C O N G R E S S I O N A L T E S T I M O N Y

Providing an Effective Bomber Force for the Future

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PROVIDING AN EFFECTIVE BOMBER FORCE FOR THE FUTURE

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[1]The views and recommendations presented 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 what is necessary to provide the United States with an effective bomber force for the future. As you know, analyzing long-range bombers has been one of RAND's principal research areas for several decades. 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 Department of Defense, and various Congressional audiences on different aspects of this issue.

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
- Bomber Flexibility Study (1992–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 range of alternative bomber force structure options for a 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 three years ago. Since then, we have periodically updated that work to reflect the implications of continuing changes in the world and various programmatic and budgetary decisions that affect the bomber force. The material we are presenting here represents our most recent update of the bomber force structure analysis.

We are currently completing a detailed analysis of some of the modifications needed to make the various bombers effective in future conventional operations. While some of the preliminary results of that analysis are included here, we must defer a more detailed treatment until the analysis is complete. Then, we will be happy to share the results with you.

Issues

Here's what we plan to cover. First, we want to discuss why the United States ought to be interested in long-range bombers in the first place: what unique capabilities they offer and how those might be relevant to the emerging world. Then, we will consider what has to be done to make the bomber force effective. Major topics are weapons and modifications to the bombers. At least equally important is developing effective operational concepts to make the best use of long-range bombers in the new situations that might arise in the rapidly changing world environment. From there, we will address force structure issues, particularly in view of the planned reductions recently announced by the Air Force. We will compare the currently planned force to one that is more optimally configured for the spectrum of future bomber missions. We will conclude by discussing some unresolved issues that future research will have to address.

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 that kind of capability is important, planners should be interested in heavy bombers.

As Figure 1 suggests, bombers have historically played major roles both 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 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 no naval presence at the critical moment when the campaign begins or

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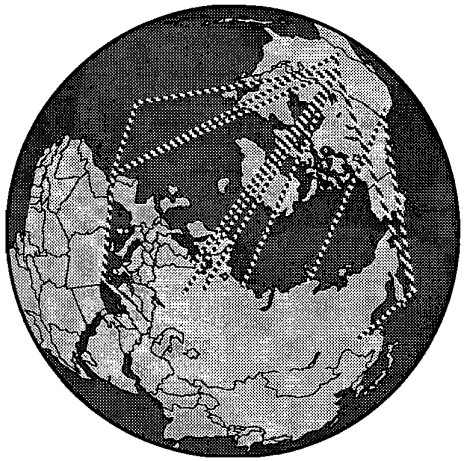
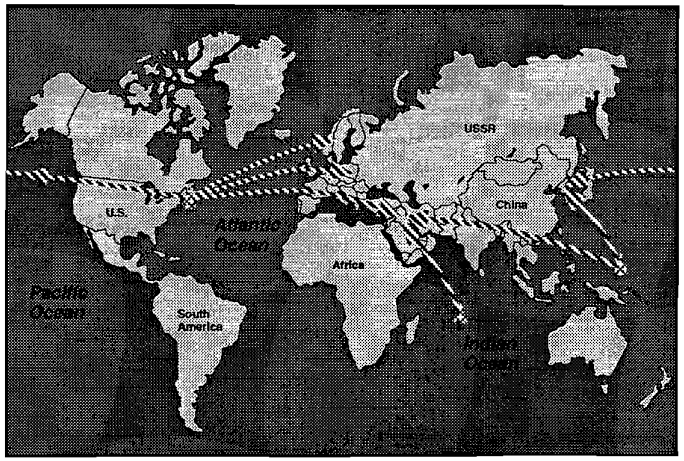
Nuclear Deterrence



Conventional Power Projection



Long Range

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

Large Payload Capacity

- **Massive firepower**

Figure 1—The Role of Long-Range Bombers

in situations where either massive or sustained firepower is needed. Moreover, we found that *structuring a bomber force to deal with demanding contingencies in the early phases of a conventional war would provide a bomber force that would be adequate for a full spectrum of other contingencies.*

Our analysis showed, however, that achieving the potential capability of the bomber force to deal with a spectrum of future missions will require some effort: new weapons, modifications to the bombers themselves, and new operational concepts. Then, force level issues can be addressed.

Matching Bombers and Weapons

All of our analyses of using heavy bombers for conventional operations have demonstrated the critical need for better weapons. Moreover, the quite different characteristics of the B-52, B-1, and B-2 make matching the appropriate weapons to the right bombers particularly important.

Figure 2 tells a much more encouraging story than an earlier version did a couple of years ago. Since then, the Air Force has initiated several new weapons programs—JDAM, JSOW, WCMD, in particular—that could remedy a number of the major deficiencies identified in earlier RAND bomber studies. Some limitations remain, as we will discuss shortly, but having actual weapon programs underway in critical areas is an important step. The chart illustrates the substantial payload advantages to the bomber of getting very close to the target. Carrying longer-range weapons to allow the bomber to standoff from targets to avoid defenses comes at the price of reduced payload. Standoff weapons also become more complex and costly as their ranges increase. Choosing the proper standoff range for weapons depends on the capabilities of particular types of bombers to penetrate various sorts of air defenses.

Using larger warheads also reduces the number of weapons that a bomber can carry and may or may not be necessary depending on the types of targets to be attacked. Achieving the right combination of accuracy and lethality against various target classes of interest is the key to weapons effectiveness. We turn to that issue next.

Weapons Effectiveness

Figure 3 shows how the effectiveness of different classes of weapons varies against different kinds of potential targets of interest as a function of the accuracy of the weapons. On the right hand side of the chart are the unguided "dumb"

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	Penetrating bombers			Standoff cruise missile carriers
	Very short range	Short range	Medium range	Long range
Nuclear weapons	Bombs		Short range attack missile (SRAM-A)? ~~SRAM-II~~	Air launched cruise missile (ALCM) Advanced cruise missile (ACM)***
Conventional weapons	Bombs, submunitions dispensers – *Inertially or inertial/GPS guided weapons* • 2000 lb bombs (JDAM-1*) • Smaller bombs • TMDs (WCMD**) – *Other precision-guided bombs (JDAM-III)**	Have Nap *Joint Standoff Weapon (JSOW)*	*Tri-Service standoff attack missile (TSSAM)*	Tomahawk? ALCM-C New conventional cruise missile
Typical carriage capability	30 – 80 (≤1000 lb) 16 – 24 (2000 lb)	8 – 22		

* Joint Direct Attack Munition (JDAM)
** Wind corrected munitions dispenser (WCMD)
*** Buy limited to 528 (PAA), 640 (TAI)

• Existing weapons
• *Planned weapons*
• Possible new weapons

Figure 2—The Proper Matching of Bombers and Weapons is Critical for Developing an Effective Bomber Force

