Chapter Eight

COUNTERING WEAPONS OF MASS DESTRUCTION AND BALLISTIC MISSILES

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The attractiveness of both ballistic missiles and weapons of mass destruction (WMD) to various actors throughout the world represents a serious threat to U.S. security. These weapons and delivery systems are popular in part because they are highly visible symbols of military prowess. As such, they provide significant influence on regional balances of power, even among friends and allies. Furthermore, as the ranges of available delivery systems increase, proliferants will eventually be able to reach, and therefore threaten, the U.S. homeland. Such weapons also give at least the appearance of being unstoppable, even by active defenses. All these features together make such weapons highly attractive as asymmetric counters to potential U.S. regional power projection. Increasing proliferation over the next few years is likely to change the very nature and scope of conflict.[1]

Ironically, the various U.S. policies and initiatives that attempt to stem proliferation and to delegitimize these weapons simply enhance potential proliferants' beliefs in and quests for these weapons. And there are questions about the helpfulness of various defenses against ballistic missiles. What, then, can the United States do to respond to these threats?

Ballistic missile systems themselves are relatively well understood, but there seem to be significantly different views of the nature and

[1]Thanks to RAND colleagues Ted Warner, Joel Kvitky, Greg Jones, David Vaughan, Gary McLeod, and Myron Hura for their thoughtful reviews of the material in this chapter. Any residual errors are, of course, the author's.

significance of WMD. A ballistic missile armed solely with conventional high explosives is inefficient and expensive compared to one armed with WMD. This is so even though WMD-bearing missiles may be "unusable" except for coercion or in extreme circumstances. What makes these warheads so valuable is the enhanced terror potential they provide.

The next section elucidates this potential by considering the three distinct classes of WMD—chemical, biological, and nuclear—separately. This is particularly important because the nature, scope, and significance of these classes are dissimilar. For example, as this chapter will explain, chemical agents are the most "usable" but the easiest to counter; biological agents may be the least suitable for ballistic missile delivery but are the most difficult to counter; and nuclear weapons are the most expensive and challenging but are the least likely (one hopes) to be used.[2]

After that discussion, the chapter postulates a wide range of candidate U.S. responses and identifies those that may be most compatible with the roles, missions and capabilities of the Air Force of the 21st century. The following two sections then focus on possible Air Force counterforce attacks and active defenses—theater missile defense (TMD) and national missile defense (NMD). Finally, the chapter concludes with a brief summary.

WMD CHARACTERISTICS AND SCENARIOS

The proliferation of WMD threats is worrisome for a number of reasons we will attempt to summarize in this section. The term *WMD* is in many ways an unfortunate aggregation of very dissimilar threats, unfortunate because the differences in nature, scope, and significance could yield profoundly different effects, not just for Air Force operations, but on the entire force structure, power-projection strategy, and warfighting tactics.

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[2]Of course, the word *use* has different meanings in practice. This qualitative assessment of relative likelihood of WMD use pertains to *actual use* for WMD effects rather than, for example, veiled or explicit "use" as a coercive instrument. The absolute likelihood of nuclear and biological use is, obviously, impossible to estimate. The relative likelihood, however, reflects an analysis of differences in the range of conceptual opportunities and risks this chapter outlines.

Biological weapons have been a part of warfare throughout recorded history.[3] They are sometimes referred to as the "poor man's nuclear weapons" both because of their potential, pound-for-pound, to inflict human casualties on a scale comparable to nuclear weapons and because their costs could be less than the costs of even modest nuclear arsenals by a factor of ten or more. They are of increasing concern to national security policymakers and warfighters.

Chemical weapons were widely employed in World War I. Since then, defenses against them have played an important role whenever deployed U.S. forces have faced adversaries possessing chemical weapons (e.g., Iraq and North Korea).

The nuclear weapons dropped on Hiroshima and Nagasaki helped end World War II but spawned an arms race between the United States and the Soviet Union that ended with the demise of the latter. Nuclear weapons continue to be a serious proliferation concern.

WMD, particularly biological and nuclear weapons, could have a *revolutionary* impact on warfighting. But the United States has yet to address these complex counterproliferation problems adequately—and this brief summary certainly cannot do so. The threat WMD pose may be a forcing function for revolutionary changes. If so, a much broader consideration of WMD and their implications in the overall strategic context is certainly warranted.

The following pages describe biological, chemical, and nuclear weapons and outline the pros and cons of employing them as

[3]Christopher et al. (1997) provides an excellent historical overview of the use of microorganisms and toxins as weapons. This well-referenced article from the Journal of the American Medical Association discusses several historical cases, including the Tatar's 14th-century use of plague in laying siege to Kaffa (now Feodossia, Ukraine). Reportedly, the Tatars turned a plague epidemic among themselves into an offensive opportunity by catapulting their own plague cadavers into the city. Plague subsequently broke out in the city, and Kaffa's defenders retreated, but whether this outbreak was a result of the Tatar "biological attack" is uncertain. This uncertainty, which is typical of many actual or alleged uses of biological weapons over the ages, is due to the difficulty of differentiating naturally occurring diseases from biological weapon–caused epidemics, the challenges of gathering convincing forensic evidence, and allegations of biological attack for political or propaganda purposes. Examples of the last point of confusion include allegations the Soviets, Chinese and North Koreans made against the United States during the Korean War and the "yellow rain" allegations the United States made against the Soviets and their proxies in Laos (1975–1981), Kampuchea (1979–1981), and Afghanistan (1979–1981).

warfighting instruments. This sets the stage for assessment of the utility of various Air Force offensive and defensive responses and will help in rationalizing investments. Table 8.1 summarizes the characteristics of these weapons.

Background

Biological Weapons. While the potential effectiveness of biological agents is well understood (and very frightening) in purely clinical terms, their strategic and tactical military potential is much less clear.

The significance of disease-producing agents in warfare is unquestionable: Over the centuries, armies have suffered more casualties from natural disease than from man-made weapons. But with very few significant and/or well-documented exceptions, biological agents have not been *effectively* used *on purpose* to disable or kill enemy soldiers or civilians.[4]

During World War II, Japan's Unit 731 aggressively explored the potential use of biological weapons in modern warfare, to the extent of testing experimental agents and delivery systems against prisoners of war and against civilians in Chinese cities. Japanese attempts to use biological weapons on the battlefield in China may, however, have backfired: Japanese soldiers were inadequately protected and reportedly suffered 10,000 casualties after a cholera attack on Changteh in 1941.

The United States, Great Britain, and the Soviet Union also pursued biological weapon capabilities during and after World War II. Indeed, after the war, the U.S. programs were able to tap into the knowledge and experience of Japanese scientists to some extent. But with the emergence of nuclear weapons as the ultimate in mass destruction, and possibly because of some of the problems associated with biological weapons that I will outline below, the United States abandoned research and development (R&D) on offensive biological

[4]Christopher et al. (1997) notes one of the most notorious cases: the use of smallpox-infected blankets and handkerchiefs to "reduce" Native American tribes hostile to the British during the French and Indian War (1754–1767).

