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Providing An Effective Bomber Force for the Future: The B-2 Debate in Perspective

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Providing An Effective Bomber Force for the Future: The B-2 Debate in Perspective

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¹The views and recommendations in this testimony are solely those of the authors and do not necessarily represent those of RAND or any of its research sponsors.

Preface

We are here to discuss RAND's assessment of how to provide the United States with an effective bomber force for the future. Of particular current interest is the issue of whether the United States should procure additional B-2 bombers to supplement the 20 that are currently planned. That issue has to be evaluated in the broader context of U.S. national security objectives, military force posture, and the overall bomber force structure. Informing such choices has been the objective of the series of bomber studies that RAND has conducted over the last several years.

Over the last several years, RAND has been studying bombers quite intensively to understand how the dramatic changes in the world, the evolution of technology in critical areas, and budgetary pressures affect the role that bombers should play in the U.S. military and what sort of bomber force would best fit future U.S. needs. We have provided a number of reports and briefings to the Air Force, the Office of the Secretary of Defense, and various Congressional audiences on different aspects of the issue. We testified before this committee last year on this topic and are pleased to have the opportunity to do so again.

The most recent bomber studies that RAND has done for the Air Force are:

- Conventional Employment of B-52s (1987–1988)
- Future Bomber Force Study (1988–1991)
 - Updated in 1992 and 1994
- Bomber Flexibility Study (1992–1995)
- Heavy Bomber Study (1994–present)

The conventional B-52 study defined new ways to employ long-range bombers in conventional operations and laid the analytical groundwork for the more refined operational concepts and bomber applications that we developed in subsequent work. That study also defined the basic technical and operational requirements for cruise missiles for long-range bombers.

The Future Bomber Force Study was a major analytical effort that derived and evaluated a number of alternative bomber force structure options for a broad range of potential nuclear and conventional missions. That study focused heavily on evaluating the B-2 in the context of the overall bomber force options. We first presented the results of that study nearly four years ago. Since then, we

have periodically updated that work to reflect the implications on continuing changes in the world and various programmatic and budgetary decisions that affect the bomber force. Subsequent work has refined some aspects of the bomber analysis. The material we are presenting here represents our most recent update of the bomber force structure analysis and the modernization required to make that force effective.

Issues

Here's what we plan to cover.

- The role of long-range bombers
- The unique contribution of the B-2
 - Implications of various B-2 force levels
 - Options for making a small B-2 force as effective as possible
- Overall bomber force modernization: making the bomber force fully effective
- Bomber force level effectiveness

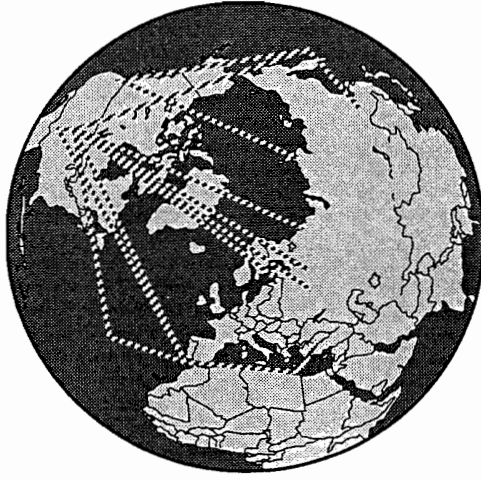
Why Bombers?

The fundamental characteristics that distinguish heavy bombers from other weapons are their long range and their substantial payload capability. They can deliver large, diverse payloads virtually anywhere in the world in a matter of hours. That means they have inherent advantages in situations where massive and/or sustained firepower matter, particularly if the attacks need to be made at long range from relatively safe bases. To the degree that this kind of capability is important, planners should be interested in heavy bombers.

As Figure 1 suggests, bombers have historically played major roles in conventional operations and in preparing for nuclear war. Unless there is a complete reversal of current trends in the world, the possible nuclear role of bombers is going to be much less important in the future than it has been in the past several decades. If so, bombers can make the transition to a conventional role much more easily than other strategic nuclear systems. Should the need arise, they could also revert back to their nuclear roles.

Although using bombers for conventional operations is nothing new, there is a new wrinkle in the evolving world. With U.S. military forces shrinking in size

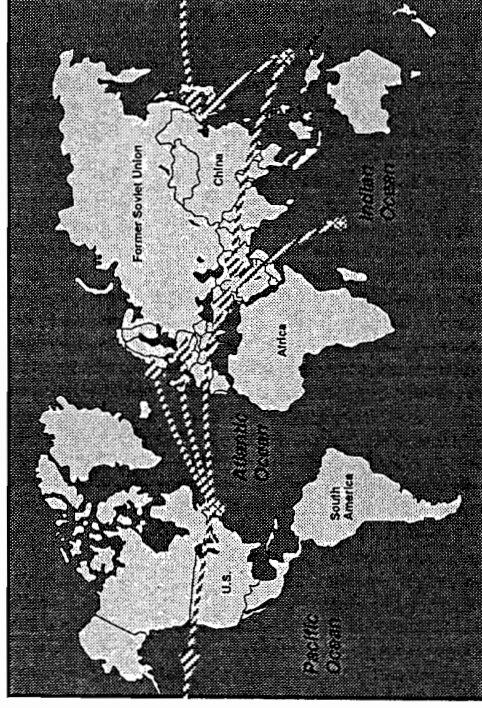
Nuclear Deterrence



Long Range

- Worldwide power projection within hours
- Sustained operations from relatively safe bases
- Loiter time

Conventional Power Projection



Large Payload Capacity

- Massive firepower

Figure 1—The Role of Long-Range Bombers

and generally withdrawing from overseas bases, the United States has limited options available for bringing force to bear in the early hours or days of an emerging conflict in a remote part of the world. Indeed, heavy bombers could be the *only practical option* in some cases of interest, which means they could fill a *unique niche* in U.S. military capability. That is particularly true in regions where there is little or no naval presence at the critical moment when the campaign begins or in situations where either massive or sustained firepower is needed. For example, as Figure 2 shows, even with two aircraft carriers already on the scene, it would have required nearly three weeks during Operation Desert Shield to move enough tactical aircraft into the theater to stop the kind of armored invasion that the Iraqis could have mounted against Saudi Arabia in the early days of the Gulf War. A long-range bomber force offers a potential counter to future contingencies of that sort *if the bombers can*:

- Survive enemy air defenses with little or no external assistance
- Locate, identify, and destroy enough critical targets to have a decisive impact during the early phases of a campaign

Our analysis showed that doing that would require new weapons for the bombers, improvements to the bombers themselves, and new operational concepts for the bombers.