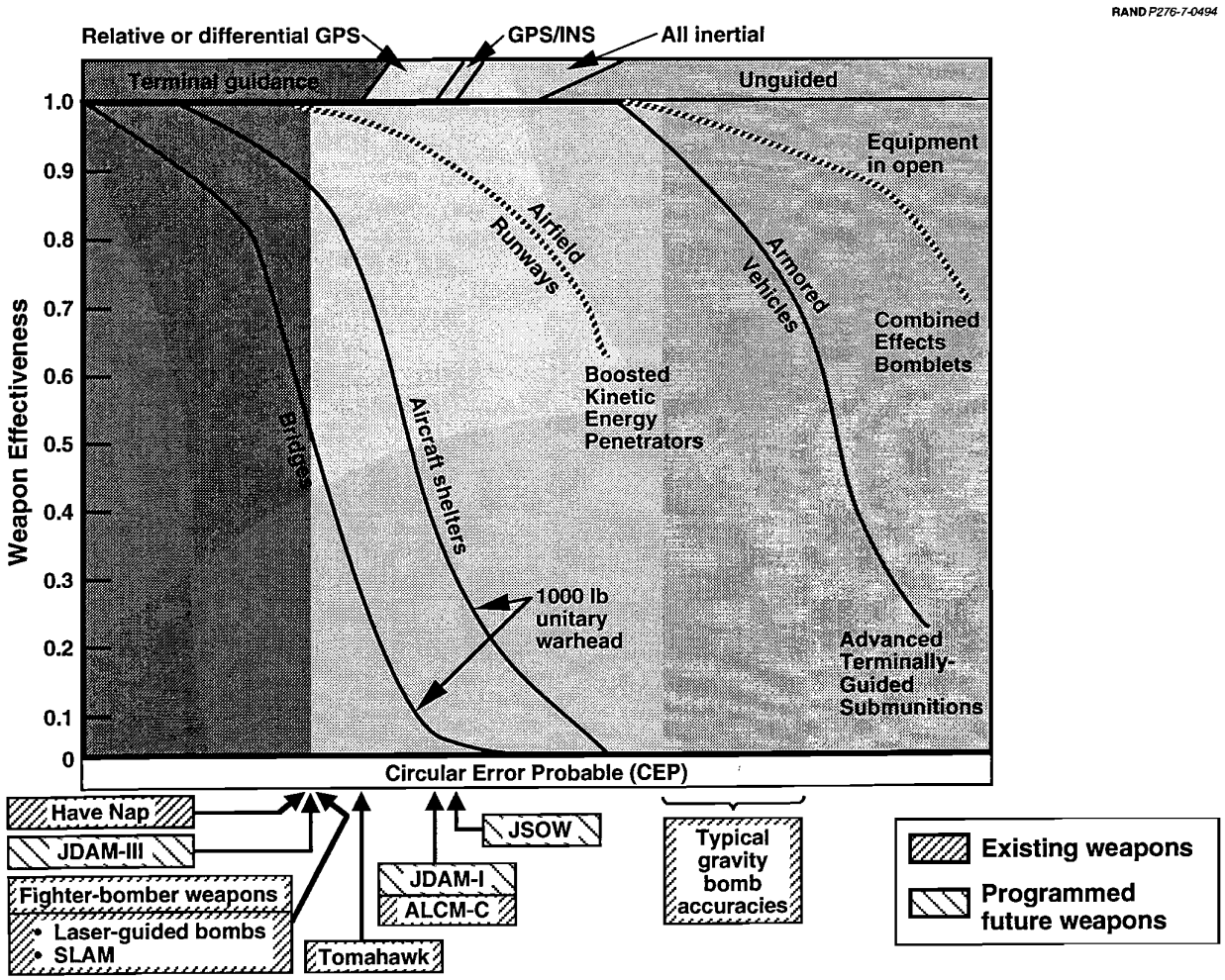

Figure 3—There is a Broad Range of Possibilities for Increasing Bomber Weapon Effectiveness

bombs dropped in great numbers by B-52s during the war with Iraq. The curves show why these attacks were relatively ineffective beyond their ability to terrorize enemy forces and do cumulative damage against masses of relatively vulnerable equipment. The weapons were simply not accurate enough.[1]

On the left hand side of the chart are the laser-guided bombs and other optically guided weapons employed by fighter-bombers for precision attacks during the Gulf War. These weapons achieve their accuracy with terminal guidance. Although laser-guided bombs are cheap, adding terminal guidance to most weapons that would be suitable for bombers, particularly autonomous weapons, greatly increases their cost and complexity. At present, the only bomber weapon that can achieve this sort of accuracy is Have Nap, the short-range missile that can be launched from conventionally modified B-52s. Future cruise missiles or other weapons with comparable or even greater accuracy could be developed for use by bombers.

However, the figure shows clearly that *that high degree of accuracy is not needed for the majority of target classes that could be important for bombers to attack.* Most of the targets lie in a middle range where sufficient accuracy can be achieved relatively cheaply and easily using currently available technology that does not depend on terminal guidance. *It is this class of weapons, which has not been included in the program until very recently, that the bombers have needed most.* Note that various new weapons, including JSOW, JDAM-1, and others, fall into this category. Past discussions of weapon accuracy have tended to ignore this middle range of improved weapons, focusing instead on the extreme ends of the spectrum: inaccurate "dumb" bombs or extremely accurate, terminally guided munitions. Recognizing the value of developing cheap, moderately accurate weapons has been a great step forward in taking advantage of the potential capability of heavy bombers.

Our analysis also shows the value of increasing the accuracy of the full range of bomber weapons, not just large (e.g., 2000 lb) bombs. In fact, we found that in analyzing actual sets of potential targets for bombers, large numbers of relatively small (e.g., 500 lb) bombs with improved accuracy were actually more effective in representative situations than a smaller number of 2000 lb bombs with many comparable or even greater accuracy. Thus, *improving the accuracy of smaller weapons is particularly important to take full advantage of the large payload capacity of heavy bombers.*

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[1]The figure actually overstates the potential effectiveness of unguided gravity weapons for one important class of targets: enemy armor. The submunitions assumed in the figure to be dispersed from unguided munitions dispensers are more advanced than anything in the current inventory. The Skeet submunitions currently being procured by the Air Force would be dramatically less effective if deployed from unguided dispensers dropped from bombers at high altitude. Unguided gravity bombs would be much worse still.

Bomber Survivability and Weapon Standoff Range

The next problem to consider is the weapon standoff range necessary to allow each of the bombers to survive enemy air defenses. That is primarily a problem in the critical early stages of a conflict when enemy air defenses could still be largely intact, the bombers might have to operate relatively autonomously with little or no support from fighters, and bomber attrition could be particularly damaging both militarily and politically.

Figure 4 shows how the survival probability of different bombers varies as a function of the standoff range of their weapons if they were to attack targets deep inside two very different kinds of emerging regional powers. In one case, the country is very large geographically with relatively thin, but modern air defenses. In the other, the country is relatively small with dense, relatively high-quality air defense. Thus, these two cases cover a broad spectrum of possible cases of interest. Current nonstealthy bombers are included along with a spectrum of notional stealthy bomber designs.

There are two striking conclusions from this figure:

- Both of the older bombers would be at serious risk if they had to penetrate even relatively modest air defenses. *Either would need long-range cruise missiles in order to survive with confidence.* (Recall from the earlier figure that TSSAM does not fall into the long-range category.)
- *Stealthy bombers of the sort shown here should be able to penetrate likely air defenses with relative confidence.* In general, most stealthy bombers could get close enough to their targets to use very short-range weapons (e.g., JDAM, WCMD), thereby taking full advantage of their payload capability. Even the least stealthy bomber design that we considered could get close enough even to heavily defended targets to use a TSSAM-class or even shorter-range missile to suppress the defenses or attack the targets directly.

We examined a large number of countries with different geography, air defenses, and potential target sets, and we found the results shown here to be broadly representative of a whole spectrum of contingencies that could arise in the future. Thus, the conclusions about the potential effectiveness of stealthy bombers and the need for long-range cruise missiles for the older bombers appear to be quite robust.