Table 8.1

Weapon Characteristics

Biological Weapons	Chemical Weapons	Nuclear Weapons
Antipersonnel, not antimateriel.	Antipersonnel, not antimateriel.	Can produce antipersonnel and/or antimateriel effects.
Biological agents produce a delayed effect (kicking in minutes to hours to days or even weeks after exposure).	The initial danger of chemical exposure in military use scenarios is by skin contact or inhalation as the aerosolized agent cloud drifts by in the wind and the liquid agent "rains out."	
The primary danger of infection in military scenarios using biological weapons is by inhalation as the aerosolized agent cloud drifts by in the wind—once the cloud is past, the danger is largely over.	Some chemical agents remain lethal for substantial periods of time (hours to days), that is, they produce a persistent effect.	Nuclear weapons produce devastating, prompt, and long-term effects.
The extent of the exposed region depends on the agent type, release conditions, weather (winds, temperature, humidity) and time of day.	The longer-term, persistent effects depend on agent type, release conditions, and weather (winds, temperature, humidity) and are caused by contact with the liquid agent that has settled out on the ground or on equipment or by inhalation of vapors from evaporation of these deposits.	Nuclear weapons produce a wide range of effects that are relatively predictable given specific target characteristics.
The release of agent may or may not be associated with observable phenomena (such as hostile aircraft flyby, bombs, artillery or missile attack).	The release of chemicals will probably be associated with observable phenomena (such as flyby of hostile aircraft or attack with bombs, artillery, or missiles).	Nuclear weapons will most likely be delivered by ballistic missiles.

Table 8.1—Continued

Biological Weapons	Chemical Weapons	Nuclear Weapons
Warning that a biological attack is under way or has recently occurred is critical—warning makes very effective defensive responses possible.	Warning that an attack is under way is critical—if warned, very effective defensive responses are possible.	Warning (minutes) will likely result in only modest survivability benefits.
Biological weapons will be viewed as strategic assets with operational limitations due to political taboos.	Chemical weapons may be viewed as tactical assets.	Nuclear weapons will be viewed as strategic assets with operational limitations because of the small number of weapons likely to be available.
Details about the size and character of an adversary's biological weapons are critical (e.g., specific agents and strains) but will likely be unknown.	Specific details about the character of an adversary's chemical arsenal (e.g., specific agents and delivery mechanisms) will likely be uncertain (but less critical than the biological weapon uncertainties).	Specific details about the size and character of an adversary's nuclear arsenal (e.g., numbers and design particulars, such as yield) will be important but likely will be unknown.

weapons and destroyed its limited arsenal of weaponized agents in the late 1960s and early 1970s.

The Biological Weapons Convention (BWC), signed in 1972, repudiated biological weapons by internationally prohibiting their manufacture, stockpiling, and use. Despite the known violations of one signatory, the Soviet Union, the BWC has succeeded in stigmatizing offensive biological weapon systems. Biological weapon use is inconsistent with generally accepted norms of "civilized" warfare. No country today openly admits it has an offensive biological weapon program but many, particularly relatively poor third-world countries, are suspected of covert programs. The "poor man's nuclear weapons" may therefore play a role in a future conflict involving the United States with these potential biological weapon proliferants.

The covert nature of potential biological threats exacerbates the problems the United States faces in anticipating and countering them but may also limit the ways biological weapons can be used and their risks. Intelligence collection may point to specific threat agents and delivery means, but the enemy's intent, as reflected in his strategy and doctrine, is less likely to be well understood. Further, the need for covertness limits the proliferant's abilities to explicitly incorporate biological weapons in his overall campaign plan and to train and exercise his troops to use them. This could limit his tactical flexibility and/or confidence in the effectiveness of the weapons at the tactical level, unless biological operations could be conducted independent of other military operations. At the strategic level, the proliferant risks becoming an international pariah if he uses biological weapons overtly. Although biological weapons put awesome destructive potential within the reach of many states, actually using them would entail awesome operational and political risks. The scenario issue we will explore below is whether the military benefits outweigh the risks.

Chemical Weapons. Chemical agents made their modern military debut in World War I. These weapons were effective in trench warfare because they could penetrate fortifications, causing causalities and demoralizing the stalemated troops. Nonlethal chemical agents have been used since then for a variety of purposes, from crowd control to defoliation. The potential effectiveness of modern lethal and nonlethal chemical agents, in purely clinical terms, is well understood, but their strategic and tactical military potential in the very dynamic and complex battlefields of the future is more uncertain, although probably not as uncertain as the effectiveness of biological weapons.

Chemical weapons also have a negative image relative to more "humane" and discriminating instruments of warfare. The Chemical Weapons Convention, which more than 140 states signed in 1993 (the United States has not yet ratified it), bans the development, production, and possession of chemical weapons and reinforces the international norm against their use.

Nuclear Weapons. The relatively crude approximately 15 kt implosion and gun-type atomic weapons dropped on Hiroshima and Nagasaki ended World War II and introduced the world to the awesome power and effects of nuclear fission devices. In a relatively short time, the development of thermonuclear weapons ("H-bombs") rewrote the book on destructive potential—with modern weapons producing the power equivalent of about 1,000 tons of high explosives per pound of warhead (a 2,000,000-to-1 increase in efficiency over high explosives). While multimegaton (millions of tons of high-explosive-equivalent power) weapons were created, the primary effect of thermonuclear weapons technology was to allow weapons with 10 to 100 times the power of the 1945 weapons to be made small enough to pack several on long-range ballistic missiles.

In the proliferant context, the assumption is that current "entry-level" weapons would be more sophisticated than the 1945 U.S. devices but would still be limited to single-stage (fission) yields on the order of a few to a few tens of kilotons. Such a first-generation nuclear weapon could be made small and light enough for a Scud missile to deliver (that is, 1,000 to 2,000 pounds).[5]

Characteristics of WMD Affecting Their Use

Characteristics of Biological Weapons. Biological agents are unlike conventional weapons in that they affect only living organisms. Anthrax can kill a human but will not harm a tank. But unlike an antitank gun, the bacteria, viruses, or, to a lesser extent, the toxins,

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[5]There is also the problem of "loose nukes." Presumably, a proliferant might be able to buy or steal all-up complete weapons from a nuclear state, in which case the single stage fission limitation here would not pertain.

take a relatively long time before their effects are observed. These qualities lead to the first two observations about biological weapons: Biological agents are antipersonnel, not antimateriel, and they produce a delayed effect (kicking in minutes to hours to days or even weeks after exposure).

