the modifications to the bomber force under Option III would almost double the capacity of the force to carry accurate WCMD antiarmor weapons and increase by three-quarters its capacity to carry JSOW standoff weapons (see Figure 14). This option would also increase the capacity for JDAMs by nearly 15 percent, unguided cluster munitions by 30 percent, and Mk-82 bombs by almost 40 percent.

Unlike the other alternatives, however, most of the upgrades proposed in Option III cannot be measured using CBO's illustrative scenarios. Some upgrades--such as adding WCMDs to the B-2 and equipping more B-1s to carry the weapon--are not taken into account by CBO's model because the scenarios assume for the sake of simplicity that JDAM is the only short-range weapon that bombers deliver. Likewise, the scenarios assume that the B-2 can already carry JSOW, which obscures the changes made in this option. Finally, several upgrades would not affect the number of munitions that could be carried, but would improve the chances that the bomber could deliver them effectively. Improvements to the B-1 radar would increase the accuracy with which the bomber could strike fixed targets using JDAM and moving targets using cluster weapons. And mission-planning upgrades would improve both the survivability and flexibility of the bombers in changing missions rapidly.

The Effect on Costs

CBO estimates that it would cost $1.1 billion to upgrade the bombers as proposed in Option III, or 4 percent of the cost to buy and operate 20 more B-2s and 35 percent of the cost of the force that has more B-52s. It would cost $90 million in 1996, and virtually all of the costs would be incurred by 2001 (see Table 17 on page 80). Against an opponent with light defenses, the bomber force in Option III would be able to deliver about the same number of weapons as in Options I or II. Against a very strong defense, however, Option III would provide less capability than either of the more expensive options. Nevertheless, the mission-planning upgrades would probably increase the survivability of the bombers.

OPTION IV: IMPROVE THE ABILITY TO DEPLOY BOMBERS RAPIDLY

Option IV illustrates one way of achieving a larger number of sorties during the early days of a conflict without buying new bombers or keeping more in inventory. It gets the most capability out of the planned bomber force--particularly during the early phases of a conflict--by prepositioning spare parts, support equipment, munitions,

and fuel so that bombers can operate from bases close to the conflict as soon as possible. Bombers operating from forward bases during the first few weeks of a conflict can fly many more sorties than ones operating from the United States.

Option IV would provide insurance against a conflict that occurred without warning, particularly if there were few forces already deployed. In such a case, a theater commander would probably operate his bomber force from the United States for the first two weeks because he would place greater priority on rushing tactical aircraft and ground forces to the theater. In that context, the fourth option could have a measurable effect on the capability of the bomber force in the early days of a conflict.

Although somewhat expensive, this approach is much less costly than adding more bombers and could provide more bomber sorties (and more B-2 sorties) during the first five days to two weeks of a conflict than either Options I or II, which make the bomber force larger (see Table 13 on page 61). It would also reduce the airlift required to relocate the bombers to forward bases, which would make more lift available for tactical aircraft and ground forces. In addition, flying from forward bases would reduce the number of tankers required, which could free up more of those valuable assets for ferrying fighters and supporting the airlift effort.

One difficulty associated with prepositioning is that, for some bases, the United States requires political commitments from its allies to allow the equipment to be stockpiled and bombers to operate from their soil during a conflict.

Current Plans

The Air Force has set up some of its bomber squadrons so that they can operate from forward bases within about five days of the start of a major, unexpected conflict. All war plans are classified, but in general, it would be at least four days from the time the bombers received warning before they could begin flying missions from a forward base. That assumes the forward base has a well-established infrastructure such as those at Guam, Diego Garcia, or Moron in Spain. At a completely bare base, it would take at least five to seven additional days to build the necessary facilities for the aircraft and the several hundred people who are required to support them during combat.

During the time that a unit was being deployed, at least some of the bombers could fly one combat mission from the United States before recovering at the forward base. The time line for an unexpected conflict would go something like this: within the first 22 hours after the bombers received warning, the first wave could be

launched from bases in the United States. The bombers would take 12 to 18 hours to reach their targets. After delivering their weapons they would fly several hours to the forward bases from which they would operate.

During that time, the ground crews and support personnel would be packing their equipment and loading it into cargo aircraft. The first pallets of equipment could be ready for loading within 12 hours and the last within 48 hours, as long as loading was not delayed by demands to prepare more bombers for combat missions (which cannot be done once ground crews have packed all of their equipment). It would take roughly 18 hours to fly the equipment to the forward base. The last of the equipment and people would arrive no sooner than three days after the squadron first received warning. All the equipment would then take at least 16 hours to unpack and set up before the first bombers could be launched on combat missions. As a result, combat operations could not be established at the forward bases until midway through the fourth day or the beginning of the fifth.