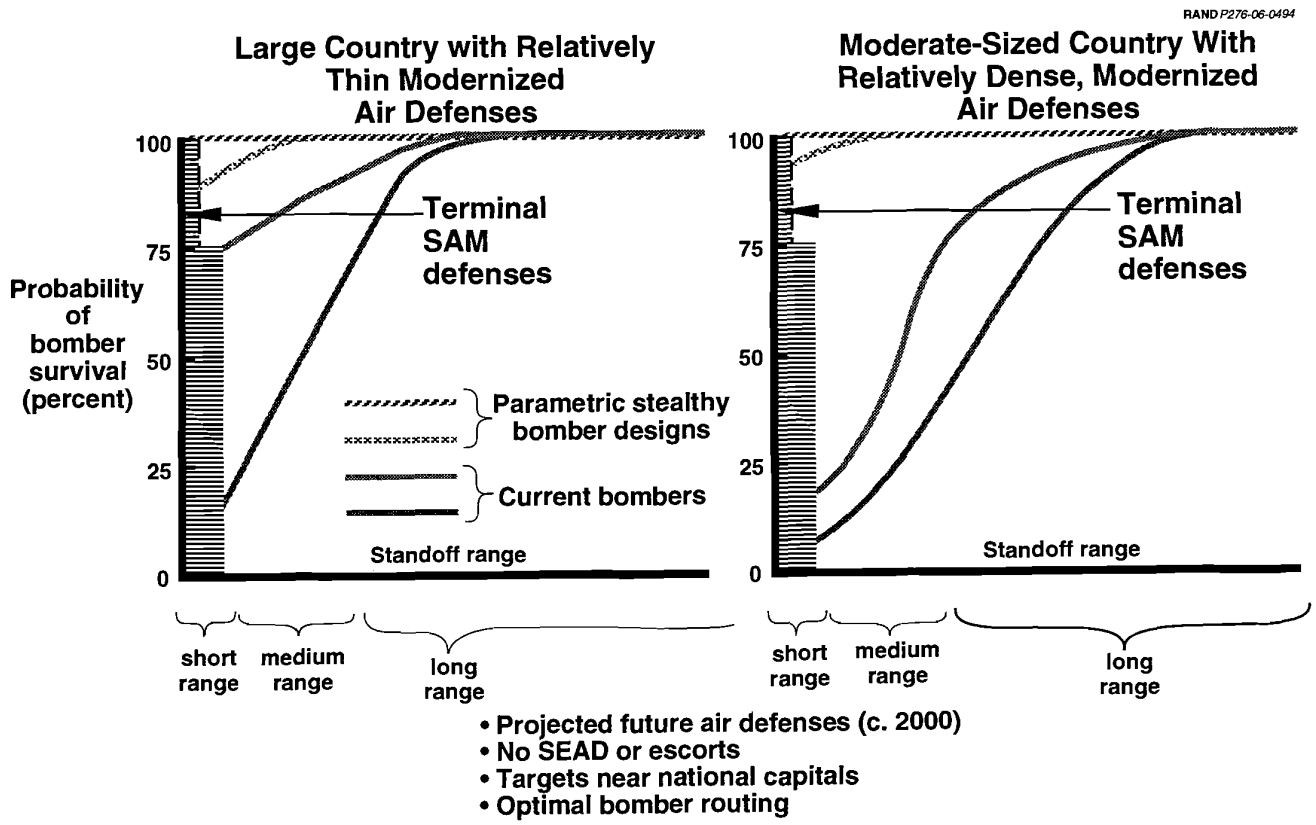

Figure 4—Penetrating Air Defenses at the Start of a War

Developing Effective Operational Concepts

The last piece of the equation for making bombers effective in demanding conventional campaigns is developing effective operational concepts. We found in general that the new range of conventional missions that bombers might be called upon to perform *involve quite different operational concepts than bombers have employed in the past.* Some are likely to be quite demanding, requiring modifications to the aircraft, different skills for the bomber crews, significant procedural changes, and higher crew ratios.

Figure 5 shows a notional operational concept for making a small B-2 force supplemented by modest numbers of B-1s and B-52s effective in a demanding regional conflict. The scenario involves blunting an armored invasion and attacking fixed targets inside the attacker's homeland prior to or during the deployment of Air Force and Navy fighters or sea-based cruise missiles. A division of labor among the bombers is necessary to make the most effective use of the different characteristics of the various bombers.

- B-52s armed with long-range cruise missiles attack fixed targets inside the country.
- The small force of B-2s concentrates on the critical task of halting the armored invasion.
- A much larger force of B-1s, with the assistance of the B-2s, provides additional firepower to interdict the advancing armor.

To make this concept work, the B-2s have to locate the advancing armored divisions, do as much damage as they can, and then help the B-1s survive in the local air defense environment and destroy the rest of the advancing armor. To help the B-1s, the B-2s would have to pass on target location information to the B-1s, suppress any high-quality, mobile surface-to-air missiles (SAMs) that could threaten them, and help the B-1s avoid any airborne interceptors that might be in the area. That means that the B-2 would have to operate not only as a bomber, but also as a limited battle manager, thus assuming some of the characteristics of AWACS and JSTARS for a very limited battle space. This concept of operations is considerably different from the role for which the B-2 was designed, but it appears to be within the potential technical capability of the aircraft and its onboard sensors, particularly if properly cued by other off-board sensors. Moreover, using two different types of bombers cooperatively is a substantial departure from past operational practice. That, however, is the sort of new thinking that will be needed to take maximum advantage of a small bomber force.

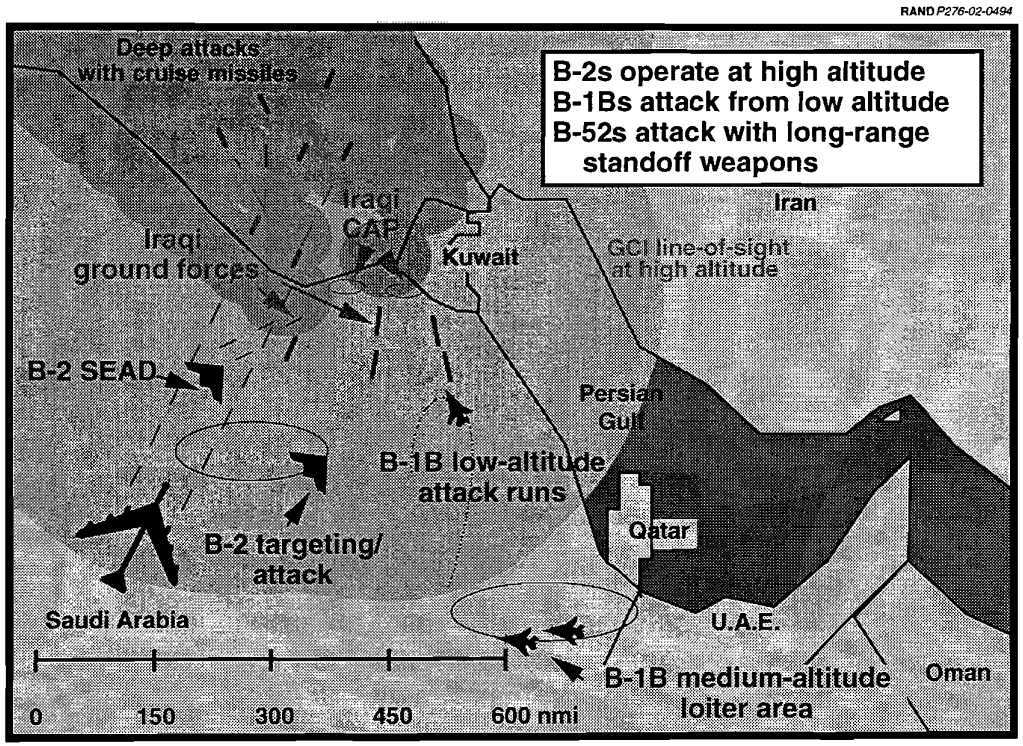

Figure 5—Making a Small Bomber Force Effective in a Stressing Major Regional Conflict – A Notional Operational Concept

Such new operational concepts will require modifications to the bombers. RAND's current research on bombers is aimed at fleshing out such concepts, analyzing their technical and operational feasibility in some detail, and identifying needed improvements to the bomber force.

