

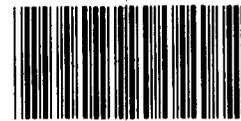
GAO

Report to the Chairman, Committee on
Armed Services, House of
Representatives

February 1993

STRATEGIC
BOMBERS

Adding Conventional
Capabilities Will Be
Complex, Time-
Consuming, and Costly



148526



United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

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February 5, 1993

The Honorable Ronald V. Dellums
Chairman, Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

In response to the former Chairman's request, we reviewed the conventional capabilities currently available in the strategic bomber force and the Air Force's plans, schedules, and costs for equipping strategic bombers (B-52, B-1B, and B-2) with conventional warfighting capabilities.

This report discusses some operational and fiscal challenges that need to be addressed by the Department of Defense and the Congress when deciding the level of funding to be provided to transition the force from primarily a nuclear to a conventional role. We identify some operational problems that must be resolved if the B-1B aircraft is to become the backbone of the conventional bomber force, and we question the Air Force's plans to equip each type of bomber with some mix of precision-guided munitions. We also point out that achieving the planned conventional warfighting capabilities will cost billions of dollars more than the \$3 billion identified in the Air Force Bomber Roadmap.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 10 days after its issue date. At that time, we will send copies to the Secretaries of Defense and the Air Force, appropriate congressional committees, and others upon request.

This report was prepared under the direction of Nancy R. Kingsbury, who may be reached at (202) 275-4268, if you or your staff have any questions concerning this report. Other major contributors to this report are listed in appendix II.

Sincerely yours,

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

With the end of the cold war, the Air Force redefined the role of its bomber force from one focused on nuclear war to one equipped to perform a variety of conventional missions. This redefinition is reflected in the "Bomber Roadmap," which was issued by the Air Force in June 1992. In response to a request from the former Chairman, House Committee on Armed Services, GAO reviewed the conventional capabilities currently available in the strategic bomber force and assessed the Air Force's plans, schedules, and costs, as outlined in the Bomber Roadmap, for equipping strategic bombers with conventional warfighting capabilities.

Background

Three types of aircraft make up the strategic bomber force—B-52s, B-1Bs, and B-2s. As of December 1, 1992, there were 244 strategic bombers in the inventory, with plans to add 20 B-2 bombers to the force. There are 148 B-52 aircraft—53 B-52Gs and 95 B-52Hs—and 96 B-1B aircraft. All of the B-52G aircraft are planned to be retired by the end of calendar year 1994. The Air Force has determined that the conventional capabilities of its strategic bomber force are not sufficient to meet the threats from potential adversaries. Therefore, the Air Force has developed a plan—the Bomber Roadmap—to enhance the conventional capabilities of the strategic bomber force. The plan outlines the operational concept and structure for the bomber force and identifies funding requirements to enhance and support the bomber force for conventional missions.

Results in Brief

The Air Force's plan for developing strategic bomber conventional capability is concentrated on making the B-1B the backbone of the bomber force and equipping all three types of aircraft with precision-guided munitions. This is a costly approach that may not be achievable by the year 2001 as envisioned by the Bomber Roadmap. Currently, the B-52 provides most of the bomber force's conventional capability. While the B-1B has certain capabilities and features that the B-52 bombers do not have, it currently has less conventional capability than the B-52 and has operational problems that must be resolved before it can be expected to be the backbone of the bomber force. This current lack of capability, combined with the long-term nature of the Air Force's plan, raises questions about the Air Force's plan to retire all conventionally equipped B-52Gs by the end of calendar year 1994 to reduce costs.

The Roadmap, in and of itself, cannot be considered a comprehensive document that provides congressional and Department of Defense (DOD) decisionmakers the basis for making funding decisions regarding the

conventional capabilities that will be required by the strategic bomber force. For example, because the Bomber Roadmap was developed to address only the needs of the strategic bomber force, the plan does not address the contributions that carrier-based and long-range theater attack aircraft may make in the first 2 days of a future conventional conflict. Moreover, the Air Force's estimated costs for achieving the planned conventional capabilities are not all inclusive. Not included are the costs of developing and procuring precision-guided munitions, resolving B-1B operational problems, equipping the B-1B with an effective defensive avionics system, and providing adequate quantities of war readiness spare parts. These costs would add billions of dollars to the \$3 billion that the Bomber Roadmap estimated it will cost to achieve the bomber force's planned conventional capability.

The Roadmap's emphasis on equipping the three types of bombers with precision-guided munitions does not reflect the strategic bombers' almost exclusive use of nonprecision-guided munitions during Operation Desert Storm. This use, combined with the costs of developing and procuring precision-guided munitions during a period of declining defense budgets, makes it questionable whether the Air Force needs to equip each of its strategic bombers with these weapons, as called for in the Roadmap.

GAO's Analysis

Capabilities and Limitations of Bombers

Currently, the capability of the strategic bomber force to conduct conventional bombing missions is provided in varying degrees by the B-52 and B-1B aircraft. The B-52 can deliver 8 types of general purpose gravity bombs weighing 500 to 2,000 pounds, 6 types of cluster bombs, 2 types of chemical bombs, 2 types of laser-guided bombs, 12 different sea mines, and 2 special purpose leaflet/chaff bombs. In addition, 30 of the 41 conventional B-52G aircraft have been modified to carry the Harpoon missile and 7 have been modified to carry the HAVE NAP missile. The B-52H can also carry the conventional air launched cruise missile. The ability to deliver a variety of weapons allows the B-52 to perform a variety of missions.

In contrast, the B-1B can currently deliver only one type of conventional munition—the 500-pound gravity bomb. As a result, its conventional role and mission are currently limited. In addition, the B-1B's effectiveness

with the 500-pound bomb may be reduced due to the bombs colliding with each other when released from the aircraft. These bomb-to-bomb collisions were more common during low-altitude testing (200 to 500 feet) than they were at high-altitude testing (20,000 to 34,000 feet). To avoid those collisions, the bombs will have to be released from the B-1B's bomb bays at a rate slower than planned, which will string out the bombs and cause fewer bombs to directly hit the target. Although DOD acknowledged the bomb collisions, it stated that operational changes that do not affect mission objectives can be made while a permanent solution to the collision problem is developed.

The B-1B's operational effectiveness is also limited by excessive bomb-loading times. During operational testing it took almost 40 hours to load 84 500-pound bombs on the B-1B. These excessive bomb-loading times could reduce B-1B sortie rates. During Operation Desert Storm, sortie rates were critical to B-52 aircraft performing repetitive bombing missions. In its comments on a draft of this report, DOD stated that B-1B bomb-loading times have been reduced to about 8.5 hours using a single load crew and to about 5 hours using two load crews. In contrast, according to Air Force data, a B-52 can be reloaded with 45 to 51 500-pound bombs within 1 to 2 hours. GAO could not assess the operational viability of the claimed reduction to about 8.5 hours because the Air Force was unable to provide data comparable to that developed during operational testing. Regarding the claimed reduction to about 5 hours, GAO noted that these loading times were accomplished during a bomb-loading competition and may, therefore, not be achievable under more realistic conditions.

The B-2 was designed to have both a nuclear and conventional role. Originally, its primary role was for nuclear missions. Recently, however, its primary role has been shifted to conventional missions. The B-2 is currently in production, with aircraft deliveries expected between 1993 and 1998. It is projected to have the capability to deliver a wide range of conventional munitions. However, it is too early to confirm its operational performance in a conventional role.

Roadmap Does Not Resolve Conventional Role of Bombers

The experience of Operation Desert Storm raises questions about the concept of operations and the related requirements, as set forth in the Bomber Roadmap. For example, the Roadmap envisions each strategic bomber (B-52, B-1B, and B-2) to have precision-guided munitions to attack a large number of high priority targets. While conventional air launched

cruise missiles were used by B-52Gs on the first day of the air campaign, most of the munitions dropped by the strategic bomber on Iraqi ground targets in later phases of the war were “dumb” bombs. The contributions of carrier-based and long-range theater attack aircraft to that operation were significant early in the war, but the Roadmap does not recognize these contributions. The Air Force’s Roadmap assumes that the strategic bombers will be the only assets available in the first 2 days of a conflict.

Costs Associated With Conventional Enhancements

The Bomber Roadmap estimates that it will cost about \$3 billion to modify and equip the B-1B and B-52 bombers with conventional capabilities. However, this cost is understated by billions of dollars when B-1B costs associated with fixing operational problems, acquiring an effective defensive avionics system, and providing adequate war readiness spare parts are considered. Additionally, the total cost is significantly higher if the bombers’ portion of the costs to develop and procure precision-guided munitions is factored in. The majority of the costs that are not included in the Roadmap are associated with the Air Force’s share of the cost of developing and procuring the Joint Direct Attack Munition, Joint Stand Off Weapon, and Tri-Service Standoff Attack Missile. These munitions involve joint efforts by the Air Force, Navy, and Army. The Air Force’s portion of the munitions cost is more than \$11 billion. The Air Force did not include any of these costs in the Bomber Roadmap because these munitions are not being developed exclusively for the bomber force. Rather, they are planned to be used to enhance the conventional capabilities of the Air Force tactical and strategic bomber aircraft.

Recommendations

GAO makes no recommendations in this report, but believes it contains information that will be useful to the Congress in its deliberations on the Air Force’s plans to enhance and support the conventional capabilities of the bomber force.

Agency Comments

In commenting on a draft of this report, DOD agreed that the process of adding additional conventional capabilities to the B-1B weapon system will be complex and time-consuming. DOD disagreed, however, that the development costs of precision-guided munitions should be added to the Bomber Roadmap costs. According to DOD, munitions costs are separate and should not be included in weapon systems costs. GAO recognizes that total munitions costs cannot be wholly allocated to the bomber force. However, the magnitude of these costs to achieve the conventional

capability envisioned by the Bomber Roadmap is significant and should be recognized and debated when making decisions on enhancing the strategic bomber force's capability.

DOD disagreed that the bomber force will necessarily be employed in the next war as it was employed in Operation Desert Storm. GAO recognizes that Operation Desert Storm is not the only way a future war might be fought. The question is whether the Roadmap assumption that bombers alone would be available in the first few days of a conflict or whether the advantages of precision-guided munitions demonstrated during Operation Desert Storm translate into a requirement that each type of strategic bomber be equipped with precision-guided munitions. GAO believes that, because precision-guided munitions were primarily delivered by aircraft other than strategic bombers during Operation Desert Storm, and significant contributions were made by non-bomber assets in the first day of the war, the need for multiple types of precision-guided munitions on each type of strategic bomber is questionable. The lessons learned from the strategic bomber's only conventional employment since the Vietnam War cannot be overlooked in mapping out the bomber's future conventional role.

DOD's comments are included in their entirety in appendix I.

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Abbreviations

DOD	Department of Defense
GPS	Global Positioning System
JDAM	Joint Direct Attack Munition
JSOW	Joint Stand Off Weapon
TSSAM	Tri-Service Standoff Attack Missile

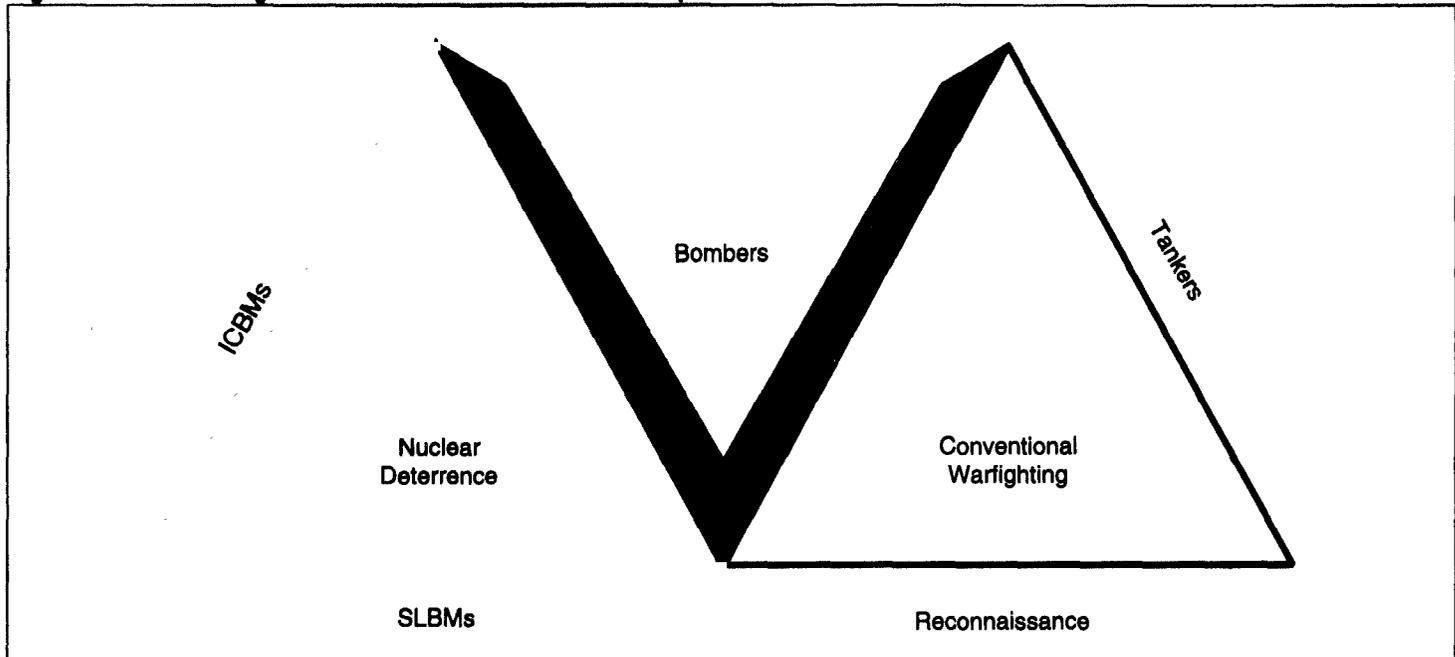
Introduction

For many years, manned bombers stood alert to deter the Soviet nuclear threat. However, in 1991, with the cold war ending, the President ordered a stand-down of all U.S. nuclear bomber forces. Even though nuclear deterrence continues to be the basic objective of national security, the reduced nuclear threat has resulted in an increased emphasis on conventional warfighting capabilities. The Air Force's plans for converting from a bomber force focused on nuclear war to a force equipped to perform conventional missions are detailed in the "Bomber Roadmap."

A Change in Focus

The changing international environment required that our national security strategy be refocused from cold war nuclear deterrence to a strategy that emphasizes conventional warfighting capabilities. In 1991, the Strategic Air Command, recognizing the need for change, concluded that its mission could best be described in terms of two warfighting triads: the nuclear deterrence triad and the conventional warfighting triad. Although the "Twin Triad" upholds strategic nuclear deterrence as the cornerstone of the nation's security, it recognizes that the cold war is over and that the conventional warfighting role of the bomber force is no longer of secondary importance. The nuclear deterrence triad is made up of intercontinental ballistic missiles, submarine-launched ballistic missiles, and manned bombers. The conventional warfighting triad is composed of aerial refueling tanker airplanes, reconnaissance aircraft, and manned bombers. Figure 1.1 shows the Strategic Air Command's Twin Triad concept.

Figure 1.1: The Strategic Air Command's Twin Triad Concept



Source: Air Force.