Most, though not all, of the principal agents are highly infectious but not contagious; smallpox is one that is contagious, while anthrax is not. Noncontagion is obviously a desirable property to control the spread of disease beyond the targeted group. The principal means of becoming infected with a biological agent is by inhaling a vapor containing the organisms or toxin. This mechanism is effective only if the aerosol particles are in the 1 to 10 μm range. Particles this size are invisible to the naked eye and are suspended in the air in Brownian motion. They diffuse and drift with the wind. To infect people, of course, these winds have to be near the surface of the earth, in the mixing layer. This means that the aerosol must be released in this region (typically below 1,000 m, depending on meteorological conditions and time of day). Once released, the agent begins to lose its potency from drying out or exposure to ultraviolet light. Some agents, such as anthrax, can live for years as spores under the right conditions, but most biological agents are relatively short lived (hours to days). Also, the agent cloud disperses as it drifts away from the release point, reducing the density of the agent, eventually below concentrations needed to achieve the desired effect (whether incapacitation or death). Particles that settle out of the cloud and come to rest on surfaces, such as the ground, no longer constitute a serious threat since reaerosolization in sufficient quantity seems unlikely (although this is a somewhat controversial area in which additional tests are planned).

This illustrates two more observations: The primary danger of infection in military scenarios using biological weapons is by inhalation as the aerosolized agent drifts in the wind—once the cloud is past, the danger is largely over. The extent of the exposed region depends on the agent type, release conditions, weather (winds, temperature, humidity), and time of day.

Delivery means could range from slightly modified commercial handheld agricultural sprayers to spray tanks on high-performance aircraft or ships to sophisticated munitions delivered in gravity bombs or in warheads on cruise and ballistic missiles. Water and food contamination is also possible but is much less significant in military actions than in terrorist actions against urban populations. Weaponizing biological agents is probably the most challenging aspect of developing an effective biological weapon capability. The process of aerosolization is hard on the agent, and achieving a particle size appropriate for effective distribution is also difficult. Delivery means are generally relatively inefficient, either killing much of the agent or allowing it to fall out prematurely because the particles are too large. Therefore, despite the theoretical potency of very small quantities of an agent, military effectiveness requires releasing amounts larger than theory would suggest.

Another characteristic of these agents is that their release may or may not be associated with observable phenomena (such as flyby of a hostile aircraft or a bomb, artillery or missile attack). Once dispersed, the agent cloud is generally invisible. People in its path will not see it coming and will not notice when the cloud engulfs them. Warning systems are being developed to detect and characterize biological aerosols both at a distance (e.g., light detection and ranging [LIDAR] on helicopters and detectors on unmanned aerial vehicles [UAVs]) and locally, as the cloud passes by (e.g., the Biological Integrated Detection System [BIDS] equipment mounted in Army trucks).

These warning and agent identification systems are important because, with adequate warning, very effective defensive measures can be taken. These measures include moving out of the cloud's path, if possible, or, if not, donning simple, inexpensive face masks for partial protection. Note that, unlike the case of chemical agent threats, which require full-body protection (e.g., using mission oriented protective posture [MOPP] suits), which can significantly impair operations for an extended time, the biological agents can be mitigated simply with a mask. The mask that is included as part of the standard MOPP ensemble will work, but so will less-elaborate masks that simply cover the mouth; nose; and, just to be on the safe side, the eyes.

Even if there is no warning, so that troops are exposed to the biological cloud before they can don masks, there may still be some hope. Prior inoculation against the specific agent is one possibility, assuming the individual does not inhale enough agent to overwhelm whatever immunity the inoculation provided. The last is, however, a big "if," for a number of reasons. Further, identifying the agent before observable symptoms develop and promptly beginning an appropriate treatment (e.g., with antibiotics or vaccines) may prevent adverse effects (other than psychological effects). Even when antibiotics are not effective, as with smallpox, vaccination immediately after exposure may be beneficial. However, once the agent's symptoms appear, it is generally too late to prevent the disease from running its course. This means that warning that a biological attack is under way or has recently occurred is critical—warning makes very effective defensive responses possible.

In summary, biological agents can be delivered by a variety of means (some exceedingly stealthy or covert); a small amount can cover a large (but "controllable") area (e.g., a few kilograms of anthrax could cover a city, airfield, or port); the effects are delayed; and warning and attack assessment are technologically and operationally challenging. However, with adequate warning of an attack, very effective treatment is possible.

Characteristics of Chemical Weapons. Chemical agents are unlike conventional weapons in that they primarily affect living organisms. The nerve agent VX can kill a human, but it will not harm an airplane (although some agents are corrosive). But the direct causalities in a chemical attack may be considered a bonus to the primary military effects, which are generally indirect: Chemical agents are antipersonnel, not antimateriel.

Agents are characterized as lethal or nonlethal and by their physiological effects (e.g., blister, blood, nerve agents). They are also characterized by their persistence, that is, the length of time that an exposed area remains dangerous after agent release. Persistence is a function of the chemical properties of the agent and environmental factors (e.g., temperature, moisture, winds). Most modern agents are delivered as liquid aerosols—not as a gas. Their effects can be produced by skin contact (percutaneously), but causalities will also result from inhalation or eye contact.

The initial danger of chemical exposure in military use scenarios is by skin contact or inhalation as the aerosolized agent cloud drifts by in the wind and liquid agent "rains out." Some chemical agents remain lethal for substantial periods of time (hours to days), that is, they produce a persistent effect. The longer-term, persistent effects depend on agent type, release conditions, and weather (winds, temperature, humidity) and are caused by contact with the liquid agent that has settled out on the ground or on equipment or by inhalation of vapors from evaporation of these deposits.

Delivery means could range from slightly modified commercial handheld agricultural sprayers to spray tanks on high-performance aircraft or ships to sophisticated munitions delivered in gravity bombs or in warheads on cruise and ballistic missiles. Water and food contamination is also possible but is much less significant in military actions than in terrorist actions against urban populations. Weaponization of chemical agents is relatively straightforward.[6] The release of chemicals will probably be associated with observable phenomena (such as flybys of hostile aircraft or attack with bombs, artillery, or missiles).

Warning systems are important because adequate warning allows very effective defensive measures to be taken. Protection against chemical threats requires total-body MOPP gear, which can significantly impair operations for an extended time. If troops are exposed to the agent before they can be warned and don protective (MOPP) gear, there may still be some hope. If chemical symptoms appear, the soldiers can inject themselves with chemical antidotes, such as atrophine. Thus, warning that an attack is under way is critical.

In summary, chemical agents can be delivered by a variety of means; a small amount can cover a large (but "controllable") area; and, with adequate warning, very effective defenses are possible.

Nuclear Characteristics. The principal characteristic of nuclear weapons in the proliferant context is that very few are likely to be available because the critical nuclear materials (plutonium and/or highly enriched uranium) required to fabricate these weapons are difficult and expensive to make. Of course, if this process is circumvented by buying or stealing the materials or even complete weapons—the so-called "loose nukes" problem—this may not be a limiting factor.