Note that a larger B-2 force would simplify operations, eliminating the need to devise effective cooperative tactics to help the B-1s survive and perform effectively in a difficult environment. It would also eliminate the need for some of the modifications that both bombers would need to implement cooperative tactics. Moreover, a larger B-2 force would be more capable and robust than a combined B-1/B-2 force involving many more total aircraft. However, even without the B-1s, using the B-2 force this would require new operational procedures and changes to the aircraft as well.

Most Effective Combinations of Bombers and Weapons

Taking into account weapons effectiveness, survivability of the bombers, and use of effective tactics, we can now choose the most suitable weapons for each bomber. Table 1 shows the most effective combinations of bombers and weapons.

First, all of the bombers that remain in the force should be able to carry effective very short-range gravity or glide weapons (i.e., JDAM, TMD/WCMD) for use in later stages of a conflict when the air defense environment could be sufficiently benign. Those same weapons are appropriate for the B-2, even in the demanding early phases of a major campaign. The B-2 also needs a short- to medium-range defense suppression missile (e.g., TSSAM) to attack some critical air defense targets (e.g., long-range mobile SAMs).

The other bombers need standoff weapons to survive enemy air defenses in the early stages of a conflict. Either the B-1 or the B-52 would need long-range cruise missiles to execute deep attacks against fixed targets. Even if it were operating on the periphery of an enemy country out of range of its homeland defenses, the B-1 would need a JSOW-class weapon to survive modern mobile SAMs that might protect armored divisions or similar targets. Note that being forced to use JSOW rather than a very short-range weapon reduces the effective carriage capacity of the bomber, roughly doubling or tripling the number of B-1s required to achieve comparable overall effectiveness.

Table 1—Most Effective Bomber/Weapon Combinations

Stage of the campaign \ Bombers	B-52	B-1	B-2
Early	• Long-range cruise missiles	Interdiction: JSOW Deep attack: long-range cruise missiles	• JDAM • TMD/WCMD • Short-/medium-range defense suppression weapon
Later	• JDAM • TMD/WMCD	→	→

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Modifying the Bombers for Effective Conventional Use

However, the bombers themselves will need modifications as well if they are to be used as effectively as possible. Table 2 illustrates the general types of modifications that be might pursued to ensure the flexibility of the heavy bomber force across a wide spectrum of missions.

The modifications fall into four general categories:

- Enhancing the capability of the bombers to use better weapons by adding reliable racks that exploit the carriage capability of the bombers, improving weapon integration (i.e., standard aircraft/weapon interface), improving selected sensors for weapon employment, and perhaps improving defensive countermeasures.
- Improving the capability of the bombers to operate as parts of force packages, and to allow them to effectively engage targets with the help of offboard C4I assets. These modifications consist largely of communications upgrades that allow at least medium data-rate connectivity to theater and national intelligence sources, as well as command and control assets.
- Increasing the autonomy of the heavy bomber force so it can be better employed in leading-edge operations when other support assets (e.g., fighters, AWACS) are not readily available. The primary focus is on specific modifications to the B-2 that would allow it to better support the activities of other bombers in missions such as halting invading armies and selective suppression of enemy air defenses (SEAD), and to exploit its own onboard sensors. The addition of a third crew member as a tactical officer and adjunct information processing systems seems to be required for this class of operations.
- Increasing sensor performance and onboard processing to allow for the bombers to better perform missions. This includes adding the ability to search larger areas through sensor enhancements, and more exotic counter-countermeasures.

Some of the modifications highlighted above, notably many of those associated with integrating high-quality weapons onto the bombers, are currently being pursued by the Air Force. However, there are a large number of items not currently being pursued in the current modernization program. Much of the current bomber modernization plan implicitly focuses on employing the bombers in structured pre-planned operations against fixed installations, and does not address some of the areas that we have determined to be potentially critical to

Table 2—Bombers Need Modifications to Maximize Their Effectiveness Across a Spectrum of Conventional Missions

B-52	B-1B	B-2
Weapon carriage modifications/integration/ OAS modifications/data bus modifications†	**Weapon carriage modifications/integration/ OAS modifications/data bus modifications†**	**Weapon carriage modifications/integration/ OAS modifications/data bus modifications†**
Communications upgrades (esp. data links and Medium data rate satellite communication)*	Communications upgrades (esp. data links and Medium data rate satellite communication)*	Communications upgrades (esp. data links and Medium data rate satellite communication)*
Limited information processing upgrades for stand-off weapon target changes*	Sensor upgrades*	Sensor upgrades*
	Limited information processing upgrades to support situational awareness updates and weapon targeting*	Moderate information processing upgrades and addition of tactical officer for advanced employment concepts*

†High-volume carriage option not currently programmed (e.g., JDAM–500lb)

*Unfunded

the employment of heavy bombers in a dynamic and flexible manner. For instance, *the current plan does not make significant improvements in the ability of the bombers to find and attack targets on demand or to exploit the intrinsic capabilities of bombers such as the B-1B and B-2 to use their sensors and air crew to adapt to tactical needs.*

Computer system upgrades are needed to extend the current architecture of the bomber's computers, which is designed to support control of avionics devices and sensors, to allow more inflight manipulation of data and control of information flow. That is essential for executing flexible operations in a highly dynamic environment. Information can be both the sword and shield of the bomber force, allowing bombers to choose the time and place of engagement most favorable to the attacking force and to react to enemy actions. In this approach to information systems, the air crew and their computers form the heart of the force. The humans act as decision-makers, and the computer systems as facilitators by converting the myriad of data into information digestible by the air crew. The longer timelines associated with bomber operations, plus the concentration of the computer systems on planning operations that will not occur for tens of minutes, provides an opportunity for bomber crews to get more involved with modifying their mission plans enroute if the computer architecture is designed properly. One possible approach includes building a dedicated information processing system that would exist in parallel with the existing computer and bus system, and would use the existing system to interact with avionics devices whenever possible.

Communications and sensor improvements fit hand-in-glove with the computer system upgrades. Whereas the computer helps extend the crew's ability to process data, the communications and sensory improvements extend the sphere from which they can gather information. Communications improvements allow for the sharing of data between bombers, and between the bombers and other off-board systems. This adds significant capability to the bombers without proliferation of expensive sensory apparatus. The sensory improvements extend only to those areas where the basic capabilities are already present on the bomber and the improvements are vital to successful completion of the mission.