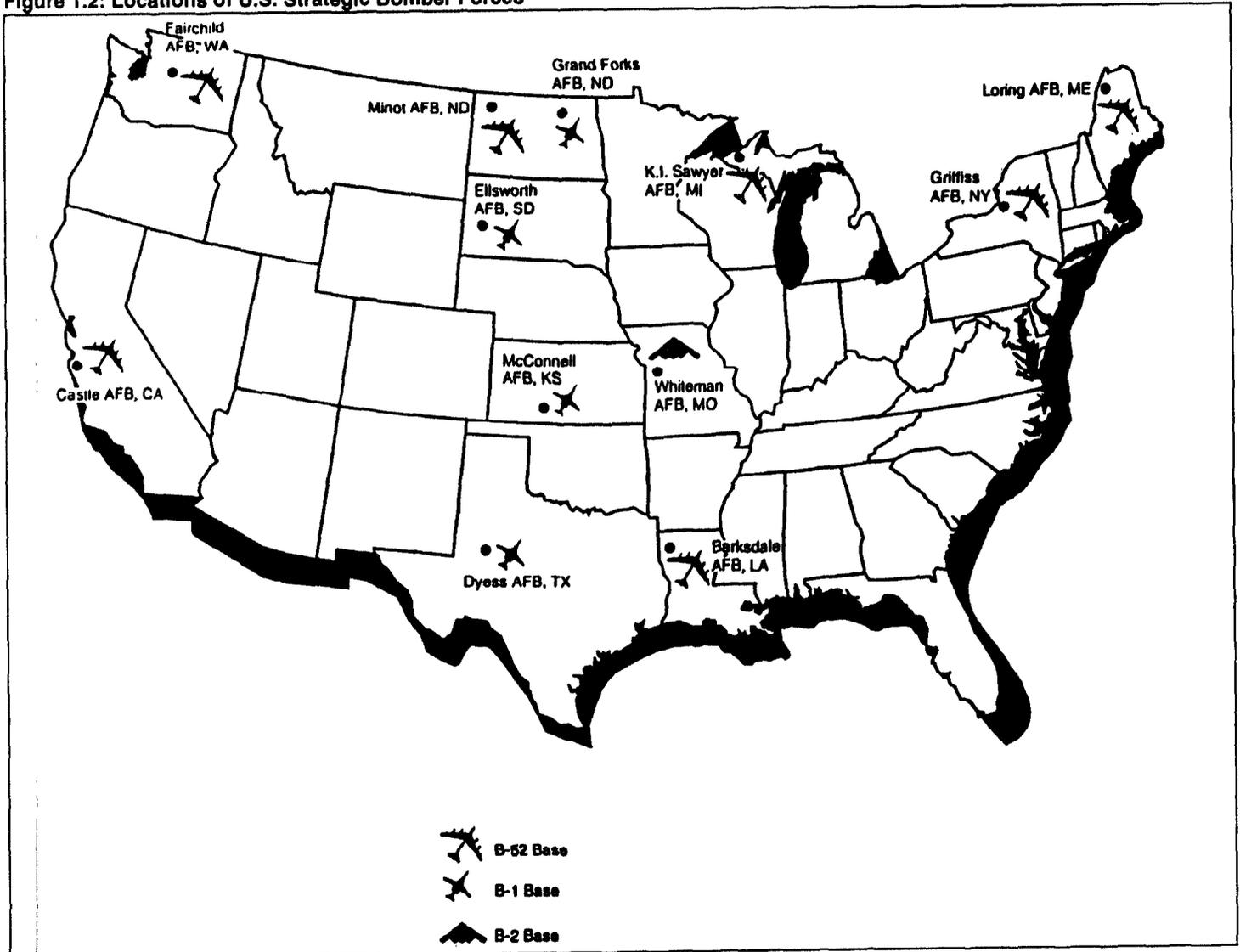
In June 1992, the Air Force reorganized the management of its forces. Many of the functions of the Strategic Air Command and the Tactical Air Command were incorporated into the newly created Air Combat Command. For the first time, a single commander will control bombers, fighter aircraft, and intercontinental ballistic missiles.

To meet the challenges of change in the international environment, the Air Force redefined the roles and missions of its strategic bomber force. This redefinition is reflected in the Bomber Roadmap. The Roadmap, issued in June 1992, outlined the operational concept and structure for the strategic bomber force and identified the funding requirements to enhance and support the bomber force for conventional missions. It identified the number and type of strategic bombers that the Air Force believes are needed and the weapons the bombers will carry in a conventional role.

Three types of bombers make up the strategic bomber force: the B-52, procured in the 1950s and 1960s; the B-1B, procured in the 1980s; and the

B-2, to be procured in the 1990s. The operational bases for these aircraft are shown in figure 1.2.

Figure 1.2: Locations of U.S. Strategic Bomber Forces



Note: The B-52 squadrons at Loring and Castle Air Force Bases are assigned a dedicated conventional bomber role.

Source: Adapted from a chart in the February 1992 Secretary of Defense Annual Report to the President and the Congress.

Today's bomber force totals 244 aircraft, with plans to add 20 B-2 bombers to the force. Table 1.1 shows a breakdown of the current and future strategic bomber force by aircraft type.

Table 1.1: Number and Type of Strategic Bombers

Aircraft	Current Inventory	Active aircraft		Future inventory
		Primary role		
		Conventional	Nuclear	
B-52G	53	41	12	0
B-52H	95	0	95	95
B-1B	96 ^a	0	96 ^a	96 ^a
B-2	0	0	0	20
Total	244	41	203	211

^aThe Air Force has 95 operational aircraft and 1 test aircraft.

Source: Air Force.

The B-52 is the oldest of these aircraft. The first B-52 aircraft was delivered to the Strategic Air Command in 1955, with the last B-52 coming off the production line in 1962. The B-1B was the intended replacement for the B-52 as a penetrating bomber against defenses of the former Soviet Union until the B-2 was deployed. The Air Force declared the B-1B operational in September 1986 and received the last aircraft in April 1988.

The B-2 bomber is currently in production with deliveries scheduled between 1993 and 1998.

Objectives, Scope, and Methodology

Our objectives were to determine the current conventional capabilities of the bomber force and to assess Air Force plans, schedules, and costs for enhancing the conventional capabilities of the strategic bomber fleet. We performed our work at the Strategic Air Command Headquarters, Offutt Air Force Base, Nebraska; the B-2 Systems Program Office, Wright-Patterson Air Force Base, Ohio; the B-1B, B-2, and B-52 Program Offices, Tinker Air Force Base, Oklahoma; and the Office of the Secretary of Defense and Air Force Headquarters, Washington, D.C. In addition, we observed B-1B bomb-loading operations at Ellsworth Air Force Base, South Dakota. We also interviewed Air Force officials at the newly created Air Combat Command to discuss the Bomber Roadmap.

At each location, we interviewed Air Force officials to identify the current conventional capabilities of the bomber force and the challenges the Air Force will face in enhancing the conventional capabilities of the force. We obtained documents, particularly those relating to future plans, schedules, and costs at each of the locations we visited. Some schedule and cost information for the B-2 bomber is classified and is therefore not discussed in this report.

In assessing the Air Force's plans for enhancing the conventional capabilities of the B-1B and B-2, we used the B-52 as a baseline weapon system. For example, we identified the equipment used by the B-52G during Operation Desert Storm and compared it with that currently available or planned for the B-1B and B-2. We determined whether similar equipment and aircraft modifications might be needed to enhance the conventional warfighting capabilities of the B-1B, B-2, and B-52H.

We did not evaluate the potential conventional missions of the strategic bomber force in relation to carrier-based or theater attack aircraft. The Senate Committee on Armed Services report on Department of Defense (DOD) authorizations for fiscal year 1993 requires that such an analysis be included in the roles and missions report required of the Chairman of the Joint Chiefs of Staff under 10 U.S.C. 153(b).

We performed our work from June 1991 through November 1992 in accordance with generally accepted government auditing standards.

Current Capabilities and Limitations of Strategic Bombers

Currently, the capability of the strategic bomber force to carry out conventional missions is provided by the B-52 and, to a lesser extent, by the B-1B. The B-52 can carry a wide variety of conventional munitions, such as cluster bombs, general purpose bombs, and sea mines. It can also deliver precision-guided missiles that can be launched at standoff range from outside enemy air defenses. The role of the B-52G in Operation Desert Storm is an example of what could be expected of the bomber force in a future conventional conflict. During Operation Desert Storm, these B-52s were tasked to repeatedly attack ground forces from high altitudes and saturate target areas with large quantities and a variety of munitions.

The B-1B cannot presently meet these demands. The B-1B can currently carry only one type of conventional munition—the 500-pound bomb. This lack of flexibility currently limits the role of the B-1B in a conventional conflict. Furthermore, while the B-1B can carry a larger quantity of bombs than the B-52, it has to release them more slowly, which strings them out and can cause fewer bombs to hit the target. Also, the B-1B's capability to fly repeated missions is less than the B-52's demonstrated capabilities because the bomb reloading process for the B-1B is much longer than the B-52 process. The B-2 bomber, which is still in production, is intended to carry a wide variety of conventional munitions.

B-52 Provides Most of Bomber Force's Conventional Capability

The B-52 aircraft provides the United States with a significant conventional bombing capability. While the roles and capabilities of the B-52G and B-52H vary, both have the capability to deliver a variety of conventional weapons. Figure 2.1 shows the array of conventional munitions that the B-52s can deliver.

B-52 Provides Diverse and Technologically Advanced Capabilities

The Air Force has a total of 148 B-52s—53 B-52Gs and 95 B-52Hs. Twelve of the 53 B-52G aircraft are primarily equipped to deliver nuclear weapons, but they can also deliver conventional weapons and did so in Operational Desert Storm. These 12 aircraft were to be retired by January 1993. The remaining 41 B-52Gs, which will be retired by the end of 1994, have been specifically modified to deliver conventional weapons, including precision-guided munitions. These aircraft have the flexibility to deliver 8 types of general purpose gravity bombs weighing 500 to 2,000 pounds, 6 types of cluster bombs, 2 types of chemical bombs, 2 types of laser-guided bombs, 12 different sea mines, and 2 special purpose bombs. Thirty of these aircraft can also deliver the precision-guided Harpoon missile and 7 have the capability to carry the precision-guided HAVE NAP missile. These missiles can be fired from standoff range while the aircraft is far removed from the target.

The Harpoon, an antiship missile, gives the B-52G a maritime capability. The B-52G can launch the Harpoon missile while the aircraft is approximately 75 miles away from the target. The aircraft provides the missile with range and bearing information about the target. Once the missile is released, the pilot can maneuver the aircraft away from the target. The missile then uses a radar seeker to attack the target autonomously.

The Israeli-made HAVE NAP air-to-ground missile has a standoff range of about 75 miles. A camera in the nose of this missile sends pictures back to aircraft; the pictures are used to direct the missile to its target.

The conventional air launched cruise missile, while not a precision-guided munition, is a highly accurate missile that can be launched from long range (about 650 miles). Using the Global Positioning System (GPS) signals for guidance, it can find and attack fixed targets, such as military installations. The cruise missile can be launched from the 12 nuclear-oriented B-52Gs and all of the B-52Hs.

Currently, the conventional capabilities of the B-52H are less than those of the B-52G. The B-52H does not have the capability to deliver the precision-guided Harpoon and HAVE NAP missile, the laser-guided bombs, or the MK40 and MK63 sea mines. It can, however, deliver the other conventional munitions that the B-52G carries. The Air Force plans to retire all B-52Gs by the end of calendar year 1994 and transfer their conventional capabilities to the B-52Hs as the retirement is implemented. The Air Force chose to retain the B-52H because its fanjet engines are

30 percent more powerful than the B-52G water-injected engines. Additional advantages cited by the Air Force were that the B-52H costs less to operate and has a greater range.

Operation Desert Storm
Illustrated Potential
Demands of the
Conventional Bomber Role

Operation Desert Storm marked the first conventional use of heavy bombers since Vietnam. Seventy-five B-52Gs were deployed to support air strikes against Iraq. During the first day of the air campaign, seven B-52Gs attacked eight high priority targets in Iraq with conventional air launched cruise missiles fired from outside Iraq's air defense network. The missiles were guided to their targets by signals from the satellite-based GPS. It was the first wartime use of a conventional, long-range standoff weapon by a strategic bomber.

However, reflecting the desires of the theater commander, the primary role of the B-52 during the war became the regular bombing of mobile targets, such as ground forces and Scud missile launchers. In this role, the demands of the B-52 included

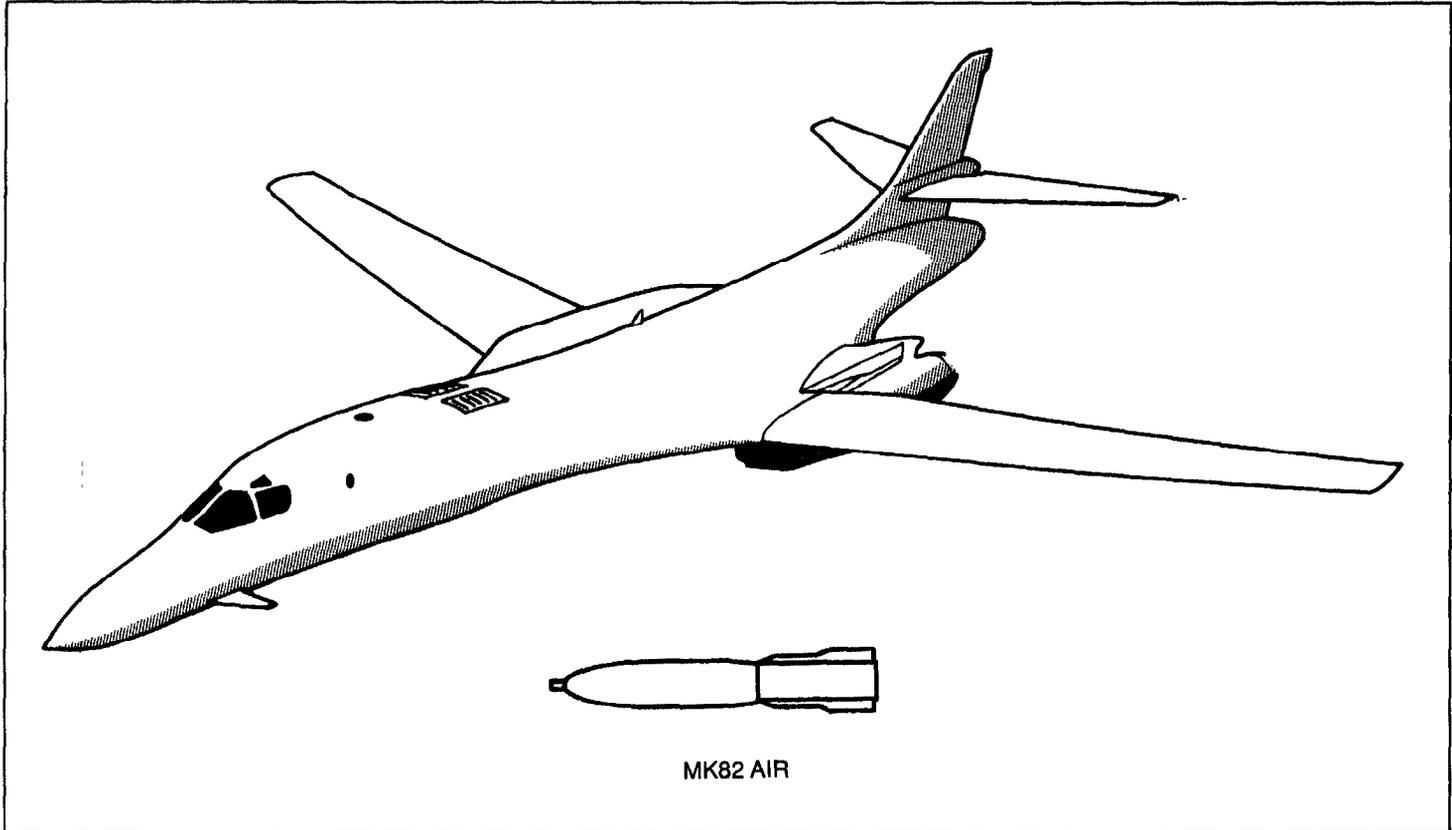
- sustaining high sortie rates to maintain pressure on Iraqi troops,
- dropping a large volume and variety of gravity bombs, and
- flying at high altitudes.