In examining alternatives for structuring the bomber force, we have tried to identify and emphasize cases in which:

- Bombers can have a real impact
- Conditions stress the bomber force and provide a basis for structuring it.

Many other scenarios then tend to be “lesser included” cases for evaluating the bomber force and policy makers can then decide how much weight to attach to the stressing cases. *Value judgments about what military situations the U.S. needs to be able to deal with and can afford to prepare for are really the decisive factors in determining what sort of bomber force the U.S. should have.*

In general, we found that long-range bombers make the greatest relative contributions in scenarios in which:

- Massive firepower is needed (for example, to halt an invasion—particularly an armored invasion—of a relatively weak country by a much stronger neighbor).

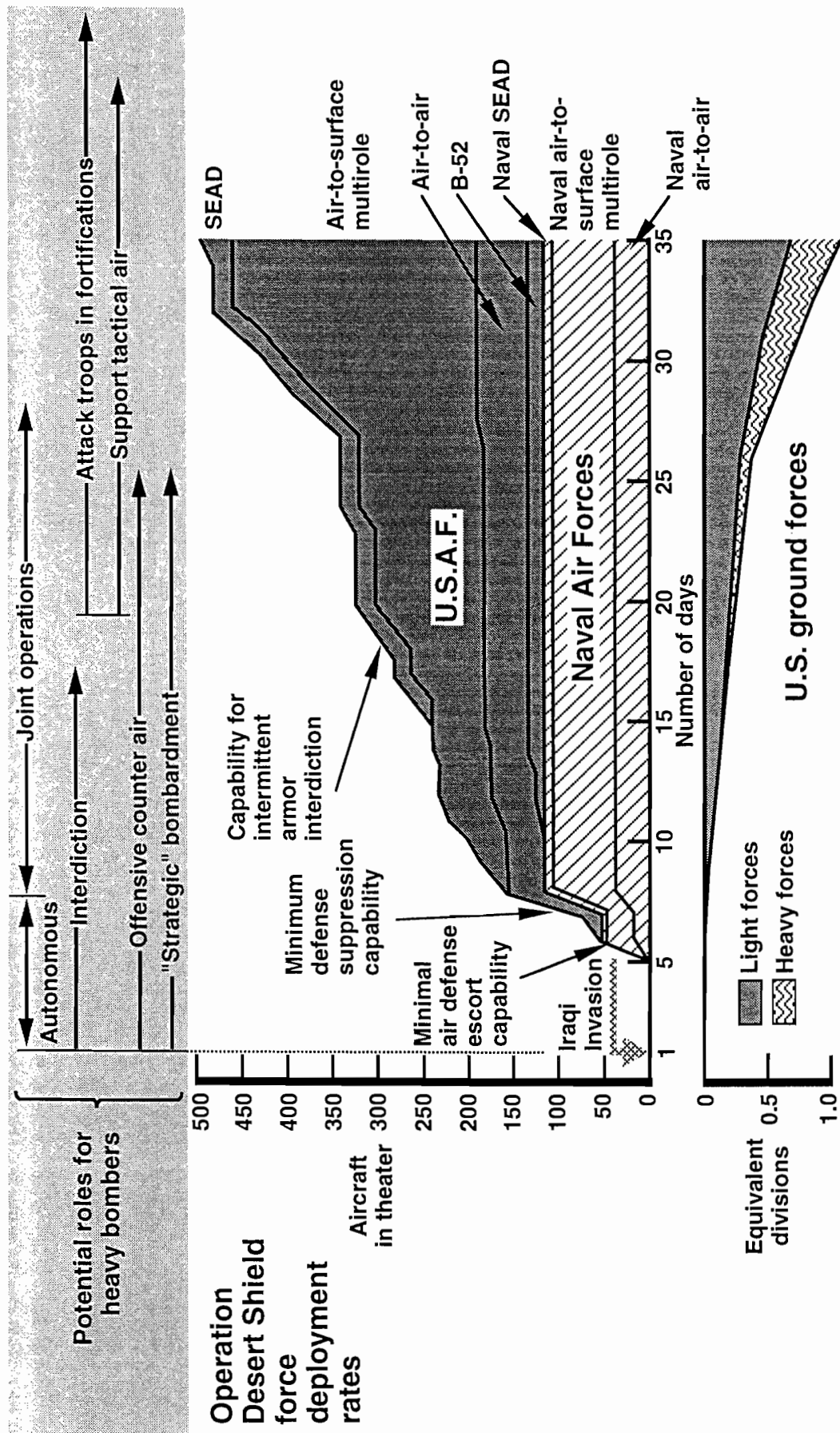


Figure 2—Potential Role of Long-Range Bombers in the Initial Phases of a Major Theater Campaign

- There is very limited U.S. or other allied military presence in the area at the outset of the conflict (e.g., few prepositioned forces, little or no advanced warning)
- The theater of conflict is a long distance from the United States or other concentration of "friendly military forces"
- The theater is large enough to provide "battlespace" for the defenders (i.e., to prevent a successful blitzkrieg that could produce an early victory for the attacker before the U.S. could react)

The more of these characteristics a particular scenario includes, the more likely it is that a large, capable bomber force could make a relatively large contribution. That's why, for example, Southwest Asia is a "bomber theater" (i.e., one where a large, capable U.S. bomber force could have a substantial effect) and Korea is not. It also suggests why assumptions about strategic warning time and the U.S. reaction to warning critically affect choices about the size and character of the bomber force. Adding in capable enemy air defenses stresses the bomber force still more, as does the need to find, identify, and attack difficult targets (e.g., invading maneuver forces) efficiently.

Focusing on the most difficult cases such as short-warning scenarios for evaluating bombers would, of course, tend to lead to requirements for a larger, more capable (and more expensive) bomber force than would be needed otherwise. However, designing a bomber force to deal with short-warning contingencies might provide enough excess firepower in less-demanding situations that other types of forces could be reduced to help defray the costs of the more robust bomber force. So far, there has been only a limited attempt in the defense community to address these trades.

Why B-2s?