The current plan for weapons carriage improvements consists of adding the ability to carry a variety of new weapons (e.g. JDAM, JSOW, and TSSAM) to bombers. However, *the current plan does not address the ability to carry a larger number of smaller munitions to effectively exploit the payload capacity of the bomber or increasing commonality in weapon carriage hardware and software* to simplify deployment and decrease system integration costs.

An Approach to Structuring the Bomber Force

Even before the end of the Cold War, RAND analysis concluded that large-scale conventional (rather than possible nuclear) use should be the dominant factor in structuring the long-range bomber force. The START II agreement drastically reducing nuclear arms has reinforced that assessment. On the nuclear side, the only real bomber force structure issues remaining are how many nuclear cruise missile carriers the United States will retain and whether they ought to be retained exclusively for nuclear use or "dual DOCed" for both conventional and nuclear use. About 40–50 B-52s could carry the entire inventory of Advanced Cruise Missiles (ACMs) plus a few hundred older ALCM-Bs. A larger nuclear B-52 force could be maintained if more of the existing ALCM-Bs were retained for nuclear use.[2] However, in general, 40–50 nuclear cruise missile carriers is a reasonable force to maintain for nuclear use. The remaining nuclear force structure question is whether these should be considered part of the conventional force or an addition to it. This decision rests on a value judgment about how much risk the United States should take in putting part of the force that it United States relies on to deter nuclear war in harm's way in a conventional campaign.

Structuring the conventional bomber force is the critical planning issue. We focused on identifying situations where bombers could make a difference, recognizing that there are many military situations where they might not. For planning purposes, we also tried to emphasize cases that stressed the bomber force so we would have some confidence that a force designed for those cases would be adequate for any reasonable contingency that might arise.

After examining a wide range of possible conflicts in various parts of the world, we identified four generic classes of situations that dominated bomber force structure considerations, as Figure 6 shows.

- *Limited Raids.* Raids of the Libya variety require only a small number of bombers if the bombers are suitably armed. For most scenarios, bombers with long-range cruise missiles would be adequate, even preferable. For operations demanding more flexibility, stealthy B-2s might be the bombers of choice. In either case, quality rather than force size is the driving factor because of the risk to the aircraft and the need for effective weapons and targeting systems.

[2]There is an issue regarding the future of the 1000 or so remaining ALCM-Bs. They could either be retained for nuclear use or converted into conventional cruise missiles (ALCM-Cs), so there could be some competition for those missiles.

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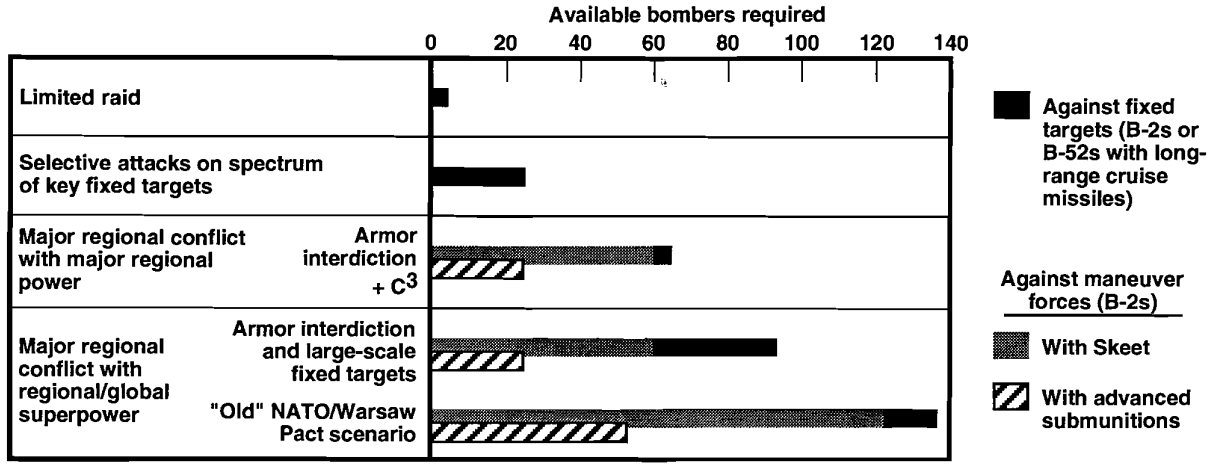
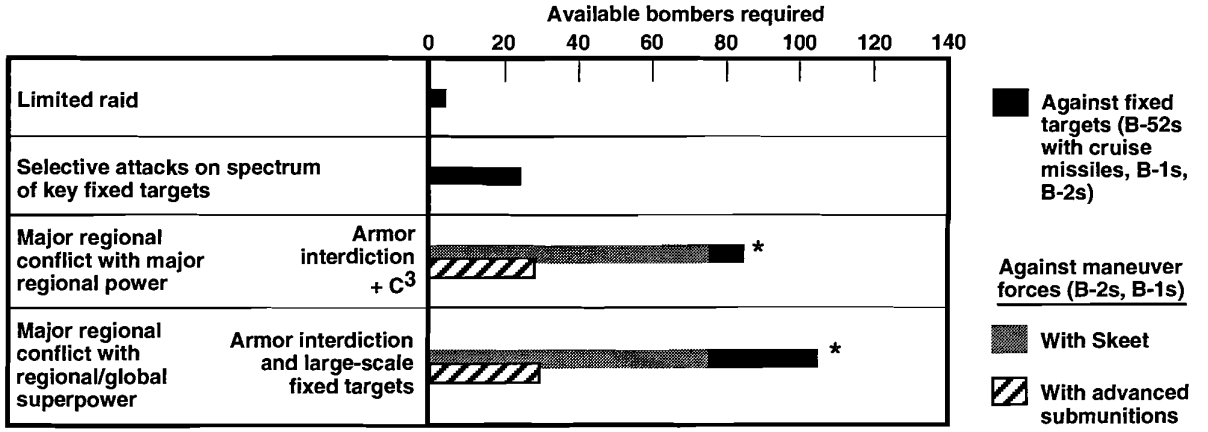
- **B-2 – Heavy**



- **Small (≤20) B-2 Force**



*Reduced overall antiarmor effectiveness against operational countermerasures

Figure 6—Long-Range Bomber Forces for a Spectrum of Conventional Conflicts

- *Selective Attacks on a Spectrum of Key Fixed Targets and Assorted Other Missions*. Analyzing those relatively unusual situations where attacking a modest number of fixed targets could be militarily decisive early in a campaign, we concluded that about one wing of cruise missile carriers or B-2s was probably an adequate force. If this is the only way that bombers were to be employed, such a force might be sufficient. Similarly, it would probably be adequate for some of the other tasks that bombers could perform such as ocean surveillance and naval mining. Interestingly, the specific cases that led to this generic class of scenario were more typical of the "old world" than the "new."
- *Major Regional Conflict with a Major Regional Power*. This is a class of conflict that typically places serious demands on most elements of U.S. military forces. The most stressing situations are those in which an enemy controls the operational tempo—by launching an invasion, for example—and the United States and its allies are obliged to respond. As the Bottom Up Review correctly pointed out, countering such an invasion should have the highest priority in a major conflict. A large-scale armored assault might be part of such an invasion. If so, that is likely to be the driving factor in determining bomber requirements and should certainly be the dominant factor in planning for this generic level of conflict as Figure 6 shows.
- *Major Regional Conflict with a Regional/Global Superpower*. The difference between this level of conflict and the previous one is the quality of the opposition. As a practical planning matter, that is likely to mean being prepared to deal simultaneously with an armored invasion and launch a major sustained attack against critical fixed tactical targets at the outset of a campaign. Thus, as Figure 6 indicates, the main impact on the bomber force is an increase in the number of fixed targets that it has to deal with early in the campaign. A regional power that could mount both a major armored offensive and a significant tactical air campaign simultaneously would fall into this category and is a useful planning surrogate since sustained attacks against airfields can absorb large numbers of weapons.