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[6]An important exception is fusing. The dispersal of chemical (and biological) weapons is most efficient if the agent can be dispersed before it hits the ground. Achieving a reliable, optimal airburst is a technical challenge that few potential proliferants have yet managed to achieve.

This brings us to the first three observations regarding nuclear weapons: Nuclear weapons will be viewed as strategic assets with operational limitations because of the small number of weapons likely to be available. Specific details about the size and character of an adversary's nuclear arsenal (e.g., numbers and design particulars, such as yield) will likely be unknown. Finally, the details about the adversary's nuclear capabilities may be important (e.g., do they have one weapon, a few, or a few tens?).

While one tends to think of the blast and radiation effects of a ground or low airburst nuclear weapon and the resulting mushroom cloud and downwind radioactive debris fallout, these weapons can also be used in other ways to produce tailored effects. For example, they can be detonated at high altitudes or in space (a) to disturb radio frequency propagation; (b) destroy unhardened missiles and satellites promptly with long-range X-rays; (c) degrade the effective lives of satellites through trapped radiation effects; or (d) expose aircraft and terrestrial systems to high-energy magnetic pulse (HEMP), which can upset or damage electronic components.

The specific effectiveness of nuclear weapons used in these various ways depends on device design specifics, but proliferants would, typically, already understand the effects of nuclear weapons and how to best achieve any desired damage mechanisms. In particular, even limited-yield, first-generation weapons can produce significant HEMP effects.[7] So, nuclear weapons can produce antipersonnel and/or antimateriel effects, and the effects are devastating, prompt, and long term.

WMD Scenarios

Biological Weapon Scenarios. As we noted above, there is very little historical precedent or published doctrine that the analyst can rely on when postulating how a proliferant might use biological weapons. Further, intelligence breakthroughs in this area are more a matter of

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[7]While the physical effects of the nuclear detonation are relatively well understood, the response of specific systems exposed to these environments is much more contentious. Significant testing (some unintentional, as occurred in Hawaii during the high-altitude U.S. nuclear tests conducted in the South Pacific in the mid-1950s) was carried out during the Cold War years, but most of today's military and commercial systems have not been hardened or tested against HEMP.

luck than effort (e.g., the right defector at the right time). So, it is necessary to fall back on common sense, letting the characteristics above suggest how biological agents might most reasonably be used against the United States or its regional allies. This amounts to "informed speculation." This structuring of the problem of anticipating the potential use and effectiveness of biological weapons is not predictive, and measures of "confidence" cannot reasonably be provided; however, the logical framework should be helpful in stimulating further community consideration of these threats to help identify and prioritize Air Force response options.

An adversary might consider two generic types of biological weapon "use":

1. coercive threats of biological weapon use
2. military use (covert and overt).

Because of the significance of biological weapons as an instrument of terror (e.g., potentially massive casualties among unprotected urban populations), the existence of even a *suspect* capability will cast a shadow over future regional crises. The use of or even overt threats of the use of biological weapons would violate generally accepted international norms of proper behavior, thanks to such instruments as the BWC.

Therefore, it seems that the most likely form of coercive use would be rather unspecified, veiled threats of "dire consequences" if the aggressor's demands were not met. The demands could involve specific actions by the states under attack or could be aimed at the United States. The principal concerns are that these threats will do one of the following:

1. cause the victim state (a friend or ally of the United States) to acquiesce to the aggressor's demands because the risks of resisting seem too high
2. deter the United States from intervening successfully to protect both its short-term and long-term national interests.

The bottom line in each of these issues is the potential cost of resisting the aggressor versus the cost if the United States or our allies acquiesce. "Costs" can be measured in terms of blood or treasure or can be more abstract, involving a either a loss of stature and influence in the region (or even globally) or a weakening of the moral underpinnings and rule of law that govern interstate relations.

These coercive threats will be of concern in three scenario contexts:

1. in a crisis, before the start of military hostilities
2. during the course of a military campaign
3. after the war has come to an end.

The crisis scenarios would involve the attempts of a would-be regional hegemon to compel his neighbors to do his bidding "or else." The threat of using biological weapons—whether explicit, or, more likely from our perspective, veiled—may introduce an asymmetry in the regional balance of power. If the threatened states cannot protect themselves adequately, are relatively weak militarily, and have no credible punitive threats with which to deter the use of biological weapons, the coercive threats may succeed. Of course, the United States could address these deficiencies to some extent through security commitments, including an "extended" deterrent policy and posture. The credibility of U.S. commitments and capabilities will depend, of course, on its ability to deal militarily with the biological threats, which will be discussed in more detail below.

During the course of a regional conflict in which the United States is engaged, there is a chance that biological threats will be used to attempt to limit U.S. war aims through escalation potential. A possible threat, for example, might be: "If the Great Satan advances to within 250 km of Baghdad, the wrath of God will be visited upon the Infidels." Such threats could be punctuated by limited "demonstrations" of the potential of biological weapons, although the decision to cross the "use line" is not likely to be taken lightly. Perhaps the more serious concern would be the enemy's threats to, in effect, take his opponents with him in defeat. If the United States were prevailing militarily, as would be expected, the enemy might at some point believe that all is lost. At this point, threats to lash out in revenge with biological weapons would become much more worrisome.

After the end of the war, a defeated aggressor may still pose a biological threat to the world by sponsoring terrorist organizations or reconstituting an offensive biological weapon capability to regain influence in the region.

Actual use of biological weapons for military purposes (i.e., other than purely for revenge, as discussed above), would seem to pose two distinct possibilities:

1. that limited, covert (or possibly even overt) use could tip the military balance significantly in the opponent's favor
2. that unlimited, overt use could win the war.

If possible, successful covert use would be preferable to overt use from the enemy's perspective for two principal reasons:

1. It would reduce the risk of punitive responses (military and political).
2. It could increase the effectiveness of the biological attack.

Here, *covert use* refers to the release of biological agents through unconventional means that deny timely attack warning and leave no "smoking guns" to implicate the user. The military goal would be to confuse and demoralize the forces attacked and to cause them to take defensive precautions that reduce their military effectiveness so that the aggressor's conventional forces would have a better chance of prevailing. The intent would not be to inflict extensive casualties. In fact, the goal may be to limit casualties to a very small number to minimize the likelihood of a "disproportionate" punitive response and to help mask the true nature of the attack.[8] Many biological agents occur in nature. So, for example, it is possible for troops to contract anthrax after stirring up the soil where sheep or camels have been grazing. If the agent were delivered in very low concentrations and even during daylight hours (as opposed to night, which would be the preferred time to maximize agent coverage area), the release might be difficult to detect, and the casualties might be appropriately small.