In this role, the precision of the B-52's munitions and its ability to attack fixed targets were not viewed as important to meeting the needs of the theater commander as the regular delivery of gravity bombs. Furthermore, tactical aircraft—primarily fighters—made a large contribution in performing air strikes. In fact, tactical aircraft flew the majority of sorties against both fixed and mobile targets and delivered the majority of gravity munitions. Strategic bombers were used primarily to deliver gravity bombs and dropped 30 percent of the total tonnage of general purpose bombs.

B-1B's Conventional
Capabilities Are
Limited

As currently configured, the B-1B's conventional capabilities are significantly more limited than the B-52's. Among these limitations are the B-1B's capability to carry only one type of conventional munition—the 500-pound gravity bomb (see fig. 2.2); problems experienced with bomb-to-bomb collisions during bomb release; a complex bomb carriage system that is difficult to load and maintain; a limited number of bomb carriages, which limits the number of B-1Bs that can be fully loaded with 500-pound bombs; and the lack of a sea mine capability that was part of the B-1B's baseline weapons requirement.

Figure 2.2: B-1B Current Conventional Capability



Source: GAO.

B-1B Can Currently Deliver One Type of Conventional Munition

The B-1B's effectiveness with the 500-pound bomb may be reduced due to the tendency of bombs to collide when released from the aircraft. According to DOD criteria, bomb-to-bomb collisions are unacceptable because the bombs can be damaged to an extent that they will not detonate or the collisions can result in dangerous premature explosions.

The bomb-to-bomb collision problem was revealed during testing of the B-1B's capability to deliver the 500-pound bomb. This testing, conducted between April and July 1990, was comprised of 13 low-altitude (200 to 500 feet) sorties in which the B-1B dropped inert bombs. As shown in table 2.1, at least 294 bomb collisions occurred during these test flights.

**Chapter 2
Current Capabilities and Limitations of
Strategic Bombers**

**Table 2.1: Bomb Collisions During
B-1B Final Operational Testing and
Evaluation**

Sortie	Weapons released	Collisions			Total
		Hard	Medium	Soft	
1 ^a	84	15	6	31	52
2	36	4	5	5	14
3	32	b	b	b	b
4	20	8	1	0	9
5	13	0	1	1	2
6	20	2	3	1	6
7 ^a	40	14	7	1	22
8 ^a	30	7	5	2	14
9 ^a	49	2	4	16	22
10	56	4	9	3	16
11	84	12	9	9	30
12	83	21	4	1	26
13	84	28	35	18	81
Total^b	631	117	89	88	294

^aThese sorties included multiple bomb drops. The number of weapons shown in the weapons-released column is the total released during the entire sortie.

^bData from sortie number 3 were not available.

Source: Air Force.

The Air Force defines hard collisions as a severe contact that causes physical damage to the bomb, prevents the fuze from arming, or causes early bomb detonation. Two or more hard collisions occurred in 11 of the 13 test flights. These hard collisions introduce the possibility of mid-air detonations that can cause harm to the aircraft and aircrew if the bombs explode near the aircraft. The Air Force describes a medium collision as one in which the contact may affect accuracy but does not cause physical damage to the bomb body. A soft collision is a grazing contact that is not expected to cause damage to the weapon or alter its overall accuracy.

According to the Air Force's B-1B test report, the only way to avoid collisions is to increase the intervals that bombs are released from the bomb bays. The release intervals must be increased by a significant amount to avoid collisions. Although the B-1B was designed to deliver bombs at intervals as low as 20 milliseconds, the test results show that a release interval of 120 to 150 milliseconds will be required to avoid bomb collisions. Comparatively, the B-52 can release the same 500-pound bomb at 85 to 90 millisecond intervals. The Air Force's objective is to minimize

the release interval, thereby maximizing the number of bombs directly hitting the target. The longer release intervals can reduce operational effectiveness because increasing the intervals strings the bombs out. Although DOD acknowledged the bomb collisions, it stated that operational changes that do not affect mission objectives can be made while a permanent solution to the collision problem is developed.

In May 1991, the Air Force continued its low-altitude testing and for the first time began testing with live 500-pound bombs. All previous tests had been made using inert bombs with live fuzes. The first test with live bombs was unsuccessful because all bombs from the aft bay fell to the ground unarmed. After an investigation, live bomb testing was resumed on July 15, 1991.

In April 1991, after Operation Desert Storm had shown the importance of high-altitude bombing to avoid anti-aircraft artillery, the Air Force added a high-altitude (24,000 feet) demonstration sortie to its low-altitude test program. This was the first drop of bombs from the B-1B at a high altitude. The Air Force described the test as yielding unexpected results in the extent of weapon dispersion. Several of the bombs could not be found and of those found, one was about 1.7 miles away from the others. As a result, the Strategic Air Command directed that a separate high-altitude test program be conducted after completion of the low-altitude test program.

In December 1991, the Air Force began the high-altitude test program comprised of 10 sorties in which the B-1B dropped 500-pound bombs at altitudes of 20,000 to 34,000 feet. The test team concluded that the system met user requirements for bomb release and weapons accuracy. However, they also found that some of the problems that occurred during low-altitude testing still needed to be addressed. For example, although bomb collisions are considered unacceptable, five bomb-to-bomb collisions and one premature bomb detonation occurred during the high-altitude testing. The problem of bomb collisions, however, was much less severe and less frequent than that which occurred during low-altitude testing. The reduction in collisions was attributed to less air turbulence from thinner air at high altitude. Also, bombs dropped from high altitudes do not require ballutes (small parachutes) to slow the bombs down during descent. Ballutes are used at low altitudes so the bombs can arm before hitting the ground. The ballutes can contribute to bomb-to-bomb collisions.

**B-1B's Operational
Capability Is Limited by
Excessive Bomb-Loading
Times and Number of
Bomb Modules**

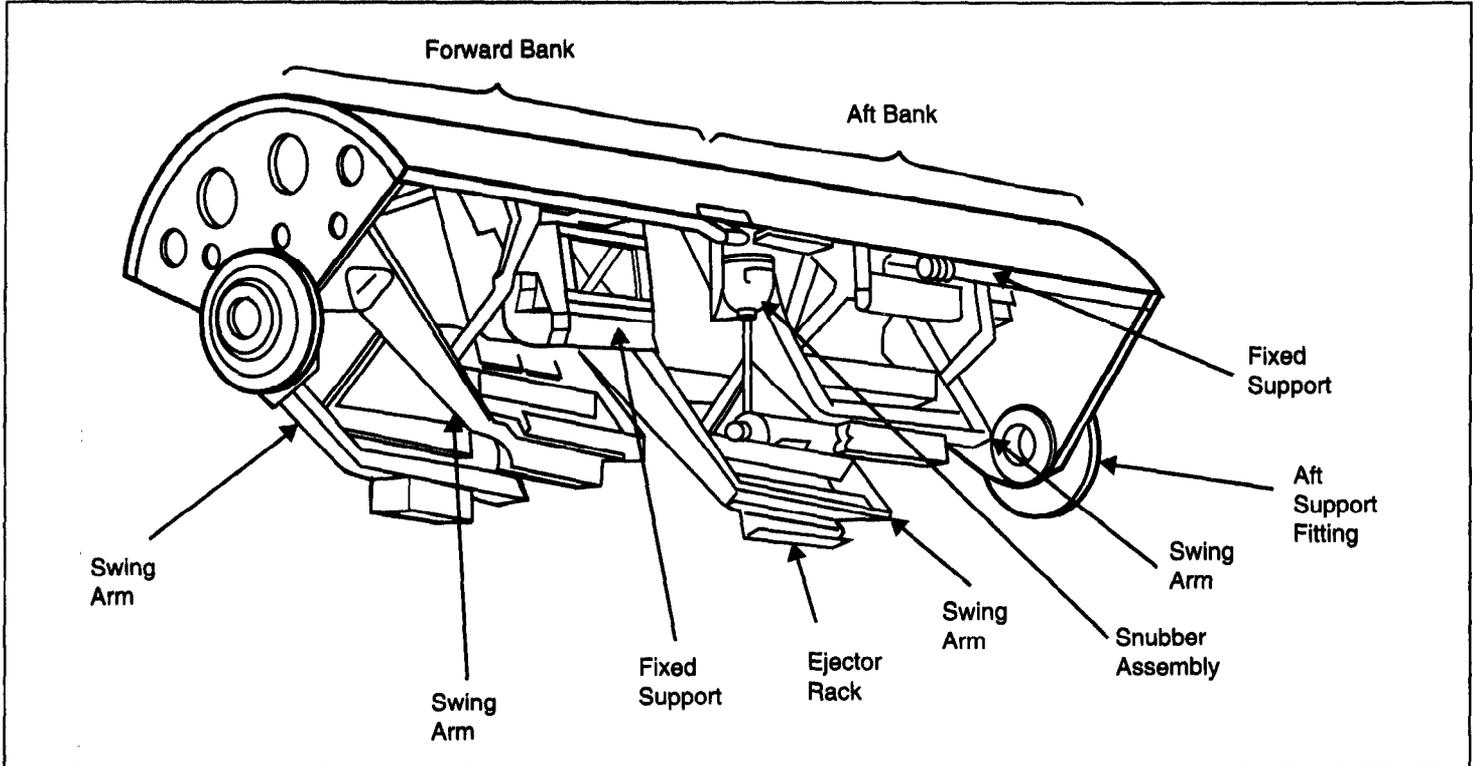
The B-1B carries its bombs in a bomb module. These modules are very complex, which makes bomb-loading difficult. Bomb-loading exercises showed that it took an excessive amount of time to load the B-1B with 500-pound bombs. These excessive loading times could reduce B-1B sortie rates that are critical to performing repetitive bombing missions.

The bomb modules are designed to be loaded with 500-pound bombs in a preload facility. The preloaded modules are delivered and lifted into the aircraft on the flight line via a large trailer. The Air Force estimated that it would take about 22 hours to load each module with 28 bombs and place the modules in the 3 bomb bays. However, it took 40 hours to fully load the B-1B with 500-pound bombs in what the Air Force described as realistic bomb-loading exercises.

Because of the time required to load the bombs using the preload facility, the Air Force evaluated an alternative loading method. This method did not include use of the preload facility, but relied on loading the bombs one at a time with the module already installed in the aircraft. The objective of this alternative method was to load 84 500-pound bombs in the 3 bays in 13.5 hours. Although the time improved, it still took more than 29 hours to load the bombs one at a time with the modules installed in the aircraft.

One of the reasons loading the B-1B with 500-pound bombs is time-consuming is the complex design of the aircraft's bomb module. The module consists of a system of swing arms, ejector racks, and explosive ejector cartridges to carry 84 bombs. The explosive cartridges must be removed and replaced after each sortie, and the swing arms and ejector racks leave little room for munition crews to install the bombs. Figure 2.3 shows a conventional B-1B bomb module.

Figure 2.3: B-1B Conventional Bomb Module



Source: Air Force.

In contrast to the bomb module of the B-1B, the B-52 and the B-2 use less complicated bomb racks to release bombs. These racks do not have the swing arms that the B-1B has, and they are much easier to load and maintain. Neither of these bomb racks can be used in the B-1B due to the different bomb bay design. According to Air Force data, a B-52 can be reloaded with 45 to 51 500-pound bombs within 1 to 2 hours.

In commenting on a draft of this report, DOD indicated that progress has been made in reducing the amount of time required to load the B-1B with 500-pound bombs. According to the DOD comments, the time required for a single load crew to reload has been reduced to 8.5 hours. We could not assess the operational viability of the claimed reductions in bomb-loading times nor could we determine whether these tests were realistic because the Air Force was unable to provide us with data comparable to that

developed during operational testing and evaluation. Although the claimed reductions are significant, 8.5 hours to reload the B-1B exceeds the 1 to 2 hours required to reload the B-52 and can adversely affect sortie generation rates.

The Air Force also claims that by using two crews rather than one, a B-1B can be loaded within 5 hours and that this capability was demonstrated in a Lancer Joust Conventional Munitions Loading Competition at Ellsworth Air Force Base in September 1992. According to the Air Force, the Air Combat Command uses the 5-hour loading time for mission planning purposes. Two crews require additional personnel and do not represent a typical work crew scenario. The use of unrealistic loading times can result in overly optimistic estimates of sortie generations. Sortie generations were critical to the Air Force's success in Operation Desert Storm and were difficult to sustain, even with the B-52's substantially lower bomb loading times.

A fully loaded B-1B needs three bomb modules. Because the Air Force procured 100 bomb modules for the B-1B, no more than 33 aircraft can be fully loaded with 500-pound bombs at any one time. According to Air Force officials, one option would be not to load all bomb bays with munitions. This would allow one bay to be used for fuel storage. While plausible, this option would reduce the number of bombs from 84 to 56, about the same quantity carried by the B-52s. Another potential option would be to buy more modules, but the Air Force has decided against this.

Sea Mine Capability Has Not Been Achieved

In 1981, the Air Force established a B-1B baseline requirement for a 500-pound sea mine. In July 1989, the Air Force certified the B-1B as having a 500-pound sea mine capability, even though the mine's test performance was unsatisfactory. According to a Navy report, the B-1B System Program Office did not consider operational performance in determining whether the B-1B should be certified for the sea mine. Instead, the System Program Office certified the mine on the basis that it could safely separate from the B-1B's bomb bay without damaging the aircraft. According to the Navy, which is responsible for the sea mine, the B-1B did not demonstrate the capability to satisfactorily deliver the mine. After reviewing the test results, the Navy withdrew its support for further testing, awaiting Air Force improvements.

During testing, the mines experienced unpredictable pitch down and yaw¹ after release from the aircraft. Navy test reports stated that the pitching, possibly caused by the turbulent airflow beneath the aircraft and short mine-release intervals, caused mine-to-mine collisions. These collisions may damage the mines and are therefore considered unacceptable. The Navy noted that the failure rate was 33 percent, even though the mines were released only from the B-1B's most aerodynamically favorable middle weapon bay. The Navy indicated that the failure rate could possibly worsen when the forward and aft weapon bays are used.

In November 1988, the Navy notified the B-1B Program Office that it would not authorize the Air Force to use the sea mine on the B-1B until the problems were resolved. The Navy concluded that the failures encountered during the certification test made the B-1B unsuitable for load, carriage, or release of the sea mine.