For planning purposes, we constructed a notional generic adversary based on a composite of several representative regional powers to use as a surrogate for evaluating major conflicts. The critical target sets fell into three categories:

- Armored forces roughly comparable to those Iraq could have used against Saudi Arabia after it captured Kuwait, as well as mobile air defenses.

- Fixed tactical targets (e.g., airfields, EW/GCI radar sites, military headquarters, and C^3 sites, lines of communications): ≈150 ± 100 major installations (15% time critical)
- Fixed "strategic" targets[3] (e.g., leadership, military production facilities, electric power, industrial infrastructure): ≈200 ± 80 major installations (5% time-critical)

Figure 6 compares the total force requirements for two different bomber forces to deal with this spectrum of conflicts. The force in the upper part of the figure has a larger number of B-2s in order to take advantage of their greater potential capability against large-scale maneuver forces in a hostile environment in the early days of a major campaign.[4] Note that a force of about 60 B-2s and 40 cruise missile carriers (B-52s in the figure) *if properly equipped* could handle the bomber portion of a major campaign against even a very powerful regional aggressor. A smaller force of B-2s (i.e., 20–25) would need a more advanced antiarmor submunition than Skeet to achieve comparable effectiveness.

The lower part of Figure 6 shows that a bomber force that included only the programmed B-2 force (e.g., < 20 B-2s) *if properly equipped* might be able to handle the same sorts of conflicts under relatively favorable conditions *if* the sort of cooperative operational concepts described earlier could be employed to make the older bombers more effective. Even then, however, that force would be much less effective in the face of simple operational countermeasures by the enemy (e.g., spreading vehicle formations). Moreover, the programmed force would have much less flexibility than the B-2-heavy force to deal with a second major contingency if one should arise at roughly the same time. We will consider that possibility next.

Potential for Handling a Second Major Regional Conflict

The Defense Guidance and the Bottom Up Review have called for U.S. military forces to be able to deal with two major regional conflicts that occur nearly simultaneously. In principle, the bomber force, because of its capability for rapid global response, could play a particularly useful role by helping hold the line in each conflict until the rest of U.S. forces could arrive. If the conflicts did not

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[3]By "strategic" targets, we generally mean those that are of long-term value to a society but have little immediate impact on a fast-moving military campaign. There are some exceptions, such as national leadership, that have strategic and tactical value.

[4]Because they can get closer to their targets, properly modified B-2s can carry much larger payloads of antiarmor submunitions than B-1s. Also, B-2s could function effectively without B-1s, but the converse is not true.

occur at literally the same time, the bombers could shift relatively quickly to the second conflict as the first stabilized.

The practical capability of long-range bombers to do that depends on the structure and quality of the bomber force as well as the nature and timing of the conflicts. Figure 7 shows how two different bomber forces might be employed in a very demanding regional conflict and what the implications are for using bombers to support a second major regional conflict.

The *notional "first" major conflict* shown includes several elements that make serious demands on the bomber force:

- A large-scale armored invasion against an opponent with weak defenses and little or no U.S. support in the theater.
- An enemy air force that is capable enough to warrant a heavy initial, sustained attack against airfields.
- A relatively large number of other time-critical fixed tactical and "strategic" targets by the standards of these kinds of conflicts.

As the figure shows, the bombers have to carry the load for about the first week of the conflict. After that, the fighter force in the theater should have grown enough in size and capability to take over much of the load, freeing a portion of the bomber force for other duty.

The two bomber forces shown are roughly the same size (≈ 100–120 aircraft) but differ considerably in composition and capability. The force shown in the top part of the figure is specifically designed for this sort of conflict. It consists of roughly 60 B-2s and 40 B-52 long-range cruise missile carriers. The large B-2 force is largely dedicated to halting the armored invasion. It is large enough to cope with a sizable enemy armored force even if that force takes some operational countermeasures to reduce the effectiveness of the Skeet submunitions.

The second force is roughly equivalent in size and composition to the programmed force at about the turn of the century, although it has more capability because of additional modifications. It consists of less than 20 B-2s, 60 B-1s, and about 40 B-52s. As noted earlier, this force might be adequate for the job under reasonably favorable conditions (e.g., no enemy countermeasures), but it is not as robust or as capable as the force with the larger B-2 component. It is merely the best that can be done with a force that includes only a small number of B-2s. *A force of about 38 B-2s and 40 B-52s would be about as effective as this force.* Both forces use new operational concepts as discussed earlier, but the mixed