The matériel that must be deployed with the bombers includes spare parts in mobility readiness spares packages; ground support equipment, which includes generators, tools, test equipment, and other supplies essential to maintaining the aircraft and preparing it for its next mission; the gear necessary to repair--not just replace--some parts at the forward base; and munitions that would be too expensive to stockpile at every possible base.

The Air Force has developed two types of packages: an independent package including equipment that is unique to a specific type of bomber and allows six bombers to locate at a forward base by themselves, and a smaller dependent package that would allow six bombers to be deployed at the same base at which an independent package would be deployed. Because it includes more equipment, the independent unit would require 20 C-141s (or some equivalent) for six B-1s or 19 C-141s for six B-52Hs to be lifted to a forward base. Lifting a dependent unit of B-1s or B-52s would require 13 or 14 C-141s, respectively.

How quickly those units would actually be deployed to forward bases in a conflict is another matter. Although bombers could operate from forward bases within five days, it is by no means certain that they would. Speed would depend on the priority that the theater commander gave to the bombers. In a conflict that occurred without warning and where few if any U.S. forces were deployed--the type of war in which bombers matter most during the early days of battle--it is unlikely that the theater commander would divert the necessary airlift assets. He would need airlift to rush tactical aircraft and ground forces to the theater, and given that bombers can fly combat missions from the United States, albeit at lower sortie rates, he would probably allocate his lift to other critical assets. It is thus reasonable to assume that

the bombers would operate from their bases in the United States for the first two weeks of a major regional conflict that occurred without warning. (That is what CBO's illustrative scenarios assume.) If the United States had at least a few weeks of warning before a conflict began and had the political resolve to deploy forces in advance, bombers might be deployed near the region before the onset of hostilities. The bombers could also be deployed within five days if the United States and its ally already had large forces in the theater and did not require as much lift for other reinforcements.

Prepositioning Equipment and Spares to Reduce Airlift Requirements

Ideally, bombers would take off from the United States on their first mission and recover at a forward base. There they would be met by their maintenance crews, weapons loaders, and fresh flight crews who would be airlifted in at the same time the bombers left. Bombers could then be serviced, loaded with fuel and weapons, and sent on another mission while the first air crews rested. Enough fuel, spare parts, and munitions would be stored at the forward base to last until more arrived by sea or air. Although this ideal would be difficult to achieve, Option IV should reduce the lift and time required by enough so that the bombers could operate from a forward base on the fourth day of a conflict. That is when their contribution would be most important and also when commanders would want the maximum possible number of bomber sorties each day. According to the Heavy Bomber Force Study, the scenarios in which there is no warning and no tactical aircraft in the theater are the most demanding for the bomber force. By enabling a theater commander to deploy bombers more quickly, this option would help address that problem.

To achieve that goal, Option IV would purchase, preposition, and maintain enough equipment and spares at forward bases in two theaters for 18 B-1s, 18 B-52s, and all 16 B-2s. (This option assumes that the selected bases would have adequate facilities, fuel, and basic munitions for the bombers.) Freeing the bomber units from deploying this equipment during a conflict would reduce the lift required from 210 C-141 sorties to 81, a reduction of 61 percent. (The Air Force has not yet developed its plans for deploying the B-2s, so CBO assumes that they would require the same number of C-141s as the B-1s.) In the Persian Gulf region, the equipment could be placed at Diego Garcia, Moron, and Jiddah. For the Korean peninsula, it could be deployed at Guam or Okinawa. All of those bases are close enough to the theaters to increase the sortie rates significantly, but far enough away that they are not vulnerable to attack and would not occupy bases that could be used by short-range aircraft.

Reducing the number of C-141s required would allow the remaining equipment to be delivered more quickly. Under Option IV, each unit would still have to deploy some equipment and spares, but less than 40 percent of the original total. CBO estimates that the option could reduce deployment times by about one day. As a result, the bombers would be able to fly missions from their forward bases after the third day. Operating bombers from forward bases, however, would require some lift from depots in the United States to support them after they were deployed.