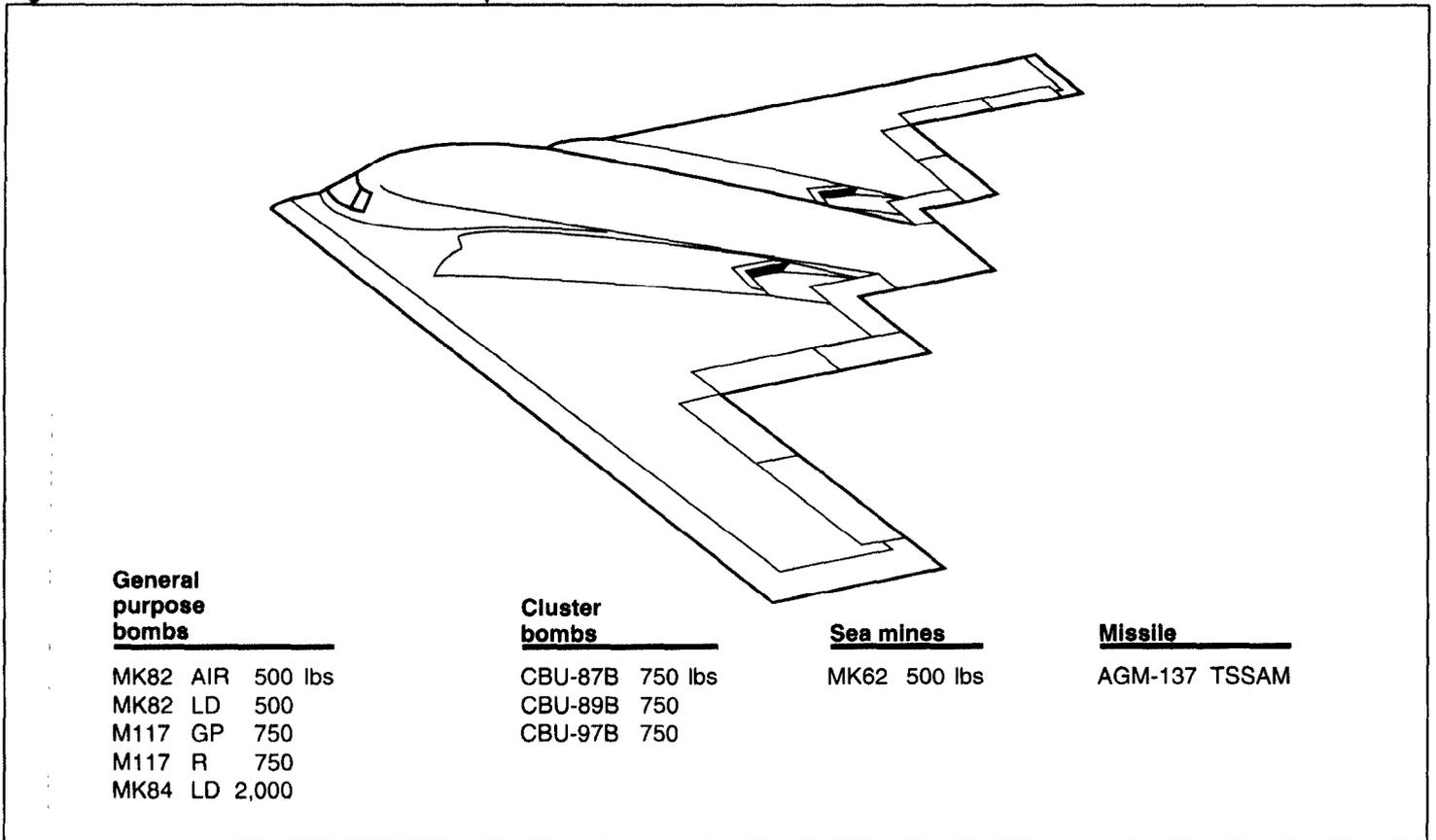
According to Air Force officials, the sea mine will be removed from the Navy's inventory in 1993. The Air Force plans to test another sea mine, which it expects to be more compatible with the B-1B in 2001. Since certification and testing of this mine is not planned until 2001, the B-1B will not have the capability to deliver the sea mine until 2001 or beyond.

B-2's Conventional Capabilities

The original B-2 design was for a long-range, multi-role bomber capable of penetrating Soviet air defenses at both low and high altitudes. Although designed to have a conventional and nuclear role, its primary role at the outset was to support the nuclear single integrated operational plan mission. Recently, however, the primary role of the B-2 has been shifted to conventional missions. Figure 2.4 shows the baseline conventional weapons planned for the B-2.

¹Yaw is defined as a side-to-side motion in contrast to pitch, which is an up or down motion.

Figure 2.4: B-2 Baseline Conventional Weapons



Source: Air Force.

The B-2 is currently in production, with aircraft deliveries expected between 1993 and 1998 under the current delivery schedule. It is projected to have the capability to deliver a wide range of conventional munitions. Given the early stage of B-2 development, we believe it is premature to confirm its operational capabilities in a conventional role.

In commenting on a draft of this report, DOD disagreed with our assessment of the conventional capabilities of the B-2. DOD stated that most performance factors, such as weapons accuracy, range, and stealth characteristics, are fully understood. In that regard, the National Defense Authorization Act for Fiscal Years 1990 and 1991 (P.L. 101-189) requires an

annual certification by the Secretary of Defense to the congressional defense committees that, among other things, the B-2 aircraft has a high probability of being able to perform its intended missions. The Secretary has not yet submitted such a certification.

In 1981, the Air Force planned to develop and buy 132 B-2 aircraft. Today, only 20 B-2s, about 15 percent of the original quantity, are planned to be procured.

Precision-Guided Munitions and the B-1B Are Key Elements of the Air Force's Plan

The Bomber Roadmap is based on two primary concerns. First, in the future, unlike Operation Desert Storm, the United States may not have several months to deploy all the capability needed to hit critical targets with short-range joint forces. Second, future adversaries will improve air defenses or otherwise protect intended target areas. These concerns form the basis of the key assumptions inherent in the Roadmap. These assumptions are that (1) strategic bombers may be the only means available to strike enemy targets early in a conventional conflict, (2) there is a need to equip the strategic bombers with precision-guided munitions, and (3) the B-1B will become the backbone of the conventional bomber force through operational enhancements. According to the Roadmap, the Air Force estimates that it will cost about \$3 billion to modify and equip the B-1B and B-52H bombers with conventional capabilities. Conventional enhancements for the B-2 bomber are included in the B-2's total program cost of \$44.4 billion.

Roadmap Emphasizes Bomber's Unique Contribution

The plans and priorities in the Bomber Roadmap revolve around improving the bombers' ability to attack an enemy's war-making potential, especially time-critical targets that could inflict unacceptable damage on U.S. interests if the targets are not destroyed in the first hours or days of a conflict. These targets include the following:

- enemy conventional forces threatening or invading a friendly state;
- emerging capabilities for the production, support, and use of weapons of mass destruction;
- key nodes of enemy command and control and air defenses; and
- enemy air attack assets and other offensive capabilities.

The Air Force's objectives, as outlined in the Bomber Roadmap, are to have the capability to (1) hit a careful selection of the enemy's most valuable targets in a short time span, such as the first 5 days of conflict, and (2) have the capability to sustain operations against the next layer of lower priority targets.

Using the Desert Storm experience as an example for determining future requirements, the Air Force identified a hypothetical list of 238 initial high priority targets that might need to be destroyed within the first 5 days of a conventional conflict. The targets would require attacks on about 1,250 target elements, such as specific buildings or industrial complexes, that must be hit to destroy the priority target. Assuming a .4 sortie rate per day and a 75-percent aircraft mission capable rate, with aircraft being flown

from the United States, the Air Force projects that today's force of B-52s and B-1Bs could destroy about 300, or 24 percent, of the hypothetical 1,250 target elements. Thus, according to the Air Force, the current bomber force of B-1Bs and B-52s falls about 76-percent short of the Air Force's stated needs to be capable of unhinging an adversary's strategic plan and to provide additional time for the arrival of other forces in the theater of operations. The Air Force attributes this shortage of capability to a lack of (1) precision-guided conventional weapons capability, (2) a robust anti-armor capability, and (3) flexible employment options.²

According to the Air Force, without substantial improvements, the theater commander would not be able to inflict operational paralysis on enemy ground, air attack, or air defense forces—or even stall operations until weeks or months passed to bring more forces to the theater. As a result, the Air Force plans to equip the strategic bombers with the conventional capabilities necessary to strike all priority targets in the first 5 days and have adequate force structure to sustain operations against the next layers of targets. This would occur by enhancing the conventional capabilities of the B-1B and B-52H and developing the capabilities of the B-2. The Air Force plans to achieve this capability by 2001.

Roadmap Envisions Equipping Bombers With Precision-Guided Munitions

The Air Force plans to equip all of the B-1Bs and B-2s and 47 of the B-52Hs with precision-guided munitions. Currently, this capability is only available with the Harpoon and HAVE NAP missiles that can be delivered only by the B-52G. The Air Force, in joint efforts with the Army and Navy, plans to develop three new precision-guided munitions: the Joint Direct Attack Munition (JDAM), the Joint Stand Off Weapon (JSOW), and the Tri-Service Standoff Attack Missile (TSSAM). Although not being developed exclusively for bombers, these weapons are expected to significantly improve the capabilities of the Air Force's bomber force.

JDAM is a three-phased program to improve precision-guided munitions accuracy. JDAM I is a 2,000-pound weapon that the Air Force estimates will achieve accuracy of 45 feet or less. JDAM II is a 500-pound Navy weapon. JDAM III is a more advanced 2,000-pound weapon that will combine the GPS guidance technology of JDAM I with a precision seeker. The Air Force estimates that JDAM III will achieve accuracy of 10 feet or less, day or night, and in adverse weather. The JDAM weapons program is jointly managed by

²The Air Force defines flexible employment options as the capability to attack targets using a variety of tactics such as launching weapons from standoff range.

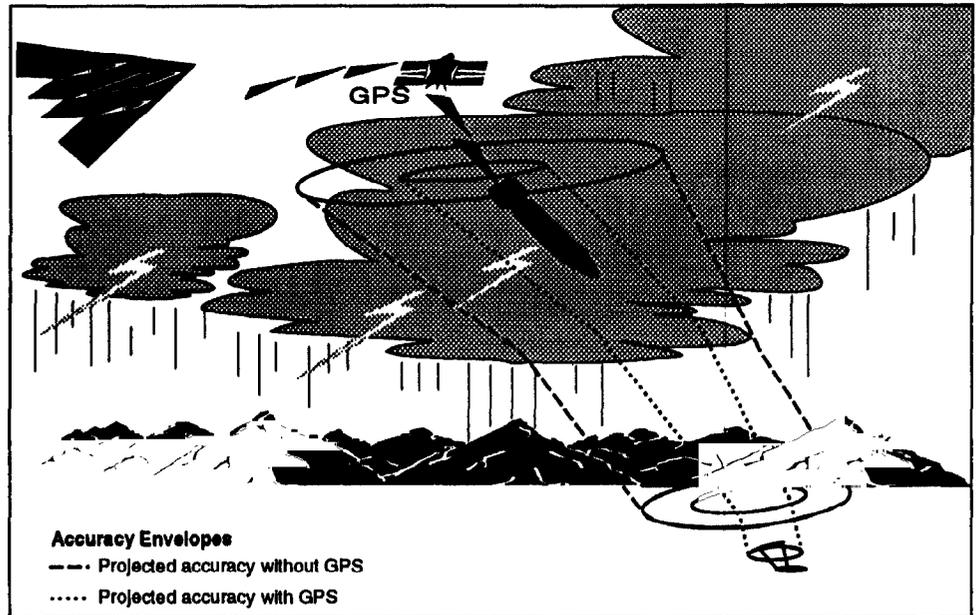
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the Air Force and the Navy. The Air Force's portion of the JDAM cost will be almost \$6 billion.

JSOW, also a joint Air Force and Navy project, is a glide bomb with a cluster-type anti-armor submunition. It is intended to provide a capability to strike from standoff range such targets as enemy tanks and other armored vehicles, maritime assets, bridges and railroads, and enemy air defenses. The weapon incorporates the Navy's former Advanced Interdiction Weapon System with the Air Force's Sensor Fuzed Weapon submunition. The Air Force's research and development cost is estimated at \$162 million.

JDAM and JSOW will use the satellite-based GPS. Figure 3.1 depicts the three-dimensional satellite navigation information that GPS provides to improve precision-guided weapons accuracy.

Figure 3.1: Depiction of Increased Munitions Accuracy Using GPS



Source: Air Force.

TSSAM, a joint Air Force, Army, and Navy project, is a stealthy standoff cruise missile with a range in excess of 100-nautical miles. Its intended use is to strike high value land and sea targets. The munition's standoff capability and its stealth features would enhance the survivability of both the aircraft and missile. TSSAM is currently in full-scale development. In October 1992, the Air Force estimated the total cost of the program at \$17 billion.

In addition to these new weapons, the Air Force plans to add two existing precision-guided munitions to the B-52H. Nineteen aircraft are to be equipped with the Harpoon antiship missile and 10 are to be equipped with the HAVE NAP missile.

In addition, the Roadmap calls for each aircraft to have several lesser sophisticated nonprecision gravity bombs to sustain combat against the next layer of lower priority targets. For example, the Air Force plans to equip all three aircraft with nonprecision gravity bombs such as the 2,000-pound bomb. The Air Force also plans for each bomber to have a mine-laying potential to augment the Navy's sea denial capability. Table 3.1 shows the Air Force's plans for equipping the B-52H, B-1B, and B-2 with new munitions.

Table 3.1: Air Force Plans for Adding Conventional Weapons to B-52H, B-1B, and B-2 Aircraft

B-52H	B-1B	B-2
Harpoon (19 aircraft)	2,000-pound bomb ^a	2,000-pound bomb
HAVE NAP (10 aircraft)	TSSAM	TSSAM
TSSAM	JDAM I, III	JDAM I, III
JDAM I, III	JSOW	Sea mine
Sea mine ^a	Sea mine	

^a Subsequent to the issuance of the Bomber Roadmap, the Air Force indicated that the B-52H would be equipped with the MK40 and MK60 sea mines and that the 2,000-pound bomb would be deleted and replaced with three types of cluster bombs—CBU-87/89/97.

Source: Air Force.

B-1B Is to Be the Backbone of the Conventional Bomber Force

The Air Force is placing its highest priority on developing the conventional capabilities of the B-1B. Early iterations of the Roadmap focused on the procurement of a force of 75 B-2 aircraft. At that time, the B-2 was planned to serve as the primary strategic bomber and the B-1B's role as a conventional bomber was given a significantly lower priority. However, the number of B-2s was subsequently reduced to a maximum of 20 aircraft.

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Therefore, according to the Bomber Roadmap and DOD, considering such things as the conventional enhancements planned for the B-1B, the greater number of those aircraft relative to the potential B-2 fleet, the future threat, and B-52 age and survivability, the B-1B was identified as the backbone of the bomber force.

The majority of the \$3 billion Roadmap costs are B-1B-related. The plan includes two major categories of investments—support costs and conventional enhancements. Support costs—such as spares and war reserves, deferred logistics, and electronic countermeasure fixes—account for the largest share of this investment. The costs to enhance conventional capabilities include weapons integration and modifications to the aircraft to enable them to use the planned weapons.

Bomber Roadmap Raises Questions About the Conventional Role of Strategic Bombers

The Air Force's Bomber Roadmap raises some important issues that must be resolved before it can be used for making future acquisition and funding decisions. These issues include (1) the Roadmap's assumption that strategic bombers may be the only means available for early strikes of enemy targets and therefore need to be equipped with the capability to strike all high priority targets in any future conventional conflict, (2) the validity of the Air Force's plans to add precision-guided conventional munitions to each type of strategic bomber, and (3) the B-1B's ability to perform as the conventional backbone of the strategic bomber force.