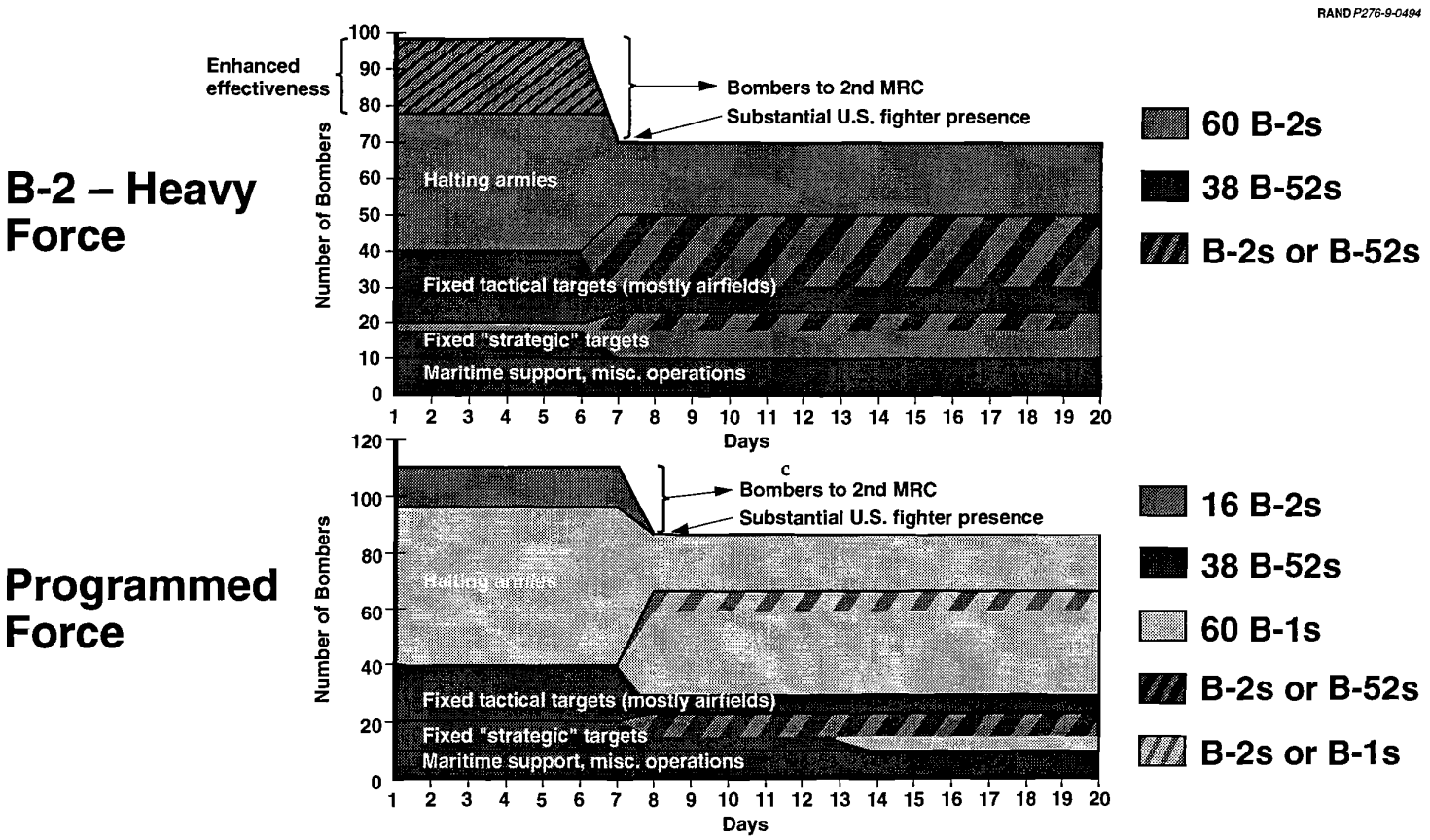

Figure 7—Prospects for Diverting Bombers to a Second Major Regional Conflict (MRC))

force of B-2s, B-1s, and B-52s involves more demanding tactics. Both forces include a small reserve force for miscellaneous missions such as maritime operations or limited raids.

If two conflicts of this magnitude were to break out at the same time, a much larger bomber force would be required to deal with them. Fortunately,

- Even a single major regional conflict might not include all of the elements that stress the bomber force (i.e., large antiarmor attack, sustained airfield attack).
- It is *extremely* unlikely that two such conflicts that the United States would care enough about to become militarily involved in could occur at about the same time in the world as it appears to be evolving.
- Even a few days' spacing between the intense parts of two major conflicts could allow the United States to divert up to 30 B-2s or B-52s in the case of the larger B-2 force or about 10 B-2s and 10 B-1s (or perhaps more B-2s and a few B-52s) from the programmed force to a second conflict. In either case, some additional B-52 cruise missile carriers could be shifted more quickly to attack time-critical fixed targets in a second theater, particularly in the absence of an overwhelming need for a heavy airfield attack in a single theater.

Thus, the sort of bomber forces considered in this example would have some capability to deal with two major regional conflicts if they were at least a few days apart and if both did not contain all of the elements that would stress the bomber force. *A force that contains a larger number of B-2s is potentially more effective for dealing with multiple contingencies* because it is more capable and flexible and requires less demanding operational employment concepts. The more mixed bomber force depends on a high level of integration to make its operations fully effective, making it more difficult to draw off portions of that force to move to other theaters.

The Limitations of the Programmed Bomber Force

Figure 8 shows the current plan for the bomber force and the weapons necessary to make it effective in conventional operations. The most striking message of this figure is the amount of time required to introduce the planned new weapons into the inventory. The improved weapons do not begin entering the force in

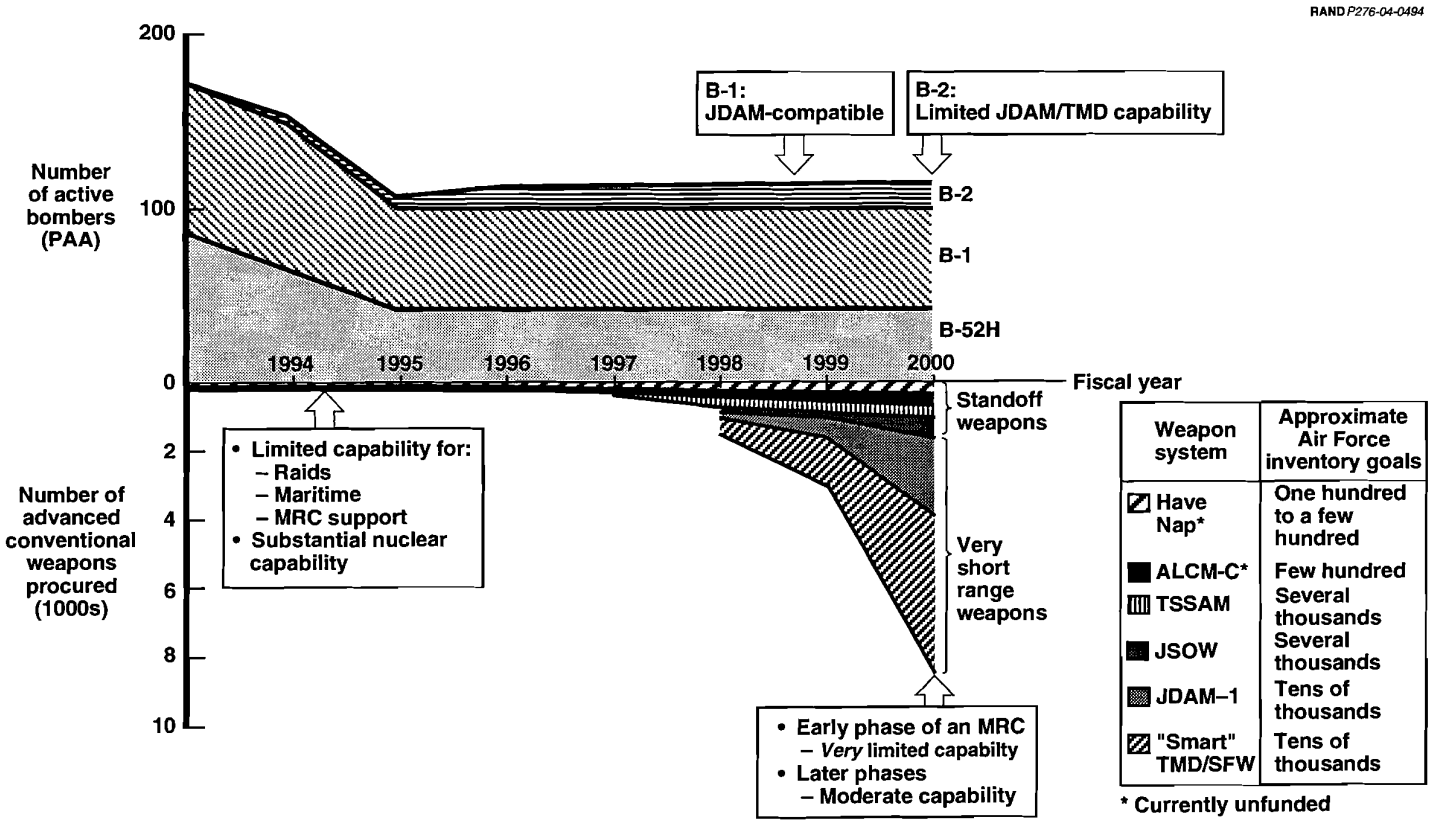

Figure 8—The Planned Bomber Force Will Have *Very Little Capability in This Century*

significant numbers until around the turn of the century.[5] *Until then, the bomber force will have very limited conventional capability regardless of how large it is.* 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 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, 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. *Being able to modify bombers relatively quickly and inexpensively is critical to maintaining an effective bomber force in the dynamic world environment.*

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 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 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. The small number of TSSAMs that could be available would probably be of most use as defense suppression weapons for the B-2. 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, when both the B-1 and the B-2 are modified to permit cooperative targeting, even the B-1/JSOW combination may be of limited utility.