One of the strengths of this option is that prepositioning would make it easier to swing the bombers from a first to a second major conflict. General Loh has expressed concern about the stress that such a move would place on an airlift system that would probably be working overtime just to meet the demands of the first conflict. By prepositioning much of the equipment and spares in both theaters, the Air Force could move the bombers to the second theater with less strain on the airlift system. Another advantage of this option is that it would reduce air crew fatigue by reducing the time it would take them to fly to and from the target areas.

Although not included in this option, another step that could improve the effectiveness of the force without adding more bombers is to increase the number of flight crews assigned to each aircraft. That would reduce the limitations on the bombers imposed by the demand that combat operations would have on the crews and could allow the bombers to conduct more sorties over a sustained period. CBO has not considered that factor in its analysis, but most likely after a few weeks of operating from the United States at the rate of one sortie every two and one-half days, all of the available flight crews would have used up their allotment of 125 hours for the month.

Effect on Capability

Although Option IV would have no effect on the size of the planned force, it could sharply increase the number of bombers attacking targets each day. CBO assumes that after the bombers start operating from the forward bases, the sortie rate for those aircraft (18 B-2s, 18 B-1s, and all 16 B-52s) would more than double from one every two and one-half days to one each day. That means 62 bombers could visit the theater each day rather than 39 in the planned force (see Table 13 on page 61). Likewise, the number of B-2 sorties each day under this option would increase from about five to 12--or two more each day than if 20 additional bombers were purchased.

The marked increase in capability that this option could provide during the first two weeks is illustrated in Figure 11 on page 66. (Because this option would

generate as many B-2 sorties as Option I, CBO has assumed that it would also destroy the air defenses within half the time that the planned force would.) The results are dramatic in relation to the planned force: against a strong defense, the bombers in Option IV could deliver up to 82 percent more weapons over 15 days; against light defenses, they could move 50 percent more weapons. During the critical first five days, this option could increase by at least 30 percent the weapons that could be delivered by the bomber force against all three types of defenses.

Compared with a force of 20 more B-2s, this option would increase the total number of weapons and the number of JDAMs that could be delivered in the first two weeks of the challenging strong-defense scenario by 35 percent and 27 percent, respectively. Against light defenses, this option would allow the bombers to deliver 34 percent more weapons during the same period. Perhaps most important, Option IV would allow more B-2 sorties and deliver more weapons during the first five days than a force with 20 additional B-2s.

Effect on Costs

Option IV would cost $1.8 billion through 2020 (see Table 19). Most of those funds (nearly $1.5 billion) would be spent by 2001 to purchase the extra spare parts and equipment that would be stockpiled at the forward bases. The remainder would pay for the small annual cost (roughly $12 million) to maintain the equipment. Enough spares and equipment would be deployed near the Persian Gulf and Korea to support 18 B-52s, 18 B-1s, and 16 B-2s in either region.

The strength of this option is that for only about one-sixteenth of the cost of buying 20 more B-2s, it could provide 5 percent more B-2 sorties during the critical first 15 days of the war, assuming that the bombers would otherwise have flown their combat missions from the United States. Moreover, it could provide 30 percent more B-1 sorties and nearly 50 percent more B-52 sorties during that period.

In short, prepositioning provides insurance against an unexpected major regional conflict--the very scenario that B-2 supporters use to justify more of the bombers. Those increases would probably last for no more than the first few weeks of a war, however, because even without prepositioning a theater commander would probably deploy the bombers as soon as he had fielded a sizable force of tactical aircraft. In less stressing scenarios, where the United States had enough warning time to deploy bombers before a conflict began or had enough tactical aircraft in the theater so that a commander could dedicate sufficient airlift to moving bomber operations to forward bases, most of the capability added by stockpiling equipment

would disappear. But in those types of scenarios the United States is not likely to need more bomber capability than the planned force anyway.

A less expensive approach to this option would be to buy only enough equipment and spares for one theater and place them in the Persian Gulf region. That would provide early capability in the theater where the United States is least likely to have tactical aircraft and ground forces in the future and where allies have very small ground forces. That approach would cut the cost of the option in half.

Limitations of the Option

Although Option IV could increase capability substantially during the first two weeks of a surprise conflict, it does have some limitations. First, it would boost the sortie rate only over the first few weeks of an unexpected conflict because the theater commander would probably deploy the bombers as soon as he had deployed a sizable

TABLE 19. COST OF PREPOSITIONING BOMBER PARTS AND EQUIPMENT (In millions of 1996 dollars)

	1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
Purchase Mobility Readiness Spares Kits	240	240	240	240	240	240	1,420	1,420
Purchase Ground Support Equipment	a	a	a	a	a	a	20	20
Build Storage Facilities	0	10	10	10	10	0	40	40
Annual Support Costs	0	0	10	10	10	10	50	280
Total	240	250	260	260	260	250	1,530	1,760

SOURCE: Congressional Budget Office based on Air Force data.