The problems with covert use from the enemy's perspective are the same problems conservative military planners have with all types of

[8]An example "biological sucker punch" scenario might go as follows: Attempts to coerce the United States have failed, and the United States is in the theater. Special operations forces (SOF) teams have covertly dispersed nonlethal biological agents (e.g., Brucellosis, Q-fever, VEE, SEB) over a wide area. As symptoms appear and chaos sets in, the aggressor launches massive combined arms strikes. The United States asks for a cease-fire to withdraw and treat casualties.

"special operations." First, the unpredictability of the results puts this kind of use into a "bonus" category—if it works, so much the better, but the user cannot count on it working to achieve the military objectives. This "bonus effect" might be desperately needed in some situations, but the conditions would seem to argue for "more aggressive" measures, such as those described below. Arguing against covert operations is the essentially incalculable risk of exposure as the initiator of a biological attack, which could, at best, embarrass the perpetrator or, at worst, compromise his conventional military plans and capabilities and/or cost him dearly in response. If the adversary state is discovered to have used biological weapons against allied forces, the allied war aims and strategy will likely change dramatically. This may hasten the user's defeat by making subsequent use of biological weapons much less effective (the opponent has been warned) and rallying international opinion against him. Such use would also likely increase the consequences of defeat (e.g., in war crimes trials).

The point of *overt use* (other than as the last desperate act of revenge of a doomed regime) would likely be to attempt to achieve both warning denial and widespread serious effects. Surprise would be important to minimize defensive actions and to give the biological agents time to take effect before executing other elements of the strategy. Widespread attacks would likely be planned to maximize the shock value of the use of biological weapons and to get the greatest possible effect from the initial use, since subsequent tactical uses may be less effective because of the defensive actions that would be invoked upon warning. But how could the dual objectives of warning denial and widespread attacks be met?

This sort of widespread, intense biological attack, whether as a preemptive move in a crisis or as an escalatory move during the war, would be difficult to plan and execute. If conventional delivery means were used, surprise would surely be impossible to achieve. For example, ballistic missiles armed with biological weapons could be salvoed to hit targets across the theater nearly simultaneously. However, the launch signatures would almost surely provide enough warning for troops in the target areas to don their MOPP gear in anticipation of a chemical or biological attack (of course, the forces might let their guard down if there were a number of false alarms). If this reasonable planning assumption were accurate, a ballistic missile attack with biological weapons would have little chance of even modest success (and a good chance of prompting a massive, punitive response). Similarly, aircraft-delivered biological attacks would be difficult to coordinate for undetected, theaterwide, nearly simultaneous release. If one or more aircraft were intercepted and found to be carrying biological weapons, the rest of the attack would likely fail.

Perhaps the best chance of both denying warning and striking theaterwide targets near-simultaneously with biological weapons would be to attack with SOF. These stealthy troops would infiltrate and, using handheld or vehicle-mounted spray devices, would release the agent upwind of their targets at a prearranged time or signal. Of course, local winds are variable and unpredictable over the interval of weeks to days to hours (or even minutes in certain situations) between the drafting of the attack plan and its execution, so some real-time adjustments would need to be made. Conservative military planners will have some difficulty endorsing important but risky unconventional operations, such as this, but they are conceivable, especially if they can be rationalized as a bonus if they work.

Whether or not massive near-simultaneous surprise attacks across a theater succeed, it is conceivable that localized biological attacks for specific tactical purposes also will be attempted. All such attacks must also achieve some level of surprise if they are to succeed. While biological aerosol clouds may be difficult to detect, it may be possible to detect the aircraft or missiles that release the agent, thereby providing warning to downwind troops. There is much less chance that more covert, unconventional delivery means (e.g., handheld agricultural sprayers) will be detected.

Chemical Weapon Scenarios. Chemical weapon use is more likely to be overt than the discussion above suggests biological weapon use would be. This is in part because the amount of agent required for a given effect is a factor of ten (or more) greater with chemical agents than with biological agents and in part because the principal effect is a reduction in the warfighting effectiveness of the exposed troops, whether measured in terms of aircraft sortie generation or the ability of soldiers to fight in MOPP gear.

Surprise may be a goal in chemical attacks to inflict causalities among unwarned troops, but once the chemical use threshold has been crossed, operational tempo and efficiency are the primary causalities. Chemical attacks can be used to attempt to shut down operations on airfields and ports, to deny territory or slow advances, and to create battlefield asymmetries (e.g., allied forces in MOPP gear but enemy forces not exposed or protected).

Nuclear Scenarios. Given the likely shortage of weapons and their strategic value, it seems unlikely that battlefield nuclear use of the sort that was envisioned in NATO versus Warsaw Pact scenarios is the greatest concern. Using nuclear weapons against large concentrations of forces and support personnel at such locations as airfields and ports would yield impressive local devastation (i.e., within a radius of about a mile or so from a 10-kt airburst). But there are likely many more such potential targets than there are available weapons. So, while a few "high-value" facilities might be attacked with nuclear weapons delivered by aircraft (for which defense penetration is an issue) or ballistic missiles (for which reliability is an issue), this application may not be considered sufficiently "strategic."

With a very small nuclear arsenal, if an adversary wanted to use part of this force for direct military effect, it could be argued that the most effective use (beyond simply brandishing them) would be to detonate one or two at high altitude over U.S. forces to produce the wide-area effects of HEMP. The risks are minimal: The lack of direct enemy causalities reduces the likelihood of a disproportionate nuclear response, and even if the detonations did not have much effect on the equipment exposed to HEMP, this might still be considered a highly dramatic warning shot and show of resolve. On the positive side, the HEMP effects could cause widespread disruptions in critical electronic systems (e.g., on Joint Surveillance and Target Attack Radar System [JSTARS] and Airborne Warning and Control System surveillance and control aircraft), which could impair U.S. warfighting abilities and allow the enemy's conventional operations to be more effective by exploiting our reduced capabilities.

Finally, of course, the adversary would likely maintain a "strategic reserve" of a few nuclear weapons to hedge against the prospect of a catastrophic defeat. This reserve would most likely be used to threaten cities in the region to convince the United States to halt the war before all was lost. At the extreme, nuclear weapons could be used as the last act of revenge by a dying regime.

Implications of These WMD Scenarios

The above WMD scenarios are somewhat one-sided. Other than alluding to U.S. "punitive" responses and the role passive defenses could play given direct or indirect warning, the scenarios do not really play both sides of the interaction. How can the United States mitigate the threats of WMD use outlined above? Several kinds of response should be considered in four areas: policy, intelligence, operations, and R&D.

Policy. This area presents several knotty issues. Active pursuit of nonproliferation policies and further reinforcement of the stigma against WMD development and use are good starting points, but more is needed to add credibility to our deterrent posture. Specifically, the United States needs to articulate its policy for deterring WMD use against the United States or our allies. Such statements as those made during the drive to renew the Non-Proliferation Treaty (NPT), to the effect that the United States would not use nuclear weapons against a nonnuclear state, may have been sensible in the NPT context but are unfortunate, or at least too explicit and/or premature, in the larger context of preventing WMD use.