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[5] Actually, 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.

Moreover, unless the ALCM-C is funded, there will be no 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, the problem of 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 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. Equipping the B-1 with JSOW is only a partial solution.

Moreover, even in the long term, significant gaps in the Air Force's current weapons procurement plan could limit the potential effectiveness of the bomber force:

- Not enough emphasis on upgrading small (e.g., 500 lb) bombs
- Lack of long-range cruise missiles will limit the ability of nonstealthy bombers to attack defended areas in the early phases of a conflict
  - TSSAM range inadequate for broad classes of missions
  - ALCM-C numbers inadequate even if funded
- Smart fuzes needed for attacking hardened bunkers are currently unfunded
- Better submunitions that are not currently programmed would substantially improve the effectiveness of a small bomber force
  - A better antiarmor submunition than Skeet (e.g., BAT)

As noted earlier, heavy bombers would be much more effective against many types of target sets if they had the option of carrying large numbers of small, moderately accurate weapons. Adding this capability should be easy, quick, and relatively cheap, but is not emphasized in the current program.

The lack of a suitable long-range cruise missile has long-term as well as short-term implications for the bomber force. The vulnerabilities of the B-1 and B-52 will increase, not decrease, over the years as even Third World air defenses continue to improve.

Some specific classes of missions can require specialized weapons or improvements to particular weapon components. For example, attacking hardened bunkers received considerable attention during the Gulf War. Attacking very hard targets stresses weapons technology in several areas. One of them is fuze technology. Equipping weapons with "smart" fuzes that would sense when the weapon had passed through the walls of a bunker and cause the weapon to detonate only when it had entered the bunker itself would make attacking bunkers much more effective. However, smart fuzes are not currently funded, although they could be used by various types of weapons, not just bomber weapons.

Better submunitions of various sorts could make a small bomber force much more effective. For example, Figure 6 showed that having a more effective antiarmor submunition than Skeet could reduce the number of bombers required to stop an armored invasion by a factor of 2 or 3. That added capability could be critical for making a small force of B-2s or a combined force of B-2s and B-1s fully effective. However, the Air Force does not currently plan to procure an advanced antiarmor submunition. The BAT (Brilliant Antitank) submunition currently being developed by the Army might be adequate. If not, there are other technical options that the Air Force could pursue.

Thus, 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 that long-range bombers potentially offer*. At best, achieving those capabilities will require many years.

Other Problems

Other problems remain as well. Some are relatively straightforward to solve given the will and resources:

- *Providing adequate crew ratios*. The Air Force currently plans on maintaining crew ratio of about 1.1 for its bomber force. That would have been sufficient during the Cold War when bombers were intended

primarily as strategic platforms dedicated to one massive nuclear attack mission. However, sustained conventional operations require more crews for each bomber. Our analysis shows that a crew ratio of about 3.0 would be necessary for the kinds of stressing missions and sortie rates that we have described here.

- *Providing sufficient repair and maintenance capability for sustained bomber operations.* Similarly, the maintenance and repair capabilities for bombers in general and the B-1 in particular were not designed for sustained operations. Using the bombers in protracted conventional campaigns will require a different approach. The Air Force leadership recognizes this problem, but whether the actual plans to correct it prove to be adequate remains to be seen.
- *Providing adequate training/flight time.* A small bomber force and fiscal austerity tend to reduce flight hours. Although the use of simulators helps, a certain amount of flying time is necessary for the crews to maintain full proficiency in the relatively demanding operations that conventional campaigns require. That is going to be a particular problem for the small B-2 force.

Solving these problems is a prerequisite to maintaining an effective bomber force of any kind in the future. However, there is a more fundamental set of issues that gets into relatively unexplored territory and will require additional research to address.

- *Developing integrated operational concepts.* The most fundamental need is to develop a set of truly *integrated* fighting concepts to take maximum advantage of shrinking U.S. military forces. There are two dimensions to the problem. The first is operational. Forces from different services and different parts of the same service need to be able to actually *fight together*, not just stay out of each other's way while operating in the same theater (i.e., joint operations). Better combat integration could open up all sorts of possibilities for innovative operational concepts that might increase the overall combat effectiveness of U.S. forces while identifying redundant capabilities that could be eliminated. That, in turn, would provide a basis for addressing the second dimension: force structure analysis and program planning.

  As forces shrink and distinctions among service roles and missions blur, making legitimate cost-effectiveness comparisons among disparate forces becomes more and more difficult. In particular, practical force comparisons will frequently involve neither equal cost nor equal

effectiveness. For example, in our past work, we have made some relatively straightforward comparisons between different bombers and carrier-based aircraft or land-based tactical fighters. These were useful for making judgments on some narrowly defined force effectiveness comparison issues. Even there, however, the comparisons have to be interpreted with care. For example, B-2s are very different from B-1s. They are capable of doing very different things, so comparisons can be tricky. By contrast, B-1s are very much like large fighter-bombers and can be compared fairly with other traditionally tactical fighter-bombers. The results can turn on how the questions are posed, but the analysis is still relatively straightforward.

That is not true for larger force structure comparisons involving disparate types of forces, say, long-range bombers, aircraft carriers, and some kinds of ground forces. Because their missions only partially overlap, cost-effectiveness comparisons have to be made more indirectly by evaluating various combinations of forces that could satisfy similar sets of overall national military objectives. *That is the kind of analysis that will increasingly be required to address national-level questions of overall force structure and military roles and missions.*

- *Modifying the acquisition process.* Next, the United States needs to revamp its military acquisition process to simplify the modification of existing or planned weapon systems. Since the United States will buy fewer major weapon systems in the future, it must get the most mileage out of the ones it already has as well as the few new ones that it plans to build. That means relying more on frequently modifying weapon systems. Making that process easier technically and institutionally is a major challenge.
- *Maintaining an adequate industrial base.* Finally, if the United States plans to stay in the bomber business over the long term, it needs to be somewhat concerned about maintaining the technical and manufacturing capability necessary to design and build bombers. Determining how best to do that and deciding whether the effort is worth the cost is a major analytical challenge.

Conclusions

After adequate weapons become available and suitable modifications are made to the bombers, the currently programmed force of about 100–120 bombers (60 B-1s, 40 B-52s, ≈ 20 B-2s) should be able to handle a stressing major regional

conflict, assuming new operational concepts can be implemented successfully. However, such a force would have:

- No reserve force for nuclear use (≈ 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.

A slightly smaller force that included more B-2s would offer greater capability if the nation were willing to invest the additional resources.

- A force of about 60 suitably equipped B-2s and 40 B-52s would have considerably more capability to support a stressing major conflict as well as a moderately demanding, near-simultaneous second major conflict.
- A force of about 40 properly armed and configured B-2s and 40 B-52s would be roughly comparable in effectiveness to an improved version of the programmed force, *but*
  - would be easier to employ operationally
  - would have more flexibility for handling a second contingency, although its firepower would still be somewhat limited

However, the details of the force structure are not the most fundamental issues that the United States has to address in developing an effective bomber force. The bomber force will be relatively ineffective until at least the year 2000 *no matter how large it is*. Better weapons and suitable modifications to the bombers are critical to making the bomber force fully effective. The programmed new weapons and improvements to the bomber force should start to have some impact around the turn of the century *but additional new weapons and modifications to the bomber are needed* if the relatively modest future bomber force is to be fully effective in important conventional roles.