The B-2s stealthiness offers particular advantages when operating relatively autonomously in a hostile environment:

- No payload penalty for standoff weapons since it can get very close to its targets
- An ability to find movable targets within limited areas using its own stealthy sensors
- The ability to use simpler, cheaper weapons than aircraft that have to standoff farther from targets by taking maximum advantage of its onboard sensors and human crew.

Thus, the B-2 is potentially well-suited to perform demanding tasks such as halting an armored invasion. *Indeed, determining the relative importance of being able to halt a large-scale invasion by a modern force in a distant theater where there is little or no U.S. presence and very little strategic warning is the critical value judgment in deciding how many B-2s the U.S. ought to buy.* The need for bombers to operate relatively autonomously for a period of time in a hostile environment and the nature of the adversary will critically affect the structure of the rest of the bomber force and its weapons as well. While no one can say with certainty how likely such a "short warning" scenario will be in the future, it is reasonable to assume that others learned lessons from the Gulf War as well, and one of those lessons certainly is that allowing the U.S. military the time to move its forces into an area, prepare fully, and then initiate a war on its own terms can be suicidal!

The B-2, however, is a new aircraft and still needs to demonstrate some of the necessary capabilities for such difficult missions. Moreover, as we will discuss later, the B-2 will require modifications and new weapons to be fully effective.

Getting the maximum mileage out of a bomber force with a limited number of B-2s suggests a division of labor among the bombers. Figure 3 shows an example of one such operational concept for employing a mix of bombers in a demanding scenario. The B-2s initially focus on halting the armored invasion, which may also require selective suppression of enemy air defenses.

Figure 4 shows how effective a small number of properly equipped B-2s could be in stopping an armored advance. The left side of the figure shows a "before photo" based on a computer simulation of an Iraqi armored division marching down the road toward Saudi Arabia. The right side of the figure shows an "after photo" following a simulated attack by three B-2s armed with inertially guided tactical munitions dispensers (TMDs) equipped with Skeet submunitions. Note that neither the B-1 nor the B-52 could do this in anything but a totally benign air defense environment. Over half of the combat vehicles in the division were destroyed within seconds, which should not only stop that division, but also, according to standard rules of thumb, damage it so heavily that it could not be reconstituted soon enough to participate further in the attack. RAND analysis at the time of the Gulf War showed that sustaining that level of interdiction on a daily basis should be sufficient to halt an Iraqi invasion (or anything similar) virtually in its tracks. It is this characteristic—the capability to stop a large-scale armored attack that occurs with little or no warning while operating from bases removed from the theater—that makes the bomber force in general and the B-2 in particular unique.

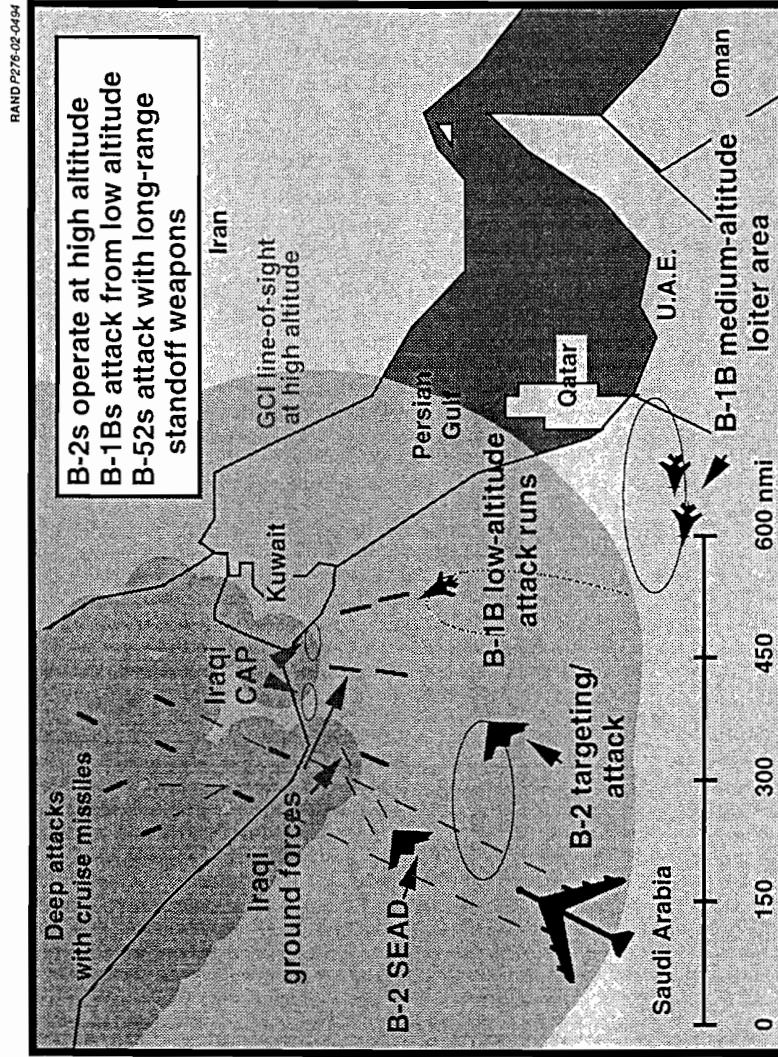
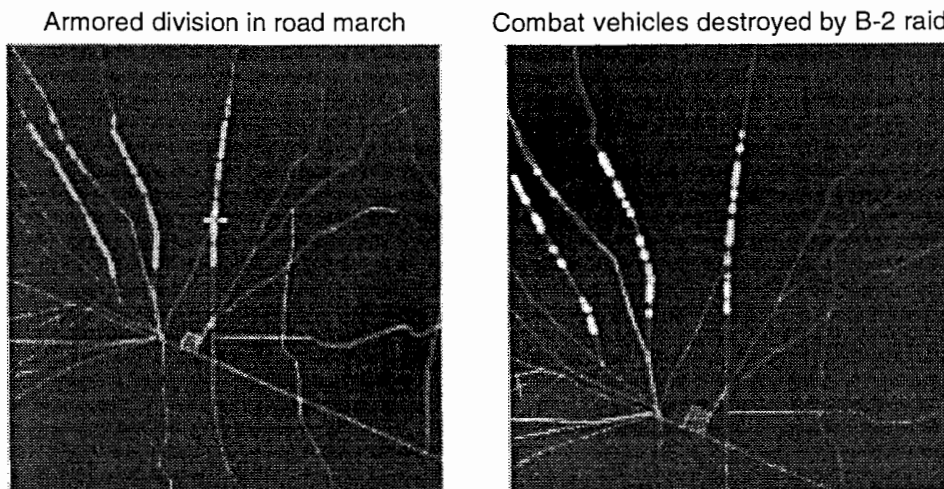


Figure 3—Making a Small Bomber Force Effective in a Stressing Major Regional Conflict—A Notional Concept

RAND#130-38-0194



- 3 B-2s above the armored column
- Inertially guided TMD/Skeet submunitions

Figure 4—Potential B-2 Effectiveness in Armor Interdiction

How Many B-2s?