An extended deterrent posture, such as the one NATO adopted during the Cold War, would seem to be an unlikely policy to adopt in the context of possible theater wars against WMD-equipped adversaries. Since the U.S. government has disavowed chemical and biological weapons, threatening preemptive first use of nuclear weapons to destroy hostile WMD systems would be contrary to its nonproliferation goals and to NPT-related commitments. However, a controlled nuclear *response* following enemy use of WMD, particularly if that use were against civilian areas and caused massive casualties, probably should not be ruled out.

More practically, what is needed is a policy statement that might go something like the following:

> The United States is dedicated to the worldwide elimination of all weapons of mass destruction (WMD). The U.S. has destroyed its chemical and biological weapons and is negotiating nuclear reductions with the other nuclear powers. The community of nations cannot be held hostage by WMD-armed aggressors. Assuring that regional predators cannot use WMD to coerce or defeat their neighbors is a vital U.S. national interest. The reasoning is simple: Non-

> proliferation and WMD disarmament are critical because WMD have no moral justification other than to deter the use of WMD by others. If WMD were used to coerce or destroy an enemy, the user of WMD for offensive purposes might win a short-term victory, but the long-term implications would be dire. Allowing a proliferant to prevail would set a precedent that would encourage further WMD proliferation (either in defense or to serve aggressive ambitions), thereby increasing the risk of further WMD use. This is a downward spiral that civilization may not be able to survive. Consequently, the United States will not let a WMD-armed aggressor prevail: No matter what the U.S. national interests are in a regional conflict, the introduction of WMD will transcend the other interests. The United States will use whatever means necessary to deny the aggressor his prize and to punish him appropriately.

Simply stated, the argument is that it should be U.S. policy (as well as that of other nations and international organizations) not to tolerate offensive (first) WMD use. The issue, of course, is making this policy credible—where are the teeth? And can this policy be enforced without creating the same sort of long-term proliferation problems the policy attempts to prevent. For example, what responses to WMD use are "appropriate" or "proportionate," and might they, of necessity, involve the United States or its allies using nuclear weapons?

This general concern suggests that U.S. warfighting capabilities should emphasize (a) intelligence collection to help counter WMD threats politically and militarily; (b) responsive operational concepts and systems, such as counterforce precision strike and defenses (passive and active) against WMD attack to limit damage and, hence, the scale of "proportionate" responses; and (c) aggressive R&D to support the development of effective conventional response capabilities.

Intelligence. Several priorities are clear for this area. Intelligence should tell policymakers and warfighters if countries show an interest in WMD, have R&D programs under way, or have deployed such weapons: Which WMD are of concern? Where are they being developed? stored? What are the characteristics of the delivery systems? What testing has been conducted? Is there any indication of enemy intent or its doctrine for WMD use? Are they training for "combined arms" battles that include WMD use? Are SOF forces, agents, or paramilitary forces training for WMD delivery?

Specific threat details that will likely be very difficult to collect will be important. The more specific the details on these weapons (e.g., production methods, strain, and delivery means for biological agents), the better, because the details help determine which responses would be most effective (e.g., the correct vaccines to be produced and used, the best postexposure treatment of casualties, and the appropriate focus for warning systems that detect and identify agents). In fact, the forensic proof that an enemy has produced and/or used specific WMD agents may be very important both during and after the conflict; the intelligence community should play a critical role in associating the enemy with a WMD attack. Details on the WMD infrastructure will be important in planning counterforce strikes, particularly with respect to limiting collateral damage from any agent that might be released by attacks on WMD production and storage facilities. Information on adversary doctrine, exercises, and any other sources would have obvious value to the regional commanders in chief who seek insights on how an adversary might employ WMD.

Operations. U.S. forces can take several actions operationally, including preventive strikes on WMD facilities; preemptive strikes on WMD stocks and delivery means; active defenses, such as airborne laser (ABL), Theater High-Altitude Area Defense (THAAD), and Patriot; and passive defense measures, such as nuclear hardening, inoculations, antibiotics, warning systems, masks, and collective shelters. Of these, the most important are passive defense measures.

The success of counterforce attacks to destroy the WMD before they can be used will be unpredictable because of inherent uncertainties in locating and destroying these weapons. Active defenses will not be leak-proof, and there are enemy countermeasures that are compatible with the delivery of biological and chemical weapons that may defeat or avoid defenses, such as the proliferation of submunitions can defeat Patriot and THAAD TMD systems, and handheld agricultural sprayers can avoid air defenses. Therefore, a prudent commander in chief will not count on counterforce and active defenses to completely neutralize the WMD threat.

Antibiotics work only against bacteria. Vaccinations work against many bacterial agents (e.g., anthrax), some viruses (e.g., smallpox), and some toxins (e.g., botulinum). Even proven vaccines, however, are strain dependent and may be overwhelmed by large agent concentrations. Inoculation is a logistical burden.[9] Moreover, adverse side effects are always a risk, particularly with multiagent vaccination "cocktails." Because of these problems, it may be preferable to treat troops after they have been exposed to certain agents, if the exposure can be detected and if the agent can be identified quickly (that is, before symptoms appear). For example, victims who receive vaccinations in parallel with antibiotics immediately after being exposed to anthrax may never experience any symptoms. Even when antibiotics are not effective (for example, with smallpox), administering vaccinations immediately after exposure may be beneficial.

R&D. Masks and shelters can be highly effective with minimal logistical and operational burdens, but effective use will require warning. Warning is a greater technological and operational challenge for biological weapons than for chemical weapons. The biological warning systems currently in R&D have limitations that a knowledgeable opponent could exploit.[10]

For example, BIDS currently can detect and identify only four specific agents, and the methods are very sensitive to operator skill and motivation. Furthermore, because of the sensitivity setting adopted to minimize false alarms, agent concentrations that can produce casualties can pass by a BIDS system without triggering an alarm. There will only be one BIDS platoon (seven vehicles) per Army corps. The long-range (50 to 100 km) biological standoff detection system currently under development using an eye-safe LIDAR on UH60 helicopters cannot identify agents but has pattern-recognition software that allows it to recognize aerosol clouds with characteristics (size, shape, particle size, and density) consistent with biological threats. These aircraft will be able to monitor suspect regions, but the operational concepts have not yet been fully developed. Other devices for timely identification of biological and chemical agents are in R&D, including the spectroscopic excitation and classification of trace effluents (SPECTRE) system.

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[9]Usually, a series of shots is required over time, with periodic boosters. Thus, at any one time, some troops will be unprotected because of the introduction of new recruits into the service and departure of older troops.

[10]The need for transparency in activities related to biological weapons means that most of these systems are unclassified, which makes exploitation easier.