Adding the conventional capabilities to the strategic bomber force will be complex, costly, and time-consuming. It is unlikely that the aircraft modifications and new weapons planned for the strategic bombers will be available to cover the high priority targets by 2001 as envisioned by the Roadmap. Further, the Bomber Roadmap estimates that it will cost about \$3 billion to modify and equip the B-1B and B-52 bombers with conventional capabilities. However, this cost will increase by billions of dollars when B-1B costs associated with fixing operational problems, acquiring an effective defensive avionics system, and providing adequate war readiness spare parts are considered. Additionally, the cost to achieve the capability described in the Roadmap increases significantly when the bombers' portion of the costs to develop and procure precision-guided munitions is factored in.

Roadmap Assumes Bombers May Be the Only Assets Available at the Outset of Future Conflicts

Based on the actual use of the strategic bomber in Operation Desert Storm, we question whether the concept of operations and the related requirements, as set forth in the Roadmap, are indicative of future conventional missions and requirements of the strategic bomber force. For example, in developing the Roadmap, the Air Force assumed that even with forward-deployed aircraft carriers and allies providing forward bases, the United States cannot count on having shorter range, tactical aircraft to attack enemy targets in the first 2 days of a conventional conflict. Consequently, the requirements for precision-guided munitions on the strategic bomber force was an extension of the assumption that strategic bombers may be the only means available to attack enemy targets early in a conventional conflict. While the contributions of carrier-based and long-range theater attack aircraft during Operation Desert Storm were significant early in the war, these contributions are not reflected in the Roadmap. Additionally, DOD officials have pointed out that the Bomber Roadmap was not a coordinated DOD-wide effort, but an Air Force plan for

equipping strategic bombers. It did not include a roles and missions analysis among Army, Navy, and Air Force assets.

DOD is currently in the process of addressing the potential contributions of these aircraft. This is in response to the Congress' concerns that were expressed during its consideration of the DOD fiscal year 1993 budget request. In its report on the National Defense Authorization Act for Fiscal Year 1993 (Report 102-352), the Senate Committee on Armed Services stated the following:

The committee is concerned that the Defense Department is proceeding with plans to upgrade and outfit B-1B, B-2, and B-52 bombers for long-range conventional missions, and, at the same time, initiate development of a long-range Navy and Air Force attack aircraft, without an explicit analysis of the possible tradeoffs and synergies between different force mixes and procurement plans. The committee is also concerned that none of the modernization plans included needed improvements in associated support aircraft, such as aerial refueling and electronic warfare aircraft.

The committee therefore directs that the roles and missions report required of the Chairman of the Joint Chiefs of Staff pursuant to section 153(b) of title 10, United States Code, and the Secretary of Defense's accompanying views include a comprehensive analysis of the respective roles and missions of long-range bombers, carrier-based aviation, and long-range theater attack aircraft as part of the fiscal years 1994 and 1995 budget submission.

Integrating Conventional Weapons Is a Complex, Time- Consuming Process

Integrating conventional weapons with bombers will be a complex and time-consuming endeavor that will be difficult to achieve by the year 2001 as envisioned by the Roadmap. Further and perhaps more importantly, we question whether all the planned precision-guided munitions are needed. For example, while highly accurate guided munitions were used by strategic bombers on the first day of the air campaign in Operation Desert Storm, the bulk of the munitions dropped by strategic bombers on Iraqi ground forces were "dumb" bombs. Table 4.1 shows the number and type of weapons the B-52Gs delivered.

**Table 4.1: Weapons Delivered by
B-52Gs During Operation Desert Storm**

Type of munition	Quantity delivered
750-pound bombs (M-117)	44,761
500-pound bombs (MK-82)	17,835
Cluster bombs (CBU-52/58)	8,652
Cluster bombs (CBU-71/87/89)	1,230
1,000-pound bombs (UK-1000)	252
Air launched cruise missiles	35
Total	72,765

The almost exclusive use of nonprecision-guided munitions during Operation Desert Storm raises a question of whether the Air Force could forego some expense by putting precision-guided munitions on only some, rather than all, of its strategic bombers.

Unlike nuclear weapons that have similar characteristics and require similar delivery tactics, conventional weapons come in a variety of shapes, sizes, and technologies. Their technologies range from “dumb” gravity bombs to precision-guided “smart” weapons. Each weapon is unique and must be operationally tested for safe separation and effectiveness in the unique aerodynamic environment of the aircraft. Success is not always ensured, as demonstrated by the B-1B’s lack of success with the 500-pound sea mine.

The complexities of adding conventional capabilities to the strategic bombers were described by General Lee Butler, Commander in Chief of the Strategic Air Command, before the Subcommittee on Defense, Senate Committee on Appropriations, on May 7, 1991. In his testimony, the General stated the following:

Providing the conventional capability which enables our strategic bombers to fulfill their dual role presents a particular challenge. When we design and then procure a strategic bomber, we get the basic airframe, the controls, displays, radars, computers and avionics for navigation, and a weapons control and delivery system, and enormous growth potential. Maturing the nuclear deterrent mission capabilities of a long-range bomber is relatively simple because the weapons and delivery tactics essentially are constant.

By contrast, the number and variety of conventional weapons, ranging in type and complexity from gravity iron bombs to standoff precision-guided munitions, makes the development of a bomber’s conventional capability more demanding. Like peripherals to a computer, each conventional munition must be carefully integrated with the bombers’ systems. For conventional weapons, this means integrating the munition to the bomber

with suitable suspension and release equipment; linking the munition to the bomber navigation and sensor suites with appropriate software; and, testing to determine how the weapon will behave when employed in the different aerodynamic environment of the bomber.

Installing the planned conventional weapons on the strategic bomber will require some modifications to each of the aircraft.

B-1B Modifications to Integrate Planned Weapons

The B-1B will need several modifications and new equipment to achieve its planned conventional capabilities. These items include a new computer, the GPS navigation system, and the Military Standard 1760 weapons-to-aircraft electronics interface.

According to the Air Force, the B-1B's computer has a shortage of memory capacity and a lack of vendors to manufacture and supply spare parts for the outmoded computer system. Further, more memory capacity is needed for the B-1B to operate precision-guided munitions. In a 1992 study of the B-1B's computer problems, the Boeing Company concluded that the existing B-1B computer needed to be replaced by a new computer and that extensive software modifications were needed to implement the new system. Estimated costs for the new system total about \$100 million. While the time frame for integrating the new computer with the B-1B has not been specifically identified, the Bomber Roadmap indicates that a full operational capability with the computer will not be achieved until 2004. This means that a full operational capability with precision-guided munitions with the B-1B is not likely until 2004 and beyond.

In addition to a new computer, the B-1B will need to be equipped with GPS and the Military Standard 1760 interface before it can operate the planned JDAM, JSOW, and TSSAM precision-guided munitions. Completion of these modifications is not expected until the year 2000 and beyond.

B-2 Modifications to Integrate Planned Weapons

The precision-guided munitions planned for the B-2 require GPS to navigate to their target; however, we found that GPS will not be installed on the B-2 during production. Instead, the B-2 will have to be retrofitted with GPS. A schedule provided by the B-2 Program Office shows GPS being installed on the B-2 between 1995 and 1998. A study is currently underway to define the B-2 GPS. Once designed and developed, GPS can be installed on the B-2 and testing with precision-guided munitions can begin.

In addition to the JDAM and TSSAM precision-guided munitions, the Air Force plans to equip the B-2 with several less sophisticated gravity weapons, including 500-pound bombs and sea mines, three types of cluster bombs, and two types of 750-pound bombs. All of the gravity munitions were scheduled for operational testing and certification with the B-2 in 1996. According to the B-2 System Program Office, follow-on test and evaluation would occur subsequent to the 1996 certification schedule and an initial operational capability date would be expected in the very late 1990s. Using this scenario, testing of the precision-guided TSSAM would not occur until the less sophisticated gravity weapons were tested. The Air Force, however, is contemplating a change in the test schedule whereby TSSAM would be tested prior to the nonprecision-guided weapons. Either way, a substantial operational capability with the B-2 is not likely until the late 1990s and beyond.

**B-52H Modifications to
Integrate Planned Weapons**

To facilitate the retirement of the B-52Gs, the Air Force plans to transfer the capabilities of the B-52G to the B-52H aircraft. Although much less complex than the modifications needed on the B-1B, the modifications planned for transferring the B-52G conventional capabilities to the B-52H are not scheduled to be completed until the mid- to late 1990s and beyond. GPS and the Military Standard 1760 aircraft-to-weapon electrical and data interface must be installed. The B-52H also needs a secure voice radio to avoid message interceptions and a new cockpit lighting system that is compatible with night vision goggles. Figure 4.1 shows the Air Force's schedule for enhancing the conventional capabilities of the B-52H.

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Figure 4.1: B-52H Conventional Weapons Modification Schedule

Item	Fiscal year				
	1994	1996	1998	2000	2002
Global Positioning System		██████████	FOC		
Military Standard 1760 (47 aircraft)		██████████	FOC		
Modify Bomb Racks		██████████	FOC		
TSSAM (48 aircraft)			████████████████████	FOC	
HAVE NAP (10 aircraft)		██████	FOC		
JDAM I (47 aircraft)				████████████████████	FOC
Harpoon (19 aircraft)		██████	FOC		

FOC—Full Operational Capability

Source: Air Force.

Adding the precision-guided munitions will be time-consuming. Table 4.2 shows the estimated initial installation of the planned precision-guided munitions on the strategic bombers.

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Table 4.2: Initial Installation of Precision-Guided Weapons on B-1B, B-2, and B-52H Bombers as Planned in the Bomber Roadmap

Aircraft type	Weapon planned	Initial installation ^a
B-1B	JDAM I	1999
	JSOW	2002
	JDAM III	2003
	TSSAM	2004
B-2	JDAM I	1997
	TSSAM	1997 ^b
	JDAM III	2001
B-52H	HAVE NAP (10 aircraft)	1994-95
	Harpoon (19 aircraft)	1995
	TSSAM	1996 ^b
	JDAM I	1998

^a This is the date the first weapon will be installed. It does not mean the Air Force has full operational capability.

^b As of November 2, 1992, the TSSAM Defense Acquisition Board revised the date of the B-2 and B-52 aircraft installation to 1998.

Source: Air Force.

The precision-guided munitions (JDAM, JSOW, and TSSAM) are in some phase of research, development, or testing and for the most part are not scheduled for full-scale production until the mid- to late 1990s and beyond. As noted in the table, some delays have already occurred in the TSSAM program. Should further delays occur in weapons development, aircraft modifications, new equipment installation, software development, or operational testing, the Air Force's plan to have the capability to destroy its stated requirement of 1,250 high priority targets could be substantially extended beyond the currently planned date of 2001.

B-1B Problems Must Be Resolved for It to Be the Backbone of the Conventional Bomber Force

While the B-1B has several performance characteristics that are highly advantageous in a conventional warfighting role, including high speed, maneuverability, and a smaller radar cross-section, the B-1B has yet to demonstrate the capability to deliver a variety of conventional munitions that might be expected of the backbone of the bomber force. The B-1B's inability to carry a variety of weapons tends to place a continuing reliance on the B-52 for delivering conventional weapons. If the B-1B is to become the backbone of the force, some new equipment will be needed and problems with the B-1B's defensive avionics system, engine failures, and the lack of an engine anti-icing system will need to be fixed.

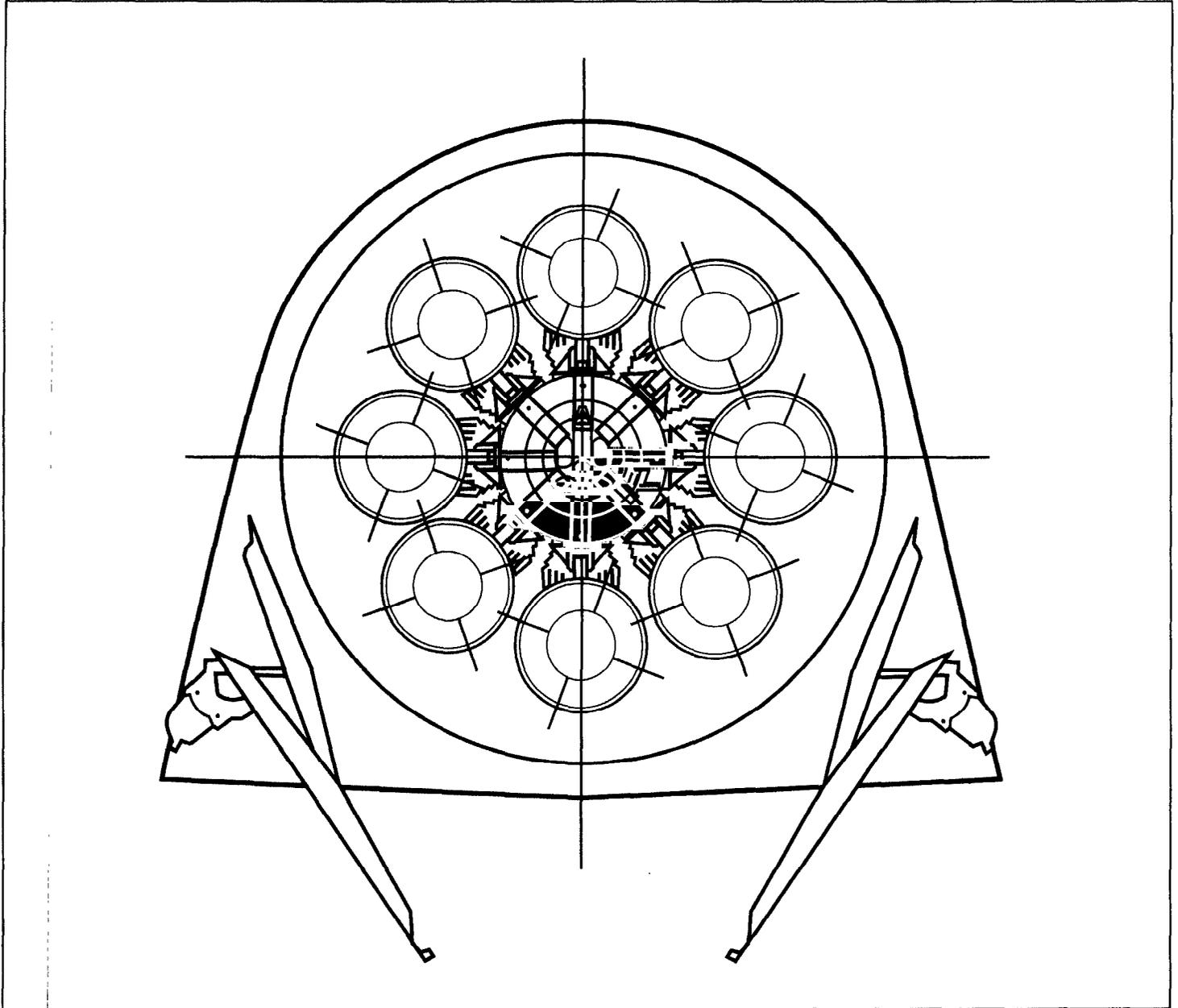
B-1B's Weapons Carriage
Limits Weapon Flexibility

Of the nine types of weapons dropped by B-52G aircraft during Operation Desert Storm, the B-1B's existing bomb carriages can only carry one—the 500-pound bomb. About 62 percent of all the bombs dropped by the B-52 during Operation Desert Storm were 750-pound bombs, which the B-1B's existing modules cannot carry. The B-1B is also unable to carry any of the five types of cluster bombs that the B-52Gs dropped on Iraqi tanks, artillery, and troop concentrations.