As Figure 4 shows, a small number of properly equipped B-2s in the right place at the right time could be extremely effective. However, a much larger B-2 force would be needed to assure that effectiveness. Figure 5 shows why.

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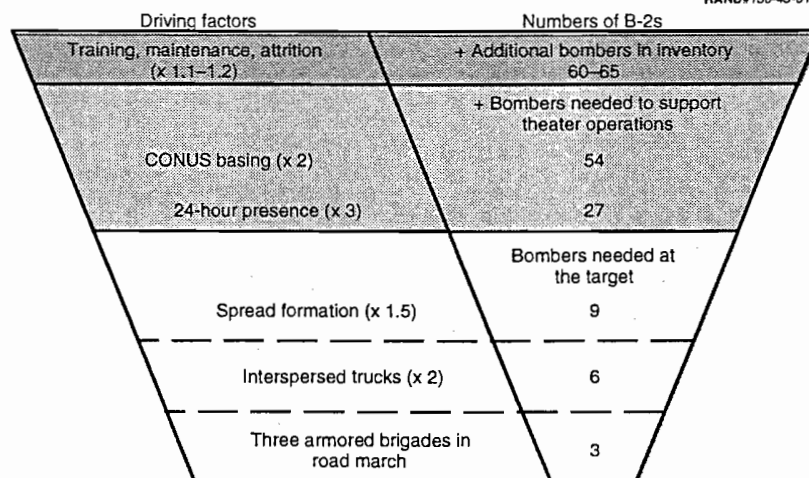


Figure 5—Conventional B-2 Antiarmor Operations—What Drives Force Levels

Although three B-2s might be adequate if the enemy “cooperates”—i.e., bunches its armored vehicles and moves in a tight formation—more bombers could be needed if a prudent adversary were to take even the simplest countermeasures such as spreading its columns and interspersing less valuable vehicles with its tanks. That could triple the number of B-2s required because of limitations of the Skeet submunitions. In fact, this is probably the most reasonable “base case” to consider. The equivalent Skeet munitions effectiveness that results is much more consistent with the standard values used in the defense community than the more optimistic case where the adversary is essentially inept.

Since the bombers need to be able to respond whenever the enemy chooses to move, that means the force needs to be sized to maintain a continuous presence, which would again triple the size of the bomber force that is needed. Being able to operate for a time from bases in the continental United States—a basic attribute of long-range bombers—would approximately double the number of bombers needed. Adding in another 10–20% for training, maintenance, and long-term attrition leads to a *total B-2 force of around 60 bombers* for this single critical class of mission!

Thus, there is certainly an analytical argument for a larger force of suitably equipped B-2s if the U.S. wants to have the capability to halt invasions in distant theaters with very little warning or other military support. However, there are other dimensions to the problem. Cost is the obvious one, but there is another key issue that we will explore later: the amount of time it takes to procure additional B-2s. *When* they might be available is a key factor in evaluating the wisdom of investing in additional B-2s.

Options for Making a Smaller B-2 Force More Effective

With the current buy of B-2s limited to 20 and a proposal to procure an additional 20 on the table, exploring options for enhancing the effectiveness of a small force of B-2s needed is particularly important. Figure 5 suggests possibilities, which are summarized in Table 1.

Better Antiarmor Submunitions

Using better technology could improve the effectiveness of a small bomber force. Better antiarmor submunitions than Skeet could reduce the number of bombers required by as much as a factor of three, which could reduce the number of B-2s needed for antiarmor missions to roughly the 20 currently planned. Whether that much improvement can actually be achieved in practice remains to be

Table 1
Options for Increasing the Effectiveness of a Small B-2 Force

Option	Desired Effect	Issues
Better Antiarmor Submunitions	Double or triple the potential effectiveness of the bomber force	<ul style="list-style-type: none"> • Submunition effectiveness needs to be demonstrated (technical issues) • Cost • No current Air Force program • No planned Air Force procurement of BAT
Forward Basing	Double the effective bomber sortie rate	<ul style="list-style-type: none"> • Base locations • Basing rights • Ramp space and POL • Prepositioning or rapid deployment of weapons, spare parts, support equipment, and maintenance crews • Base security
Supplementing B-2s with B-1s	Provide additional firepower	<ul style="list-style-type: none"> • Approximately 3 to 1 payload disadvantage • B-1 survivability • B-1 targeting • Modifications to both aircraft • New and complex operational concepts

determined. For example, using the BAT¹ submunition is a possibility. So is the Low Cost Antiarmor Submunition that the Army and Air Force are jointly developing.

Forward Basing

Moving the bombers to forward bases after the initial sorties could reduce the number of bombers needed for sustained operations by about a factor of two. That would require either prepositioning weapons, spare parts, and fuel at key bases or airlifting them there at the outset of the conflict. The latter option is particularly attractive for large theaters (e.g., Southwest Asia) where losing some ground to an attacker initially might be acceptable.

Using the B-1 to Supplement the B-2

The operational concept illustrated in Figure 3 includes B-1s as part of the antiarmor campaign. That might prove feasible *if* the B-1s can be used in a relatively benign air defense environment. That could involve:

- Using the B-1s on the periphery of the enemy's country out of range of most home and air defenses
- Relying on the B-2 to suppress particularly lethal surface-to-air missile (SAM) defenses
- Depending on external sources (perhaps the B-2 since it has to solve these problems for itself anyway; perhaps other sensor platforms) to provide targeting data and help the B-1s avoid enemy airborne interceptors
- Arming the B-1s with short-range standoff weapons (e.g., JSOW) to avoid short-range mobile SAM defenses

This is a difficult operational concept to implement, but it is the kind of thing the United States will have to do in the future to take maximum advantage of a long-range bomber force of limited size. Moreover, the B-1s pay a substantial payload penalty in the antiarmor mission for having to stand off to avoid short-range SAM defenses. It would take about 50 B-1s to provide the equivalent antiarmor capability of 20 B-2s. Thus, while using the B-1s to supplement the B-2s offers some real advantages, it also has some practical limitations, particularly if the B-2

¹BAT (Brilliant Antitank) is an advanced submunition currently being developed by the Army.

force has to bear the additional burden of suppressing defenses and orchestrating the attack operations to help the B-1s penetrate.