NOTE: Costs assume that enough mobility readiness spares kits and ground support equipment are purchased and prepositioned at forward bases in the Persian Gulf and Northeast Asia to support 18 B-1s, 16 B-2s, and 18 B-52s in either theater.

a. Less than $5 million.

tactical aviation contingent in theater. Moreover, this option might not boost the sortie rate at all if the United States had enough warning time to deploy the bombers before the conflict erupted, although it could still allow the bombers to deploy more rapidly and with fewer demands on airlift. Second, the prepositioned equipment would not be useful if a conflict occurred in some part of the world other than the Persian Gulf or the Korean peninsula, although forces deployed in Diego Garcia could reach the Indian subcontinent easily and forces deployed near Korea would be able to reach China--two regions that critics of the Bottom-Up Review have listed as possible trouble spots. Furthermore, if future trends change U.S. focus away from those regions, the prepositioned equipment could be moved to better locations. Third, this option would also not address the concerns that some people have raised about attrition because it would not increase the size of the force.

Finally, Option IV may encounter some political difficulties. Allies may be sensitive to prepositioning equipment for bombers in their countries and may be reluctant to allow bombers to operate from their soil during a conflict that does not directly involve them. As the United States found during the Persian Gulf War, securing permission to base bombers can be difficult. The Saudis would not allow B-52s to be based on their soil until the air war actually began. So the Air Force established a working base with all the necessary support at Jiddah before the air war and flew the bombers in when the war began. After the war, the United States also encountered difficulty prepositioning equipment in the Gulf region for ground forces and tactical aircraft.

This option assumes that the United States would either secure the necessary agreements or use bases like Diego Garcia and Guam where there are no major political impediments to prepositioning equipment or stationing bombers. (Guam is a U.S. territory and the British have given the United States the right to use Diego Garcia.) In order for the bombers to be deployed as quickly as possible in the event of a conflict, the agreements should establish criteria in advance for the time when an ally would allow its bases to be used and a rapid procedure for approving the U.S. request.

APPENDIX

SELECTED COSTS IN CURRENT DOLLARS

TABLE A-1. FUNDING FOR BOMBER MODIFICATIONS
(In millions of current dollars)

	1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2010
B-1B	310	360	290	380	300	310	1,950	2,740
B-2	1,090	820	890	450	440	230	3,920	4,190
B-52H	20	20	30	70	50	40	230	230
Total	1,420	1,200	1,210	900	790	580	6,100	7,160

SOURCE: Congressional Budget Office based on Department of Defense data.

NOTE: The numbers in this table reflect inflated dollars, the kind that the Congress will actually authorize and appropriate each year.

TABLE A-2. PROCUREMENT SCHEDULE AND ESTIMATED COSTS OF BUYING 20 MORE B-2 BOMBERS (In millions of current dollars)

	1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
				Number of Aircraft				
Purchased	0	2	2	3	3	3	13	20
Delivered	0	0	0	0	0	2	2	20
				Cost				
Acquisition Costs	790	2,990	2,020	2,960	2,960	2,810	14,530	21,840
Operating and Support Costs	0	0	0	0	30	140	170	14,040
Total	790	2,990	2,020	2,960	2,990	2,950	14,700	35,880

SOURCE: Congressional Budget Office based on data from the Department of Defense and the Institute for Defense Analyses.

NOTE: The numbers in this table reflect inflated dollars, the kind that the Congress will actually authorize and appropriate each year.

TABLE A-3. COST OF THE ALTERNATIVES THROUGH 2020
(In millions of current dollars)

Option		1996	1997	1998	1999	2000	2001	Total, 1996-2001	Total, 1996-2020
I	Add 20 B-2s	790	2,990	2,020	2,960	2,990	2,950	14,700	35,880
II	Keep All 94 B-52s	130	150	160	150	150	150	890	4,340
III	Improved Planned Force	90	260	230	210	190	100	1,080	1,230
IV	Preposition Equipment, Deploy Bombers Quickly	240	260	280	280	290	290	1,650	1,920

SOURCE: Congressional Budget Office.

NOTE: The numbers in this table reflect inflated dollars, the kind that the Congress will actually authorize and appropriate each year.