The cause of the B-1B's limitations is its conventional bomb module, which was designed exclusively for 500-pound weapons. Since the conventional weapons module was designed exclusively for 500-pound weapons, the Air Force plans to carry all additional conventional weapons on a different bomb carriage system—the B-1B's nuclear rotary launcher, shown in figure 4.2.

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Figure 4.2: B-1B's Multi-Purpose Rotary Launcher



Source: Air Force.

The B-1B's rotary launcher was designed to carry nuclear weapons, and its design is not compatible for the carriage and release of most existing conventional weapons. Nuclear weapons are attached to the rotary launcher by suspension hooks that are 30 inches apart. Conventional bombs and mines that weigh less than 2,000 pounds require suspension hooks that are 14 inches apart. Because the rotary launcher's hooks cannot be set 14 inches apart, it cannot carry these weapons.

A particular problem in using the B-1B's rotary launcher to carry conventional weapons is that it cannot release bombs in a rapid succession. After releasing a bomb, the B-1B's rotary launcher requires 4 to 7 seconds to rotate the next bomb into the release position. This time limitation makes the launcher unsuitable for missions that require a large number of bombs to be released in rapid succession, such as the bombing of area targets that was performed by the B-52s during Operation Desert Storm. It also raises questions about the Air Force's plan to use the rotary launcher to deliver 2,000-pound gravity bombs. According to the Air Force, the B-1B will be able to carry a total of 24 2,000-pound bombs—8 bombs in each of the B-1B's 3 bomb bays. However, the rotary launcher can only release one bomb from each bay as the aircraft flies over the target because of the time it takes for the launcher to rotate the next bomb into a delivery position. To deliver all 24 bombs, the aircraft would have to fly over targets 8 times. This dramatically increases the risk to the B-1B and its crew from enemy defenses. Rockwell International Corporation North American Aerospace Group, the aircraft manufacturer, concluded that a new, more flexible bomb carriage was needed for the B-1B. Without an effective bomb carriage, the risk of using the B-1B to deliver 2,000-pound bombs increases. The Air Force estimated the cost of a new bomb carriage at \$200 million.

After reviewing a draft of this report, the Air Force told us that it is no longer considering the use of a 2,000-pound bomb with the B-1B. The Air Force also told us it no longer plans to use the rotary launcher to deliver gravity-type weapons. The Air Force plans to add a cluster bomb capability to the B-1B and use the conventional module for delivering these weapons. Hardware will have to be removed from the module to make room for the cluster bombs. When configured for cluster bombs, the module cannot carry 500-pound bombs. The removed hardware will have to be reinstalled before the module can again carry 500-pound bombs. We were told that it will take about 36 hours to reconfigure the module from one weapon to the other. This lack of flexibility to carry a variety of

gravity-type weapons will continue to hamper the B-1B in its planned role as the backbone of the bomber force.

B-1B Defensive Avionics
Requirements Are
Unknown

The B-1B's current defensive avionics system—the ALQ-161A—will need additional jamming techniques to enhance the survivability of the aircraft as a conventional bomber. These additional jamming techniques have not yet been defined, and it is unknown whether the additional techniques can be incorporated into the ALQ-161A.

Flight testing of the ALQ-161A surfaced a series of developmental problems. In 1988, it was determined that the system was architecturally flawed and not capable of meeting contract specifications. The specifications at that time were relaxed to support the bomber's nuclear role as a low-altitude penetrator against Soviet air defenses. According to the Roadmap, an effective electronic countermeasure system is actually more crucial for conventional missions because of the diversity and number of countermeasure challenges the B-1B crew will possibly encounter.

In a June 1992 classified report, we recommended that the Secretary of Defense direct the Secretary of the Air Force to determine the requirements of a defensive system to support the future conventional role of the B-1B bomber before proceeding with either modifications to the ALQ-161A or acquiring a new defensive avionics system. In its August 1992 response to our report, DOD concurred with our recommendation. More recently, in its classified B-1B Bomber Evaluation—1992, DOD stated that during a conventional conflict requiring multiple sorties per aircraft with an operational electronic countermeasure system, the disadvantages of the current ALQ-161A would become particularly significant.

During the next year, DOD plans to establish the performance and operational suitability requirements of an improved electronic countermeasure system to support the B-1B in both conventional and nuclear missions. It also plans to review conventional mission requirements and potential air defense threat systems, establish system requirements, and begin to evaluate alternatives. Therefore, it is not yet known what the costs will be to equip the B-1B with a suitable defensive avionics system.

Engine Problems Continue
to Occur

The Air Force is continuing to experience difficulties with the B-1B's engines. Problems in supplying adequate amounts of air to cool the

engines and keep them from overheating have recently occurred. Preliminary estimates show that it will cost \$105 million to fix this engine problem. Another problem with the B-1B is the lack of an effective system to keep ice from forming around the engine inlet. In temperatures of 47 degrees Fahrenheit and less, ice can form in front of the engines, and after accumulating, it tends to break free in chunks and damage the engines. To counter the problem, the Air Force issued a directive to not operate the aircraft when moisture is present and the temperature is 47 degrees or below. This operating restriction, while achievable in peacetime, does not seem workable in a conventional war scenario requiring repetitive sorties such as those required in Operation Desert Storm. According to Air Force preliminary estimates, it could cost an additional \$200 million to develop a B-1B engine anti-icing system.

According to DOD, the cost for an anti-icing system was not included because it does not intend to purchase such a system. Additionally, Air Force officials told us that the operating restriction is a conservative, peacetime stipulation for ground operations that would likely be waived in a conventional conflict. However, waiving the restriction does not fix the problem. Lifting the restriction may cause more engine blades to be damaged, which could require more frequent engine changes and repairs. Currently, the B-1B must be visually inspected for engine blade damage after every flight. In addition, an electromagnetic check of each engine must be made after every 50 hours of operation. Waiving the restriction to allow the B-1B to operate in sustained combat would mean more flying hours, frequent inspections, and the possibility of damaged blades from flying in conditions currently prohibited.

Bomber Roadmap Does Not Include All Costs

The Bomber Roadmap does not include all the costs that the Air Force will incur in achieving the conventional capabilities of the strategic bomber force. The Roadmap includes the cost to integrate the planned precision-guided munitions on the bomber fleet. It does not include the costs associated with resolving the previously discussed B-1B problems nor does it include the cost of developing and procuring precision-guided munitions. Adding these costs to the existing Roadmap estimates would increase the cost of achieving conventional warfighting capabilities by billions of dollars.

B-1B Costs Are Understated

The cost of B-1B war readiness spares is understated in the Roadmap. Historically, the Air Force has equipped its aircraft with an

air-transportable package of spares, repair parts, and related maintenance equipment and supplies to support combat operations for 30 days. For example, as of April 1992, the Air Force had spent \$419.2 million for war readiness spares to support 56 B-52G aircraft for 30 days. The importance of these war readiness spares was reinforced during Operation Desert Storm. Air Force logistics officials responsible for supplying and managing war readiness spare parts told us that a 30-day supply of spare parts was critical to sustaining the B-52G operations during Operation Desert Storm.

In contrast to the \$419 million investment in spares for the B-52, the Air Force anticipates costs of only \$129 million to support 42 B-1B aircraft. According to Air Force officials, this would allow 42 B-1B aircraft to forward deploy for a period of 7 days. This is clearly insufficient to sustain operations such as those performed over a much more extended period by the B-52s during Operation Desert Storm. Tinker Air Force Base officials responsible for determining B-1B war readiness spares requirements told us that they did not know how the costs had been developed. According to their 1991 B-1B war readiness spares requirements study, \$529.1 million of spare parts would be necessary to support 48 B-1B aircraft for 30 days of combat.

Table 4.3 shows the estimated costs to resolve B-1B operational problems and to satisfy the B-1B war readiness spares costs requirements.

Table 4.3: Costs to Resolve B-1B Operational Problems

Item	Costs		Total
	Understated in Roadmap	Not Included in Roadmap	
	Dollars in millions		
Engine fixes		\$ 105	\$ 105
Engine anti-icing system		200	200
War readiness spares	\$400		400
Total costs	\$400	\$305	\$705

In addition to the costs to fix the operational problems identified in table 4.3, cracks were recently discovered in the B-1B landing gear. This problem occurred subsequent to the development of the Bomber Roadmap. Resolution of the problem will be an additional, not yet determined, cost.

Also, the cost to equip the B-1B with an effective defensive avionics system is most likely understated in the Roadmap. The Roadmap includes

\$676 million for this effort. However, the Air Force's plans for improving the B-1B's defensive avionics system, which the \$676 million was to have funded, have recently changed. DOD's September 1992 report to the congressional defense committees, entitled B-1B Bomber Evaluation—1992, stated that the revised role of the B-1B from primarily a nuclear to a conventional bomber is changing the performance requirements of the aircraft's defensive avionics system.

Prior to the Air Force's determination that both the currently configured ALQ-161A and its planned upgrade, the CORE program, could not meet the requirements of the conventional role, the Air Force estimated the total cost to fix the ALQ-161A to be more than \$1 billion. The \$1 billion is the sum of a \$550 million CORE estimate and a \$489 million estimate to procure a radar warning receiver. The Air Force is in the process of redefining new performance requirements to add capability, in addition to what the CORE and radar warning receiver would have provided, to the B-1B defensive avionics system. We believe this will drive the cost of the redefined defensive avionics system above the \$676 million estimate in the Bomber Roadmap. The extent of the cost variance will not be known until the Air Force completes its ongoing B-1B defensive avionics system requirements definition study, which is scheduled to be completed by early 1993.

Munition Development Cost Is Not Included

As previously stated, the Air Force is participating with the Army and Navy to develop precision-guided munitions. These munitions are planned to be used on fighter aircraft as well as on the strategic bombers. The Air Force does not allocate the costs of these munitions by type of aircraft. Therefore, we had no basis to make such an allocation.

Air Force costs for developing and procuring the planned precision-guided munitions total more than \$11 billion. The Air Force could not provide an allocation of this projected cost to the strategic bombers. These munitions are not being developed exclusively for those bombers and the costs are not included in the Roadmap. The most expensive of these munitions is TSSAM, which is planned for use by the Army, Navy, and Air Force. As of October 1992, the TSSAM program cost, including 7,450 missiles, totaled about \$17 billion. The Air Force's portion of this total program cost is classified. We have made a conservative assumption that the costs will be equally divided by the Army, Navy, and Air Force. Based on that assumption, the Air Force's share of the costs would be about \$5.6 billion. Since three of the six platforms planned to launch TSSAM are the B-1B, B-2,

and B-52H, this program adds over \$2 billion to the costs reported in the Roadmap.

The JDAM and JSOW programs are joint ventures by the Navy and the Air Force. The costs for these programs are less certain because the programs are still in the research and development phase. The Air Force's portion of the projected research and development costs for JDAM weapons is \$775 million. Projected Air Force costs for procuring 40,000 JDAM I weapons are almost \$4 billion. Projected Air Force costs for procuring 5,000 JDAM III weapons are almost \$1.2 billion. The number of JSOW weapons is not yet defined; however, the Air Force's share of the development costs is estimated to be \$162 million. Again, although the bombers are not the only carriers for these weapons, significant costs over and above those reported in the Bomber Roadmap must be spent to achieve the capability desired.

Conclusions

The Bomber Roadmap represents a costly approach to obtaining conventional capabilities in the strategic bomber force that may not be achievable by the year 2001 as envisioned by the Roadmap and that is based on a very different usage than occurred during Operation Desert Storm. Based on the limited use of precision-guided munitions by strategic bombers during Operation Desert Storm, it is not clear that the Air Force should proceed with its plan to equip each of its strategic bombers with precision-guided munitions. Even if the need for these weapons is accepted, there is an element of uncertainty about their availability, particularly those planned for the B-1B and B-2.

The extent to which the B-1B's operational problems are resolved will determine whether that aircraft will be able to fulfill its intended role as the backbone of the strategic bomber force. The resolution of these problems, combined with the long-term nature of the planned B-1B, B-2, and B-52H conventional enhancements, raises questions about the Air Force's plans to retire the 41 B-52Gs in 1994. If the Air Force retires the B-52Gs in 1994, it will be retiring its most capable conventional bomber before other bomber aircraft will have the equipment that the Air Force says will be needed to attack the high priority targets identified for its strategic bombers.

The Bomber Roadmap by itself does not provide congressional and DOD decisionmakers with the total costs involved in obtaining the conventional warfighting capabilities that the Air Force indicates the strategic bomber

force will need. The total costs will be billions more than the \$3 billion included in the Roadmap.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD agreed that the process of adding additional conventional capabilities to the B-1B will be complex and time-consuming. In the draft report on which DOD provided comments, we had estimated the Air Force's portion of the costs to develop and procure the precision-guided munitions that are planned to be integrated into the strategic bombers and added those costs to the \$3 billion of integration costs that were included in the Roadmap. DOD disagreed that the total development costs of precision-guided munitions should be added to the Bomber Roadmap costs. According to DOD, munitions costs are separate and should not be included in weapon systems costs. We recognize that total munitions costs cannot be wholly allocated to the bomber force. However, the magnitude of these costs to achieve the Bomber Roadmap's capability is significant and should be recognized and debated when making decisions on enhancing the strategic bomber force.

DOD disagreed that the bomber force will necessarily be employed in the next war as it was employed in Operation Desert Storm. We recognize that Operation Desert Storm is not the only way a future war might be fought. The question is whether the Roadmap assumption that bombers alone would be available in the first few days of a conflict or whether the advantages of precision-guided munitions demonstrated during Operation Desert Storm translate into a requirement that each type of strategic bomber be equipped with precision-guided munitions. We believe that, because these munitions were primarily delivered by aircraft other than strategic bombers during Operation Desert Storm and because of declining defense resources, the need for these munitions on each type of strategic bomber is questionable. Further, the lessons learned from the strategic bomber's only conventional employment since the Vietnam War cannot be overlooked in mapping out the bomber's future conventional role.

DOD's comments are included in their entirety in appendix I.

Comments From the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



ACQUISITION

OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3000

November 25, 1992

Ms. Nancy R. Kingsbury
Director, Air Force Issues
National Security and
International Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Ms. Kingsbury:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report titled--"STRATEGIC BOMBERS: Adding Conventional Capabilities Will Be Complex, Time-Consuming, and Costly," dated October 9, 1992 (GAO Code 392650/OSD Case 9233). The Department partially concurs with the report. The Department takes exception, however, to the GAO cost methodology and the implication that U.S. forces will be used in a future war as they were used in a single past conflict.

The Department agrees that the process of adding additional conventional capabilities to the B-1B weapon system will be complex and time-consuming. However, the Department disagrees with the inclusion of the total development costs of the munitions in a weapon system cost. By doing so, the cost of one delivery platform--the B-1B--is inflated approximately eight billion dollars. The Department does include the platform-unique munitions integration costs as weapon system costs.

Additionally, the Department disagrees with the GAO implication that the bomber force will be employed in the next war as it was in the most recent war, i.e., Operation Desert Storm. Each war is unique, and developing a force structure and planning to fight a future war based on the immediate conduct of the most recent war could seriously degrade the effectiveness of the fighting forces.