Combinations

Obviously, some of these options make sense to consider in combination. Better submunitions would help all of the bombers. Using the B-1 as effectively as possible is certainly cost-effective since the United States already owns nearly 100 of them. Forward basing would help, too, when it is practical, although it raises questions of airlift capability and prepositioning as well as ramp space limitations if a large number of bombers and tankers is involved.

Making the Bomber Force Effective: Better Weapons and Modifications to the Bombers

Addressing the B-2 question is only part of the larger problem of providing an effective bomber force for the future. Regardless of whether the United States chooses to buy an additional 20 B-2s, it will have to make changes to whatever bomber force it retains if that force is to be effective. First, large quantities of better weapons are needed. Second, the bombers themselves, including the B-2, need to be modified. Some of these improvements are funded; others are not.

Better Weapons

Equipping the bombers with better weapons is a prerequisite for making whatever bomber force the United States retains effective. This is not a tradeoff. Our analyses have shown for years the relative importance of better weapons for bombers. Without better weapons, any of the bomber force options that the United States is considering will be of only limited value.

Table 2 summarizes the combinations of weapons and bombers that our analysis has shown to be the best choices. Note the differences between the weapons required in the early phases of a conflict when the bombers must cope with largely intact air defenses and the later phases of a conflict when the U.S. may enjoy the luxury of air superiority. *That's why the planning assumptions about how bombers are to be employed are so critical.* If the United States wants to realize the potential of the long-range bomber force to react rapidly to a crisis, it will have to arm bombers accordingly. *Not currently funded*, for example, are the following weapons that bombers need:

Table 2
The Right Weapon Mix Is the Key for an Effective Bomber Force

Bombers Stage of the campaign	B-52	B-1	B-2
	<ul style="list-style-type: none"> Long-range cruise missiles^{1,3} 	<div>Interdiction: JSOW</div> <div>Deep attack: <i>long-range cruise missiles</i></div>	<ul style="list-style-type: none"> JDAM <ul style="list-style-type: none"> – 2000 lb – 1000 lb² – 500 lb TMD/WCMD – better submunitions Short-/medium-range defense suppression weapon (e.g., JSOW/CEB)
Early			
Later	<ul style="list-style-type: none"> JDAM <ul style="list-style-type: none"> – 2000 lb – 1000 lb² – 500 lb TMD/WCMD – better submunitions 		

¹About 1000 nuclear ALCMs exist, some of which could be converted to conventional ALCM-Cs. Tomahawk cruise missiles have been flight tested on B-52s and could be adapted. Other proposals exist for new cruise missiles, but are not currently funded.

²The Air Force currently plans a 1000 lb JDAM variant, but only for use on the F-22.

³Italics indicate that the program is not currently funded by the Air Force

JSOW	≡	Joint Standoff Weapon
JDAM	≡	Joint Direct Attack Munition
TMD	≡	Tactical Munitions Dispenser
WCMD	≡	Wind Corrected Munitions Dispenser
CEB	≡	Combined Effects Bomblet

- Long-range cruise missiles
- Smaller (e.g., 500 lb) variants of JDAM

Other problems relating to the bombers themselves would also limit the capability of the bombers to use them. In general, our analyses have shown the importance of having large numbers of moderately accurate, relatively cheap weapons of varying types and yields to take maximum advantage of the payload capacity of the bombers.

Modifications to the Bombers

All of the bombers, including the B-2, need modifications as well. The most critical modifications fall into three categories:

- Increased and more diverse weapons carriage
- Weapons integration
- Other electronics hardware and related software (e.g., sensor and communications upgrades, computer hardware and software improvements, displays and man-machine interface changes)

All these improvements are intended to help the bombers carry the largest possible number of various types of weapons and improve their capability to use information for targeting, mission planning, etc. as effectively as possible. Not all of the necessary modifications are currently funded. In particular, the following modifications that our analysis showed to be important are either not funded at all or only partially funded:

- Radar upgrades to the B-1 to improve its ability to engage moving targets
- A higher resolution radar for the B-2 to allow it to identify targets better
- A common weapons rack to ease logistics support for all of the bombers
- Internal modifications to increase weapons carriage
- Medium data rate communications systems to allow the bombers to receive standard intelligence data

Part of a general trend we see for the future is extending the life and increasing the value of aircraft by continuously modifying them. That is particularly important in the information arena where technology is changing so rapidly. The acquisition process needs to be flexible enough to accommodate rapid, continuing changes in technology in order to facilitate routine modification to

weapon systems. As Figure 6 shows, the relative costs of modifications are quite modest compared to the overall costs of bombers in particular, and the payoff is substantial. In particular, the additional modifications to the bombers that are described above and are currently unfunded are almost negligible compared to the bombers themselves.

Time Lags

Figure 7 illustrates the real problem with developing an effective conventional bomber force, however: the amount of time required to introduce the planned new weapons into the inventory. The improved weapons do not begin entering the force in significant numbers until around the turn of the century.² *Until then, the bomber force will have very limited conventional capability regardless of how large it is. Moreover, this problem has actually gotten worse over the last year as the budget crunch has gotten worse. Even after the weapons begin to enter the force, the stockpile will only be large enough to provide the bomber force with a very limited capability during the critical early phases of a major campaign. The development times for even the modest improvements (e.g., adding inertial or inertial/GPS guidance kits to existing weapons) are simply too long. Moreover, most of these weapons need to be procured in very large numbers, particularly since all elements of the U.S. forces need them.*

The state of the bombers themselves makes the problem worse still. According to the current schedule, the modifications necessary to make the bombers—particularly the B-2 since it is only now entering the force—fully effective for conventional operations will take years to complete. Moreover, as noted earlier, some modifications that our analysis has already identified as important are not currently part of the plan, and it is likely that other modifications will prove necessary as well.