Table 8.2 summarizes what I believe to be the projected capability of the United States to respond to WMD threats. These assessments reflect the author's experience and judgments but are admittedly qualitative. Others may emphasize different aspects of the threat and response, which could lead to different assessments. While the particulars might be arguable, however, the overall impression this matrix gives is reasonably representative of the current state of affairs.

Deterrence is an important element of a U.S. response to the more severe biological and nuclear threats, but as discussed above, deterrence based on punitive response may not be appropriate, and hence not effective, in some biological and nuclear use scenarios. The chemical threats are serious but can be managed through prudent investments in such areas as collective protection. Much the same can be said for proliferant nuclear threats, although the potential for massive casualties is very sobering. The biological agents that were the focus of much of the discussion above are, in many ways, the most troubling.

RESPONDING TO THE WMD THREAT: POTENTIAL AIR FORCE INITIATIVES

The remainder of the chapter investigates possible Air Force responses to these threats by exploring two related but distinct contexts: power projection and homeland defense. The following discussion will touch briefly on many of these potential initiatives but will focus on counterforce and active defenses.

Table 8.2

Summary of WMD Threat Implications

Priorities	Chemical	Biological	Nuclear
Deter WMD Use	Modest	Modest to Substantial	Modest to Substantial
Deny WMD Use	Poor	Poor	Modest
Defend Civilians			
Passive	Modest	Modest to Poor	Poor
Active	Modest	Modest to Poor	Modest
Defend Military			
Passive	Substantial	Modest to Poor	Modest
Active	Substantial	Modest to Poor	Modest

Generic WMD and ballistic missile responses relevant to U.S. power projection scenarios will involve a mix of approaches in which the Air Force may be a significant participant:

- *nonproliferation* measures include limiting technology transfer, delegitimizing systems, and offering security guarantees to non-proliferants
- *counterproliferation* measures include providing deterrence, passive defenses, counterforce attacks, and theater missile defense (TMD)
- *other response* measures involve doctrine and force structure, such as relying more on long-range operations with bombers).

Homeland defense has related but distinctly different elements:

- *nonproliferation* measures include limiting technology transfer and delegitimizing systems
- *counterproliferation* measures include providing deterrence, counterforce attacks, and national missile defense (NMD).

Some specific candidate Air Force activities would support the generic counterproliferation initiatives above,[11] such as the following:

- *power-projection measures*, including force protection (warning, hardening), threat avoidance (counterforce, camouflage, concealment and deception; mobility; dispersal; sanctuary basing; and operations)
- *homeland defense measures*, including strategic warning, pre-emptive counterforce, attack warning and characterization, NMD cueing, air and cruise missile defense (close other threat doors), red teaming.

As the discussion above notes, counterforce attacks and active defense are responses to WMD delivered by theater ballistic missiles (TBMs). The next section will get more specific about Air Force TMD initiatives, both ongoing and conceptual, describing candidate con-

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[11]These activities range from the conceptual state to being programmed and/or deployed. The programmatic details change over time and are not critical here and so will not be addressed explicitly.

cepts and discussing their pros and cons. The following section will then focus on NMD responses as a natural extension of the theater defense initiatives.

POTENTIAL AIR FORCE TMD INITIATIVES

The purpose of U.S. TMD efforts is straightforward: to address the emerging threats that TBMs pose for U.S. military power-projection operations. The Gulf War introduced crude Scud threats with military and political implications disproportionate to the Scuds' actual effectiveness. In contrast, the emergence of future TBM threats—most notably missiles with precision guidance, advanced conventional submunitions, or WMD—will have the potential to profoundly alter the course and conduct of major theater wars (MTWs). For example, TBMs increase the vulnerability of forward-positioned forces and equipment. TBMs can slow and complicate (politically and operationally) access to ports and air bases making rapid deployment of decisive forces to a theater more difficult. If casualties and collateral damage are an issue, an opponent could create response dilemmas by using TBMs against U.S. and/or allied forces and populations. If the United States depends on swiftly meeting its defined warfighting objectives, TBM use may change these objectives and lengthen and/or expand the conflict.

Although TMD *may* have some deterrent value, the primary purpose of acquiring and deploying TMD systems (and, by extension, as longer-range threats emerge, NMD as well), is to ensure that the United States will not be deterred from taking the appropriate actions to defend its primary security interests in an MTW fought under threatened or actual WMD strikes on the United States or our allies.

To achieve this purpose in "WMD shadowed MTWs," acceptable counterproliferation strategies will require both TMD (and, eventually, NMD) capabilities to support U.S. *offensive* campaign strategies that seek to deny or minimize the damage from possible TBM strikes against the United States, our allies, and our forward-deployed forces.

TMD offers some protection both against enemy missile delivery of advanced conventional munitions and against WMD warheads. The two types of warheads pose qualitatively different cases. Advanced conventional warheads, even with future precision guidance, are much less challenging than WMD warheads, both in terms of the threat they pose to defended areas and the difficulty of designing defenses to blunt this limited threat potential. However, the WMD case is very challenging because the price of U.S. failure to respond in some manner to WMD could be high in political, if not military, terms. Since these risks are very real but incalculable, it is impossible to calculate analytically what should be expended on the development and deployment of TMD systems, as well as on directly related intelligence, surveillance, and reconnaissance, in an attempt to mitigate the risks, so value judgments must be made. Fortunately, there is only a limited set of candidate "solutions" from which the United States can pick and choose. As these decisions are made, it is likely that TMD efforts will be focused on countering WMD threats.

The United States will attempt to field capabilities that can *deny* damage from WMD threats, but it is not possible to create a perfect defense.[12] Force developers will therefore want to create TMD systems that are good enough to make the entry price for potential opponents high enough (at best) to discourage them from developing a missile delivery capability in the first place or (at least) to increase their uncertainty of success and risk of failure, should they contemplate using WMD. The TMD system should provide "enough" protection from a conservative defense viewpoint that the United States is not deterred by the prospect of missileborne WMD attacks. Unfortunately, these complex judgments must be reviewed periodically and adjustments must be made to our TMD efforts as the political situation, emerging threats, operational experience, and technological opportunities unfold. Once the United States commits itself to pursue substantial TMD capabilities, the dynamic (and potentially very costly) action-reaction process with a determined adversary could be prolonged.

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[12]But what will decisionmakers and military planners *believe* about the effectiveness of their defenses? Unfortunately, these "beliefs" are unlikely to be well founded in careful, "real-world" tests and exercises but almost surely will not be the result of real wartime experience. This inherent uncertainty in the effectiveness of complex, scenario-dependent systems, such as TMD and NMD, has a dangerous aspect: Might our overconfidence in defenses make us more prone to taking risks we should not? What if we came to depend on defenses and they failed us? What is our fallback strategy to win this war? What about the next war—will we have to completely reshape and rebuild our military forces?