Detailed DoD comments on the report finding are provided in the enclosure. Additional technical comments were separately provided to the GAO staff. The Department appreciates the opportunity to comment on the draft report.

Handwritten signature of George R. Schneiter in cursive.

George R. Schneiter
Director
Strategic and Space Systems

Enclosure

GAO DRAFT REPORT - DATED OCTOBER 9, 1992
(GAO CODE 392650) OSD CASE 9233

"STRATEGIC BOMBERS: ADDING CONVENTIONAL CAPABILITIES
WILL BE COMPLEX, TIME-CONSUMING, AND COSTLY"

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

- o **FINDING A: The Redefined Role Of The Bomber Force.** The GAO reported that, for many years, manned bombers stood alert to deter the Soviet nuclear threat. The GAO reported that in 1991, however, with the cold war ending, the President ordered a stand-down of all U.S. nuclear bomber forces. The GAO explained the changing international environment required the refocus of the national nuclear strategy from the cold war deterrence to a strategy that emphasizes conventional warfighting capabilities.

The GAO found that, to meet the challenges of change in the international environment, the Air Force redefined the roles and missions of its strategic bomber force, resulting in the issuance of the Bomber Roadmap in June 1992. The GAO explained that the Roadmap outlined the operational concept and structure for the bomber force and identified the funding requirements to enhance and support the bomber force for conventional missions, and also identified the number and types of bombers the Air Force determined it needs, and the weapons the bombers will carry in a conventional role. The GAO noted that three types of bombers make up the strategic bomber force: the B-52, the B-1B, and the B-2. According to the GAO, the bomber force today totals 277 aircraft (180 B-52s and 97 B-1Bs), with plans to add 20 B-2 bombers to the force. (pp. 2-3, pp. 12-16/GAO Final Report)

DoD RESPONSE: Partially concur. The Department agrees that the Air Force "Bomber Roadmap" was issued in June 1992 and bomber roles and missions are being redefined. However, the Department disagrees that the bomber force totals 277 aircraft. The total active inventory of bomber aircraft, as of November 1992, is 53 B-52Gs, 95 B-52Hs, and 96 B-1Bs for a total current force of 244. The DoD also plans to build 20 operational

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Now on pp. 2, 10-13.

See comment 1.

B-2s. Following the planned retirements of the B-52Gs, and including the B-2s, the long-term bomber total inventory will be 211 bombers (184 primary aircraft authorized) to perform both nuclear and conventional missions.

- o **FINDING B: The B-52 Provides Most Of The Bomber Force Conventional Capability.** The GAO found that the B-52 provides the U.S. with a significant conventional bombing capability. The GAO reported that the B-52 can carry a wide variety of conventional munitions, such as cluster bombs, general purpose bombs, and sea mines, and can also deliver precision-guided missiles that can be launched from outside enemy air defenses. The GAO explained that 44 of the B-52G aircraft, while primarily equipped to deliver nuclear weapons, can also deliver conventional weapons, while the remaining 41 B-52Gs have been modified and specifically equipped with equipment needed to deliver conventional weapons, including precision-guided munitions. The GAO further explained that the 95 B-52H aircraft, while not capable of delivering precision-guided missiles, can deliver all other conventional munitions.

The GAO observed that Operation Desert Storm illustrated the potential demands of the conventional bomber role. The GAO explained that 75 B-52Gs were deployed to support air strikes against Iraq, and during the first day of the air campaign 7 B-52Gs attacked high-priority targets in Iraq with cruise missiles--the first wartime use of a conventional, long-range standoff weapon by a strategic bomber. The GAO also found, however, that as a reflection of the desires of the theater commander, the primary role of the B-52 during the war became the regular bombing of mobile targets. In that role, the GAO reported that demands on the B-52 included (1) sustaining a high sortie rate, (2) basing in close proximity to the theater of operations, (3) dropping a large volume and variety of gravity bombs, and (4) flying at high altitudes. (pp. 3-5, pp. 19-23/GAO Draft Report)

DoD RESPONSE: Partially concur. The Department agrees that the 30-year old B-52 provides the U.S. with a significant conventional capability and that its inherent capabilities of large payload, wide variety of munitions, and long range make it a key contributor to the U.S. force structure. However, while the theater commander tailored the B-52 use to certain roles in the unique situation of Operation Desert Storm, the

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Now on pp. 2-3, 15-18.

See comment 2.

Department need not limit the use of bombers to that role in future conflicts. Operation Desert Storm provided valuable insights to what could be needed in a future conflict, and the roadmap translated those insights into force capabilities needed, e.g., ability to strike critical targets early in a crisis.

The Department agrees that the Gulf conflict was the first historical use of conventional cruise missiles in war; however, the Department disagrees that the B-52 was based in close proximity to the war. Fifty-five of the 75 B-52s involved in Operation Desert Storm were based 1,700 to 2,000 nautical miles from the theater of operation, and the conventional air-launched cruise missile sorties were launched from the continental United States.

The B-52G presently has the capability to strike a small portion of lesser-defended targets in the critical target set. Additionally, the DoD plans to shift conventional capability to other heavy bombers as the venerable B-52Gs are being retired, and the exploitation of technology--precision-guided munitions--is integrated into the force structure.

- o **FINDING C: The Conventional Capabilities Of The B-1B Are Limited.** The GAO concluded that, as currently configured, the conventional capabilities of the B-1B are significantly more limited than those of the B-52. The GAO found, for example, that the B-1B can deliver only one type of conventional munition: the 500-pound gravity bomb. The GAO explained that the conventional bomb carriage for the B-1B was designed exclusively for 500-pound bombs and lacks the flexibility to carry a variety of weapons, as does the B-52. The GAO concluded that as a result, the role and mission of the B-1B are currently limited.

The GAO also reported that the B-1B effectiveness with the 500-pound bomb may be reduced, due to the bombs colliding with each other when released from the aircraft--a problem revealed during low-altitude testing. The GAO found that to avoid collisions, the bombs will have to be released at a rate slower than planned, which will string out the bombs and cause fewer bombs to directly hit the target. The GAO reported that since the B-1B will likely be flying at high altitude during a conventional conflict, the Air Force began high-altitude testing of the 500-pound bomb in December 1991. Although the test results were not yet available,

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See comment 3.

Appendix I
Comments From the Department of Defense

the GAO reported that an Air Force official said the high-altitude test results were more positive than were the low-altitude tests.

The GAO also found that the B-1B operational effectiveness is limited by excessive bomb loading times. The GAO explained that the B-1B bomb modules are very complex, making bomb loading very difficult. The GAO concluded that such excessive loading times could reduce B-1B sortie rates, which were critical to the B-52 performing repetitive bombing missions during Desert Storm. The GAO noted that the Air Force said progress in reducing bomb loading times was being made, but could not provide data the GAO could use to assess the operational validity of the claimed reductions.

Finally, the GAO found that the B-1B has a baseline requirement for a sea mine that has not been achieved. The GAO found that the Air Force certified the B-1B as having sea mine capability in July 1989, but the Navy withdrew its support for the sea mine due to mine-to-mine collisions during testing. According to the GAO, the Navy notified the B-1B program office in 1988 that it would not authorize the Air Force to use the sea mine on the B-1B until the problems were resolved. (pp. 5-6, p. 19, pp. 23-31/GAO Draft Report)

DOD RESPONSE: Partially concur. The Department agrees that the B-1B currently has limited capabilities. That will not be the case in the future. As an interim bomber, the B-1B was designed with nuclear deterrence as its primary mission. The B-52 has undergone significant modifications over the past 30 years to enhance its conventional capabilities, just as the B-1B now requires. When the proposed modifications to the B-1B current configuration are finished, it will be capable of carrying a full spectrum of gravity bombs, naval mines, and smart conventional weapons.

Currently, the B-1B can carry 84 Mark 82 weapons, whereas the B-52 can carry only 51 weapons. Additionally, the broadest spectrum of targets can be attacked by the Mark 82 500-pound gravity bomb, and that consideration was one reason the Mark 82 bomb was the first conventional weapon on the B-1B.

The Department disagrees that slower release rates imply the weapons would miss their targets. Testing with 20 milliseconds between bomb releases did reveal collisions; however, operational changes that do not

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Now on pp. 3-4, 15, 18-25.

See comment 2.

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affect mission objectives can be made, while a permanent solution to the collision problem is developed--the Mark 82 500-pound general purpose bomb is a non-precision weapon. Operationally, not all targets require the minimum time interval of 20 milliseconds, e.g., storage yards, rail yards, airfields, industrial complexes, and troop formations do not. Also, while low-drag bombs, used for high-altitude delivery, can be released effectively at 20 milliseconds, all aircraft release the high-drag weapons at greater than the minimum possible release interval to optimize weapon effectiveness. Additionally, a 20-millisecond restriction on the bomb module has no impact on the precision munitions, as they are carried by the rotary launcher.

See comment 3.

The Department disagrees with the GAO that "the B-1B will likely be flying at high altitude during a conventional conflict..." The operational employment is based on several factors, e.g., tactics, threat, scenario, etc. For example, in Operation Desert Storm, the B-52G flew both high- and low-altitude operations. The B-1B may fly at high altitude--the upper level of its flight envelope--or low altitude. The December 1991 testing was conducted to investigate expanding the employment envelope.

See comment 1.

Additionally, the Department disagrees that the bomb loading times are excessive and could reduce the B-1B sortie generation rate. Current timing to configure modules with munitions in the preload facility, deliver them to the aircraft, and then load them into the B-1B is 8.5 hours. In August 1992, those times were tested and verified at Ellsworth Air Force Base, South Dakota. The Air Force has recently demonstrated that two load crews can load all three bomb bays--84 500-pound weapons--in five hours. That allows two full sorties to be generated during one 12-hour timeframe, consistent with the Air Force concept-of-operation requirements.

See comment 1.

Lastly, the B-1B is certified to carry the Mark 36 sea mine. However, the Mark 36 is scheduled to leave the Navy inventory in 1993. Currently, it is the Air Force and Navy view that the Mark 62 sea mine should be used on the B-1B and certification is planned in 2001. The B-52H capabilities meet current maritime sea-lane control requirements.

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Now on pp. 4, 15, 25-26.

See comment 2.

- o **FINDING D: The Conventional Capabilities Of The B-2.**
The GAO reported that the B-2 was designed to have both a conventional and nuclear role, with the nuclear mission originally its intended primary role. The GAO found, however, that the primary role of the B-2 has recently been shifted to conventional missions. The GAO reported that the B-2 is currently in production, with aircraft deliveries expected between 1993 and 1998. The GAO also reported that the B-2 development and initial flight test program was scheduled to be completed by mid-1993; however, delays and design problems have caused the test program to extend to late 1996. The GAO noted that date may slip further, since the flight test program is currently under review. The GAO noted that the B-2 is projected to have the capability to deliver a wide range of conventional munitions, but it is too soon to predict its operational performance in a conventional role. (p. 6, p. 19, pp. 31-33/GAO Draft Report)

DoD RESPONSE: Partially concur. The Department agrees that the B-2 was designed to have both a conventional and nuclear role. However, the Department disagrees that it is too soon to predict its operational performance. Most performance factors, such as weapons accuracy, range, carriage, and stealth characteristics, are fully understood.

- o **FINDING E: The Roadmap Assumes Bombers Will Be The Only Available Weapon System At The Outset Of A Conventional Conflict.** According to the GAO, the Bomber Roadmap is based on two primary concerns:
 - In the future, unlike Operation Desert Storm, the U.S. may not have several months to deploy all the capability needed to hit critical targets with short-range forces.
 - Future adversaries will improve air defenses or otherwise protect intended target areas.

The GAO found that those concerns form the basis of the key assumptions inherent in the Bomber Roadmap.

The GAO reported that the first assumption is that strategic bombers will be the only means available to strike enemy targets early in a conventional conflict. The GAO explained that the plans and priorities in the Roadmap revolve around improving the ability of the bombers to attack the enemy

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war-making potential, especially time-critical targets that could inflict unacceptable damage if not destroyed in the first few hours or days of a conflict. The GAO reported that, using Desert Storm experience as an example for determining future requirements, the Air Force identified a hypothetical list of initial high-priority targets that might need to be destroyed early in a conventional conflict, and projected the capabilities of the current force. The GAO reported that those projections show the current force of B-1Bs and B-52s fall about 76 percent short of the stated needs. According to the GAO, the Air Force attributes the shortage capability to a lack of (1) precision-guided conventional weapons capability, (2) a robust anti-armor capability, and (3) flexible employment options.

The GAO reported that the Air Force has indicated that, without substantial improvements, the theater commander would not be able to inflict operational paralysis on enemy forces, or even stall operations for weeks or months. The GAO noted that the Air Force plans to add the conventional capabilities needed to have all priority targets covered by the year 2001 by enhancing the conventional capabilities of the B-1B and B-52H, and developing the capabilities of the B-2. (p. 3, p. 6, pp. 34-36/GAO Draft Report)

DOD RESPONSE: Partially concur. The Department agrees that the Air Force Bomber Roadmap made assumptions and emphasized the bomber's unique contribution in the critical early days of a conflict. However, the Department also recognizes that shorter range tactical aircraft (land-based or carrier-based) can be made available to bomb many targets. In the conduct of a war, there are allocation effects associated with the employment of one asset over another.

Operation Desert Storm was one scenario, and the future may be different--the Department force structure and planning for the future are not based solely on the conduct or successes of the last war. Additionally, force structure and planning for the next war is not solely based on any one assumption, e.g., availability of theater in-place or remote weapon systems at the onset of hostilities.

- o **FINDING F: The Bomber Roadmap Envisions Equipping All Bombers With Precision-Guided Munitions.** The GAO reported that the second assumption inherent in the Roadmap is that all bombers will be equipped with precision-guided

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Now on pp. 2-4, 27-28.

See comment 2.

munitions. The GAO reported that currently, only the B-52G is capable of delivering precision-guided weapons. To improve the conventional capabilities of the B-1B, B-2, and B-52H, the GAO reported the Air Force plans to develop three new precision guided munitions--the Joint Direct Attack Munition, the Joint Stand-Off Weapon, and the Tri-Service Standoff Attack Missile. The GAO found that the Air Force also plans to add existing precision-guided munitions to the B-52H, while the Roadmap calls for each aircraft to have several lesser sophisticated non-precision gravity bombs to sustain combat against the next layer of lower priority targets. (pp. 3-4, p. 6, p. 34, pp. 36-39/GAO Draft Report)

Now on pp. 2-4, 17, 27-30.

See comment 1.

DoD RESPONSE: Partially concur. The Department agrees that the Air Force plans to equip bombers with precision-guided munitions. However, only seven B-52Gs--those that have been conventionally enhanced--are capable of delivering precision-guided weapons, e.g., the Have Nap munition. (Note: the three precision-guided munitions the GAO mentions are joint service programs, not just Air Force programs.) Additionally, only 47 of the 95 B-52Hs are planned to be modified with the Joint Direct Attack Munition and the Tri-Service Standoff Attack Missile.

- o **FINDING G: The B-1B Is To Be The Backbone Of The Conventional Bomber Force.** The GAO reported that the third assumption inherent in the Bomber Roadmap is that the B-1B will be the backbone of the bomber force. The GAO explained that earlier iterations of the Roadmap focused on the B-2, when a procurement force of 75 aircraft were planned. With the number of B-2s being reduced to a maximum of 20 aircraft, however, the GAO reported the Air Force then identified the B-1B as the backbone of its bomber force.