Timing is also an issue if the option of procuring an extra 20 B-2s is to be pursued. Depending on the production rate, the fortieth B-2 might not enter the force until the latter part of the first or the middle of the second decade of the next century. If those B-2s were the “stock” Block 30 models, they would be of limited value. However, even if they were updated along the way, the basic stealth technology in the airplane would be decades old before the last aircraft became operational. *That raises a basic question about whether the B-2 would still be*

²Actually, the picture is even slightly worse than it appears because the weapons numbers shown are based on the total *procured* each year. Actual *delivery* of the weapons typically lags procurement authorization by about a year.

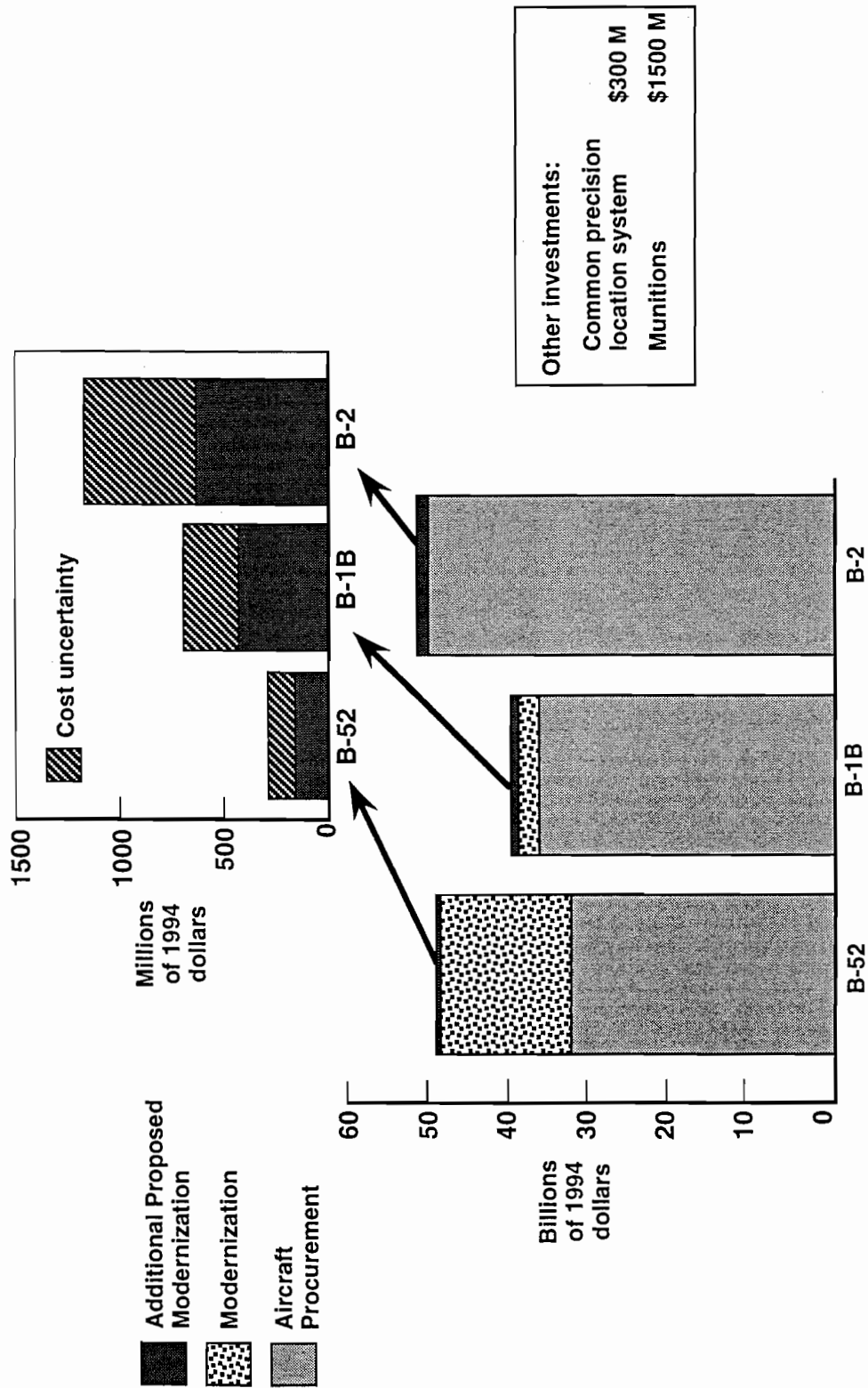


Figure 6—Modernization Represents a Relatively Small Part of Bomber Costs

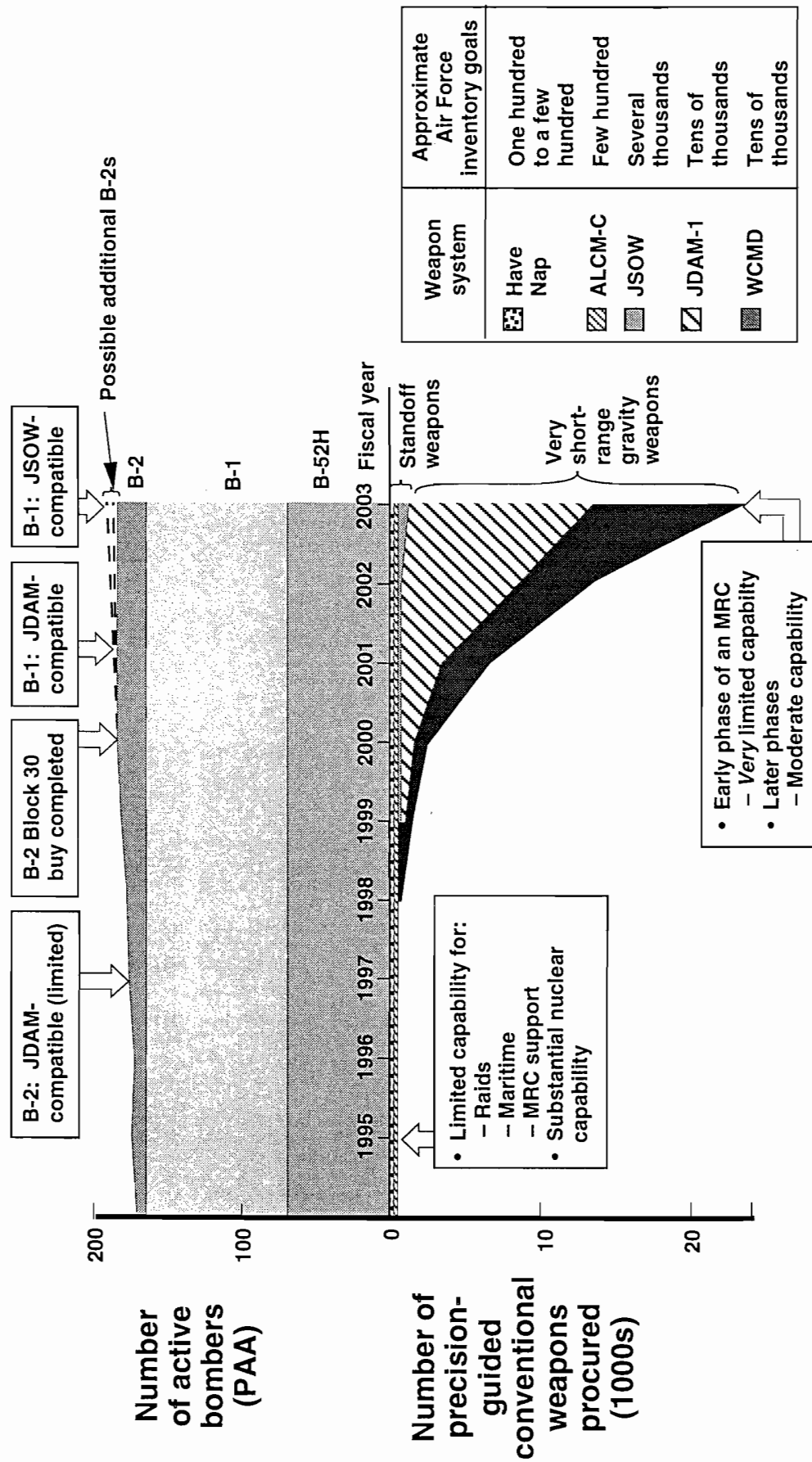


Figure 7—The Planned Bomber Force Will Have Very Little Capability in This Century and the Problem is Getting Worse

viable enough to justify the investment. If more B-2s are to be procured, acquiring them faster would certainly be desirable, although that could pose serious funding problems. Faced with that dilemma, the possibility of spending the money differently (e.g., trying to develop much "smarter", cheaper standoff weapons) needs to be seriously evaluated.

Finally, from an operational perspective, there is a significant mismatch between bombers and weapons that extends into at least the early part of the next century in the current plan. The first new weapons to come into the force in quantity are very short-range weapons—2000 lb JDAM-1s and WCMDs. While these weapons would be suitable for any of the bombers to use after the United States established air supremacy in a major conflict, only the properly modified B-2 could use them safely during the early phases of a conflict. That substantially limits the amount of firepower that bombers can bring to bear early in a major war, particularly since only JDAM-1 would be available in this century for attacking fixed targets. Moreover, the B-2s themselves are not likely to be optimally configured by the year 2000 to use these weapons to best advantage.

Standoff weapons are going to be in short supply in the programmed force, particularly in this century. JSOW is an appropriate weapon for the B-1 if it can be used effectively along with the B-2 in early interdiction roles. It will not be of much use to the other bombers, however. Also, until both the B-1 and the B-2 are modified to permit cooperative targeting,³ even the B-1/JSOW combination may be of limited utility.

Moreover, unless the ALCM-C is funded, there will be no existing long-range conventional cruise missiles for either the B-52 or the B-1 to use for deep strikes against critical fixed targets in the early stages of a war or on limited raids. Even if the planned ALCM-C conversions were funded, only a few hundred missiles would be available for B-52s to carry, which is only enough for use in isolated situations. Thus, a new weapon program or Air Force adaptation of other existing long-range cruise missiles such as Tomahawk is likely to be needed.