According to the GAO, the Air Force estimates it will cost about \$3 billion to modify and equip the B-1B and B-52H bombers with conventional capabilities. The GAO noted that the majority of the costs are B-1B related. The GAO reported that the Roadmap also includes two major categories of investments--support costs and conventional enhancements, with support costs accounting for the largest share of the investment. (p. 4, p. 34, pp. 39-40/GAO Draft Report)

Now on pp. 2, 27, 30-31.

See comment 2.

DoD RESPONSE: Partially concur. The Department agrees that the B-1B will become the backbone of the Air Force Bomber Roadmap in the future. However, the Department

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disagrees that the change in the B-2 inventory was the reason. The bomber roadmap was not driven by the B-2 decision. The bomber roadmap looked at the unique characteristics of each of the three bombers, taking into account the capabilities of each aircraft. Factors, such as the threat, arms control agreements, the age and survivability of the B-52, economic costs, etc., all led to the selection of the B-1B for the conventional role.

- o **FINDING E: The Roadmap Does Not Consider Other Air Assets.** The GAO concluded that the Bomber Roadmap raises some important issues that must be resolved before it can be viewed as a reliable basis for making future funding decisions. The first issue the GAO discussed was the Roadmap's assumption that strategic bombers will be the only means available for early strikes of enemy targets in any future conventional conflict (Finding E).

Based on the actual experience in Desert Storm, the GAO questioned whether the concept of operations and related requirements included in the Roadmap are indicative of future conventional missions and requirements of the strategic bomber force. The GAO observed, for example, that there are questions about the validity of the large number of high-priority targets the Air Force says the bombers must be prepared to strike with precision-guided munitions. The GAO found that the Air Force, in arriving at the target base, did not consider the potential missions that could be carried out against those targets by carrier-based or other land-based tactical fighter aircraft.

The GAO pointed out that the Congress has indicated its concerns over the issues during consideration of the DoD FY 93 budget request. The GAO reported, for example, that the Senate Committee on Armed Services report on DoD authorizations for FY 1993, requires that the roles and missions report, required of the Chairman of the Joint Chiefs of Staff as part of the fiscal years 1994 and 1995 budget submission, include a comprehensive analysis of the respective roles and missions of long-range bombers, carrier-based aircraft, and long-range theater attack aircraft. The GAO concluded that the Roadmap does not resolve the conventional role of bombers. (p. 3, pp. 6-7, pp. 41-43/GAO Draft Report)

DoD RESPONSE: Partially concur. The Department agrees that the future and the unpredictable nature of regional conflicts do not clearly point to one, and

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Now on pp. 3-5, 32-33.

See comment 2.

only one, asset for early strikes of enemy targets. However, while the GAO implication that a war could start with assets in place (i.e., Operation Desert Storm), either carrier-based or land-based assets, the stated assumption of the Air Force Bomber Roadmap is also logical (e.g., that Air Force bombers could be employed for early strikes of enemy targets because in-place assets may be unavailable or not in place). Potential enemies will not fail to recognize an important lesson from Operation Desert Storm--do not allow coalition forces time to get into position to mount an offensive. The bomber force, as equipped, would have been capable of attacking only 24 percent of the Iraqi critical targets. With Roadmap improvements, the smaller future bomber force could be capable of attacking the entire target base.

The Department does not base the planning for a future war solely on the success of the last war, e.g., Operation Desert Storm. For example, the United States may not have the luxury of five months to move forces into the conflict area before the hostilities begin. The Air Force bases its planning on objective threat analysis. The Air Force Bomber Roadmap used the Operation Desert Storm target set as a base case to evaluate future force structures: "...Desert Storm experience as an example...and identified a hypothetical list of 238 initial, high-priority targets...to destroy early on--within the first five days...and pave the way for joint forces arriving in theater." Additionally, the Air Force used the Non-Nuclear Consumable Annual Analysis data base, theater commander inputs, and the Joint Mobility Requirement Study 1991, for force deployment and setup of combat operations in the development of the roadmap.

See comment 2.

Lastly, it should be recognized that the Air Force Bomber Roadmap was intended to be an Air Force roadmap and not a roles-and-mission analysis among Service assets. The Joint Chiefs of Staff report was requested after the Air Force Bomber Roadmap was prepared. The Joint Chiefs of Staff report is required with the FY 1994 and FY 1995 budget submission.

- o **FINDING I: Integrating Conventional Weapons Is A Complex, Time-Consuming Process.** The GAO concluded that the second issue raised by the Roadmap is the validity of the Air Force plans to add precision-guided conventional munitions to each type of strategic bomber (Finding F). The GAO pointed out

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that the Roadmap's emphasis on equipping all bombers with precision-guided munitions does not reflect the almost exclusive use of non-precision-guided munitions during Operation Desert Storm, which raises a question of whether the Air Force could forego some expense by putting precision-guided munitions on only some, rather than all of the strategic bombers. The GAO explained that unlike nuclear weapons that have similar characteristics and require similar delivery tactics, conventional weapons come in a variety of shapes, sizes, and technologies. The GAO further pointed out that each weapon is unique and must be operationally tested in the unique aerodynamic environment of the aircraft.

The GAO also found that installing the planned conventional weapons will require modifications to each of the aircraft. The GAO found that the B-1B will need several modifications and new equipment to achieve planned conventional capabilities, including a new computer, the Global Positioning System navigation system, and the Military Standard 1760 weapons-to-aircraft electronics interface. The GAO also found that the precision-guided munitions planned for the B-2 will require the Global Positioning System, but that system is not included in the B-2 production contract and the aircraft will have to be retrofitted. In addition, the GAO reported that the plans to equip the B-2 with less sophisticated munitions will require additional testing and certification, that will probably mean that substantial operational capability with the B-2 will not occur until the late 1990s and beyond. Finally, the GAO reported that modifications to the B-52H are not planned until the mid-to late 1990s and beyond.

The GAO concluded that integrating conventional weapons with bombers will be a complex endeavor and may not be achieved within the time frames envisioned by the Roadmap. The GAO explained that all of the precision-guided munitions are in some phase of research, development, or testing--should delays occur in development, aircraft modifications, or testing, achievement of the planned capabilities could extend beyond the 2001 date envisioned by the Roadmap. The GAO further concluded that, perhaps more importantly, it is questionable whether all the planned precision-guided munitions are needed. (pp. 3-4, pp. 6-8, p. 41, pp. 43-48, p. 57/GAO Draft Report)

DoD RESPONSE: Partially concur. The Department agrees the Air Force Bomber Roadmap emphasizes equipping precision-guided conventional munitions on bombers that could be used in a conventional conflict,

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Now on pp. 2, 4-6, 32-38,
46-47.

See comment 1.

and that those modifications, along with other planned modifications, will require integration on the delivery aircraft. However, as stated in the DoD response to Finding F, the Department disagrees that all bombers will be equipped, e.g., only 47 of 95 B-52H aircraft will be equipped with Joint Direct Attack Munition and Tri-Service Standoff Attack Missile.

In future conflicts, the military may be forced to use precision-guided weapons against targets to achieve political/military objectives, while avoiding excessive collateral damage. In Operation Desert Storm, heavy bombers were first employed with highly accurate conventional cruise missiles. While a limited capability, that allowed other assets, using precision-guided munitions, to strike other time-critical targets. Then the primary role assigned by the theater command was periodic and devastating bombardment of Iraqi ground troops. The use of non-precision weapons was the most efficient and effective weapon.

However, late in the war an urgent need was established for the B-52 to deliver precision-guided munitions-- Laser-Guided Bombs. Even though there were numerous fighter aircraft in the theater with that capability, none had the range and payload combination to employ the quantity needed. Hostilities ended 26 hours before the test was scheduled to be flown. After the war, the test was conducted, and the B-52 is now certified to carry two types of laser-guided bombs. The precision-guided munition integration was neither complex or time-consuming.

See comment 2.

Additionally, the Department disagrees with the GAO implication that refighting the past or most recent war (Operation Desert Storm template) is the way to plan for the next war. History has shown that lessons are learned from each conflict, and while some characteristics of wars are similar, other aspects are unique. The employment of precision-guided munitions will play a significant role in most, if not all, future conventional conflicts, as they did in fact play in Operation Desert Storm, when precision-guided weapons were launched from a host of platforms.

The fact that a process is complex and involves development efforts does not imply it will or will not be achieved within an estimated completion schedule. For example, the roadmap installation schedule matched the normal periodic depot maintenance schedule for the

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best cost savings, and maintained modification funding at a relatively level pace. If a development difficulty did occur, then a decision on cost and schedule modifications could be made, depending upon the development difficulty and the national security environment at that time.

- o **FINDING J: Problems With The B-1B Must Be Resolved For It To Be The Backbone Of The Conventional Force.** The GAO concluded that the third issue raised by the Bomber Roadmap is the ability of the B-1B to perform as the conventional backbone of the strategic bomber force (Finding G). The GAO acknowledged that the B-1B has several performance characteristics that are highly advantageous in a conventional role, including high speed, maneuverability, and a smaller radar cross section. The GAO also pointed out, however, that the B-1B has yet to demonstrate the capability to deliver a variety of conventional munitions that might be expected of the backbone of the bomber force.

The GAO found that of the nine types of weapons dropped by B-52G aircraft during Desert Storm, the B-1B existing bomb carriages can carry only one--the 500-pound bomb. The GAO explained that the cause of the B-1B limitations is its conventional bomb module, which was designed exclusively for 500-pound weapons. The GAO reported that the Air Force plans to instead carry all additional conventional weapons on a different bomb carriage system--the B-1B nuclear rotary launcher. The GAO found, however, that the rotary launcher design is not compatible for carriage and release of most conventional weapons, and it cannot release bombs in a rapid succession. The GAO concluded that the time limitation makes the launcher unsuitable for missions that require a large number of bombs to be released in rapid succession, and also raises questions about the Air Force plan to use the rotary launcher to deliver 2,000-pound gravity bombs.

The GAO also concluded that several other B-1B problems will need to be resolved for it to be the backbone of the conventional bomber force. The GAO explained that the current B-1B defensive avionics system will need additional jamming techniques to enhance survivability of the aircraft as a conventional bomber. The GAO found, however, that those additional jamming techniques have not yet been defined, and it is not known whether the additional techniques can be incorporated into the current system. The GAO also found that the Air Force is continuing to experience difficulties with the B-1B engines, involving the

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supply of adequate amounts of air to cool the engines and an effective system to keep ice from forming around the engine while on the ground.

Overall, the GAO concluded that the extent to which the B-1B operational problems are resolved will determine whether the aircraft will be able to fulfill its intended role as the backbone of the strategic bomber force. The GAO also concluded that the resolution of those problems, combined with the long-term nature of the planned B-1B, B-2, and B-52H conventional enhancements (Finding I), raises questions about the Air Force plans to retire the B-52Gs in 1994, since it would be retiring the most capable conventional bomber before other bomber aircraft will have the equipment the Air Force says will be needed to attack the high-priority targets identified for strategic bombers. (p. 3, pp. 7-8, p. 41, pp. 49-53, p. 57/GAO Draft Report)

Now on pp. 2, 5, 32,
38-43, 46.

DOD RESPONSE: Partially concur. The Department agrees that the B-1B has several performance characteristics that are highly advantageous in a conventional role, and the B-1B has had difficulties with the defensive avionics suite. However, the Air Force Bomber Roadmap contains the modifications necessary for the B-1B to assume the role as the conventional backbone of the bomber force. The Department also disagrees that those B-1B operational problems raise questions about the Air Force plans to retire the aging B-52Gs. At great expense, the entire B-52 force could be kept operationally functional; however, the planned changes in force structure have been shown to be more cost-effective in the long run.

See comment 2.

- o **FINDING K: The Bomber Roadmap Costs Are Understated.**
The GAO found that the Bomber Roadmap does not include all the costs that the Air Force will incur in achieving the conventional capabilities of the strategic bomber force. According to the GAO, the conventional enhancements for the B-2 are included in the B-2 program cost. The GAO found, however, that the costs in the Roadmap do not include the costs of precision-guided munitions, the costs for fixing the B-1B problems (Finding J), and adequate quantities of war readiness spare parts. The GAO found that adding those costs to the existing Roadmap estimates increases the cost of conventional capabilities from \$3 billion to more than \$11 billion.

The GAO explained that the Air Force costs for developing and procuring the planned precision-guided munitions could

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exceed \$8 billion, but those costs are not included in the Roadmap. The GAO estimated that the Air Force share of the most expensive of the munitions--the Tri-Service Standoff Attack Missile--may be in excess of \$4.5 billion. The GAO noted that the Air Force costs for the other precision-guided munitions are less certain, but are estimated at more than \$3 billion.

The GAO also found that the cost of B-1B war readiness spares is understated. The GAO explained that historically, the Air Force has equipped aircraft with a 30-day supply of spare parts, the importance of which was recently reinforced during Desert Storm. According to the GAO, the Air Force anticipates costs of only \$128 million to support 48 B-1B aircraft. The GAO found, however, that a 1991 B-1B war readiness spares requirements study states that \$529.1 million of spare parts would be necessary to support 48 B-1B aircraft for 30 days of combat. The GAO concluded, therefore, that the Bomber Roadmap does not provide congressional and DoD decisionmakers with a true picture of the costs involved in obtaining the conventional capabilities the Air Force indicates will be required by the strategic bomber force. (pp. 3-4, p. 7, p. 41, pp. 53-57/ GAO Draft Report)

DoD RESPONSE: Nonconcur. The Department strongly disagrees that the total development cost of munitions, which can be used on many delivery platforms should be wholly allocated to the cost of the bomber force. The GAO has incorrectly attributed the weapon development cost (about \$8 billion) to a small set of the platforms that use the weapon. The munitions, however, are not being developed exclusively for those bombers. Requirements exist for those joint weapons independent of the delivery platforms--if they are not employed on the B-1B, B-52, or B-2 systems, they will be employed on another delivery system.

The B-2 conventional enhancement does not include the munition costs. The Department is consistent in its separation of system integration and munition development costs.

Although the GAO divided the Tri-Service Standoff Attack Missile costs by three, the GAO attributed to the bomber force the total cost (more than \$3 billion) of other precision-guided munitions, e.g., Joint Standoff Weapon and the Joint Direct Attack Munitions, that will be used by Air Force and Navy tactical forces. The bomber roadmap does include the platform-

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Now on pp. 2-3, 5-6, 32,
43-47.

See comment 2.

unique integration costs that the DoD agrees should be reported as a cost. Because the munitions are developed and purchased, regardless of whether they are integrated on the bombers, the Department reports those costs as separate costs.

A cost the Department did not report is the \$200 million cost for an anti-ice modification identified by the GAO. That effort, however, is neither in development, nor is purchase planned by the Air Force. Also, the \$200 million cost for the "new bomb carriage" identified by the GAO is not planned for the B-1B.

Additionally, the bomber war readiness spares are consistent with current Department plans provided to the Congress. The Air Force Bomber Roadmap provided a true picture of the costs of roadmap programs for support and conventional enhancements. For perspective, it should be recognized that the coalition incremental cost of Operation Desert Storm was \$61 billion.

* * * * *

RECOMMENDATIONS

- o None

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See comment 3.

See comment 2.

The following are GAO's comments on the Department of Defense's letter dated November 25, 1992.

GAO Comments

1. We have revised our report to include this information.
2. We have addressed this comment in the report text.
3. We have deleted this information from the report.

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