Thus, the problem that time lags cause in matching bombers and weapons can be summed up as follows:

- The planned weapon buys are most appropriate for a force dominated by B-2s, but the planned B-2 force is very small. Moreover, using the B-2 force effectively for anything other than strikes against high-value fixed targets

³This is an operational concept that we proposed in some of our recent studies.

requires modifications to the bombers that either are not in current plans or come along very late in the program.

- The absence of suitable standoff weapons for the B-1 and B-52 seriously limits the effectiveness of the bulk of the bomber force until later stages of the war when air superiority has been established. Equipping the B-1 with JSOW is only a partial solution.

In spite of the considerable progress that the Air Force has made in recent years in improving its conventional weapons programs, *more progress is needed* if it is going to use its declining force of aircraft, particularly its long-range bombers, as effectively as possible. As a result, the *bomber force, as currently planned, will have great difficulty providing the unique capabilities inherent in long-range bombers*. At best, achieving those capabilities will require many years.

Potential Effectiveness of the Bomber Force with 20 B-2s

Figure 8 shows how a modest-sized force including 20 B-2s could be employed in a stressing major regional conflict.⁴ If the bombers were all fully modified and suitably armed, they could be effective in halting an armored invasion, suppressing key enemy air defenses, attacking critical airfields, and destroying time-urgent tactical and strategic targets during the initial phase of the campaign *under favorable conditions*. As more tactical forces arrive in the theater, a small number of bombers (mainly, the B-2s) could be released for duty in another theater, while the rest of the bombers remain to participate in combined operations with other forces for the duration of the campaign.

However, such a modest force would be relatively fragile. It would have:

- No reserve force for nuclear use (\approx 40–50 additional B-52s would be needed)
- Very little margin for attrition
- No margin for tradeoffs of long-range bombers against other types of forces (e.g., B-1s against tactical fighter-bombers)
- No extra firepower to compensate for unexpected situations such as operational countermeasures by enemy maneuver forces
- Only a limited capability to support a second major regional conflict, although few of the “second” conflicts currently being considered would particularly stress the bomber force

⁴The particular generic scenario shown is based on a composite of eight different actual regional situations, combining some of the more stressing features of each.

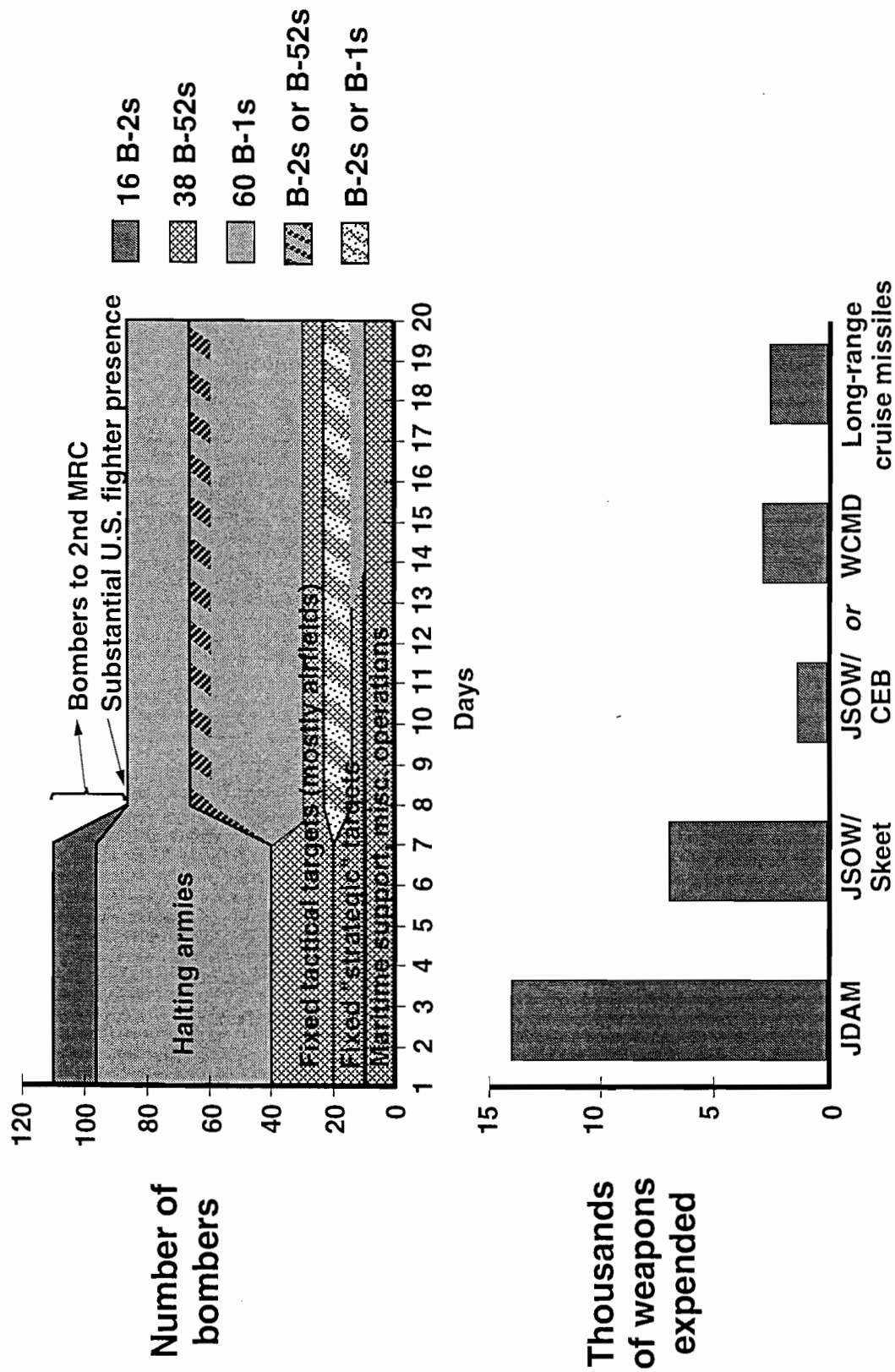


Figure 8—Employment of a Modest-Sized Bomber Force in a Major Regional Conflict

Retaining more B-52s and B-1s in the active force could alleviate some of those problems to a degree:

- The additional 30 or so B-52s could provide some nuclear reserve.
- More B-1s could provide some extra firepower early in the campaign—although their payload capacity is still limited by the need to use standoff weapons—and somewhat more firepower to tradeoff against other forces later.

More B-2s would add robustness in the early phase of the campaign and more firepower and flexibility for dealing with a second major regional conflict. For example, in this particular campaign, the need to employ large numbers of B-1s early on against invading armies required diverting all 16 available B-2s from interdiction missions to defense suppression to help the B-1s survive. Having more B-2s available would allow them to be used directly against the armored and mechanized attacking forces.

More fundamentally, the bomber campaign illustrated in Figure 8 demonstrates yet again the stark difference between the nature of the bomber force needed in the early phase of a campaign and that required later when the rest of the forces arrive:

- B-2s make their most critical and unique contribution early using their payload and operational advantages most effectively. In the later stages of a campaign, B-2s would, of course, be effective, *but generally would no longer be cost-effective* except perhaps for highly specialized missions when compared with other options. Thus, *scenarios that do not involve early autonomous use of bombers do not capture the principal value of the B-2.*
- B-1s, which can—if equipped and used properly—play a role in both phases of a campaign, are particularly well-suited for combined operations after other forces are deployed to the theater and the U.S. can achieve air superiority. Then, the B-1, which is basically a larger fighter-bomber, can take full advantage of its payload capacity⁵ and flight characteristics, which allow it to operate well in conjunction with fighters in a tactical environment. Thus, *B-1s will always look cost-effective compared to the B-2—and possibly to other types of tactical forces—in scenarios that emphasize long warning and preparation time.*

⁵If the bombers are limited to currently planned weapons carriage options, the B-1s look even better in some comparisons. However, that is an artifact of earlier design choices and biases

Conclusions

- If the nation wants to be able to halt very large-scale, short-warning attacks anywhere in the world, including places where the U.S. does not have forces already in place, then buying more B-2s is an attractive, albeit expensive, option. If not, the need is much less compelling. *In any event, the need for more B-2s is governed almost entirely by scenario assumptions.*
- All of the options for using bombers autonomously to halt invading armies are operationally and technically demanding and involve considerable risk.
- Buying large quantities of advanced weapons and modifying the bombers themselves are *prerequisites for developing an effective bomber force, whatever its composition.*
- Because of the projected time lags in procuring the needed weapons and modifying all three bombers, the conventional bomber force will remain relatively ineffective into the next century *no matter how large it is.* Moreover, extending the procurement of additional B-2s over too long a period of time could call into question the long-term viability of the aircraft's stealth technology.
- A key question remains unresolved: the tradeoffs between long-range bombers and other forces. It may turn out that retaining a larger bomber force including more B-2s at the expense of other types of forces could prove cost-effective and offer the United States new strategic options. The analysis to support or refute that hypothesis has yet to be done.