TMD Concepts of Operation

All TMD architectures have four components:

1. **active defenses,** of several distinctly different types:
   - terminal defense, in which intercepts occur primarily within the atmosphere (e.g., PAC-3, located near the targets to be defended)
   - midcourse defense, in which intercepts occur after booster burnout, but before warheads reenter the atmosphere (e.g., THAAD or Navy Theater-Wide [NTW], which covers a large area)
   - boost-phase or ascent-phase intercept defense, which would, for example, require a system of forward-operating aircraft with high-energy lasers or capable of launching hypersonic interceptors at a missile with its warhead still attached to the burning rocket motor during its boost phase or intercept of the separated warhead post boost in its ascent phase before it reaches apogee.
2. **counterforce operations** (e.g., air-to-ground or ground-to-ground systems to attack TBM infrastructure and transporter-erector-launchers [TELs]) *before, during, or after the launch of missiles*)
3. **passive defenses** (e.g., hardened aircraft shelters and revetments, suits, masks, and collective protective shelters to protect against the use of chemical and biological agents, mobility, counterforce, camouflage, concealment, and deception)
4. **battle management and command, control, communications, computers, intelligence, surveillance, and reconnaissance (BM/C^{4}ISR).**

As pictured in Figure 8.1, the overall TMD concept involves an integrated joint-service "system of systems" comprising Army, Navy, and Air Force elements. The following paragraphs will focus on the Air Force components of this system.

The Air Force is currently pursuing counterforce operations and active defenses, as outlined in Figure 8.2. Pre- and postlaunch counterforce concepts of operation (CONOPs) build on dedicated non-

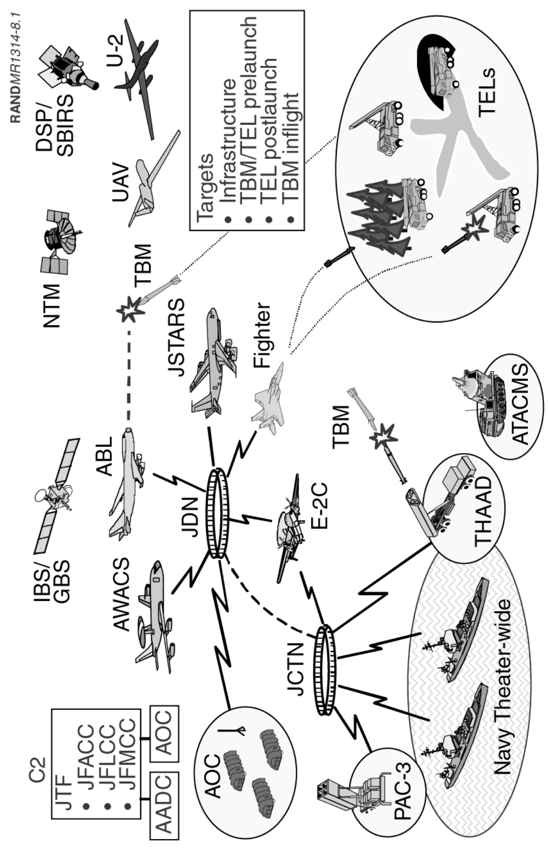

Figure 8.1—Joint-Service TMD Architecture Programs for Dealing with the TMD Problem

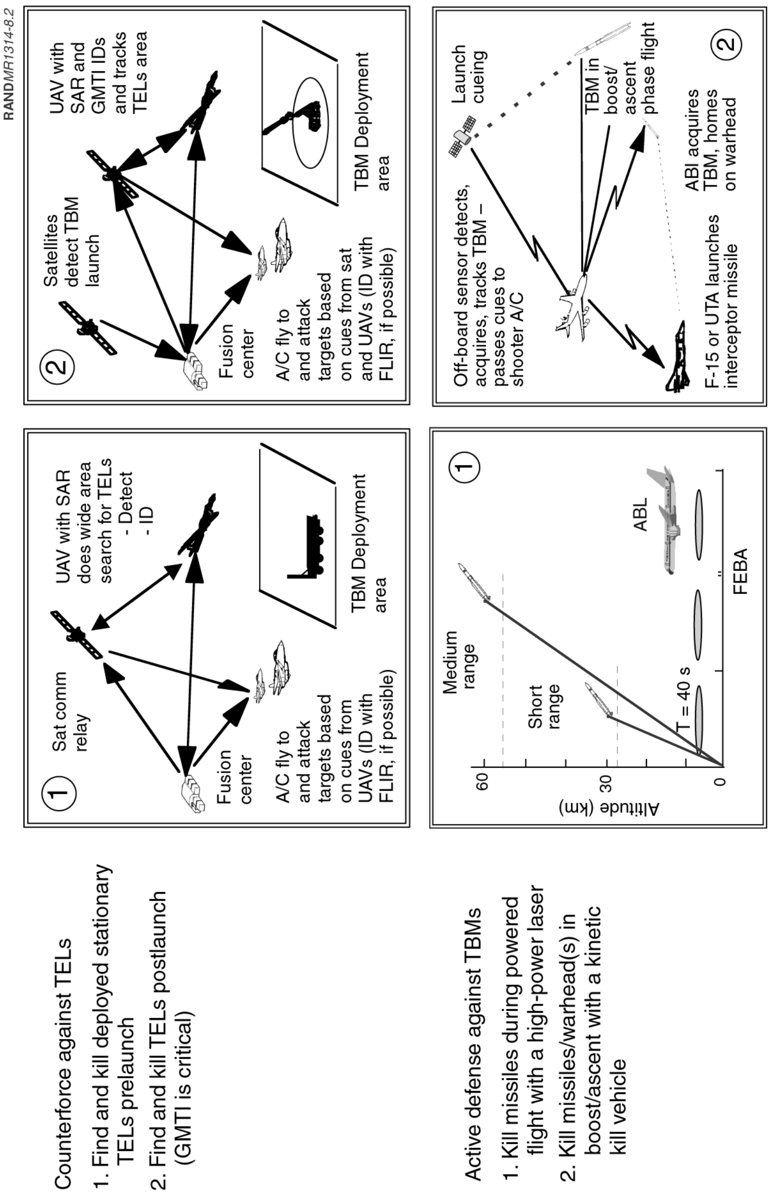

Figure 8.2—A Broad Range of Potential Air Force TMD CONOPs

TMD Air Force systems in the field or under development with the support of improved C^4ISR systems and operations. The ABL system is an Air Force active defense system currently under development, while the airborne interceptor (ABI) is a conceptual extension of air-to-air systems and capabilities, again with appropriate supporting C^4ISR advances, but ABI is not currently under development within the Air Force.

Counterforce Operations. Prelaunch counterforce CONOPs involve sensors on various platforms—satellites, stand-off aircraft, and UAVs—to find, identify, track, and target mobile TELs used to carry and launch TBMs. It is assumed that the enemy will keep his TELs hidden (in caves, warehouses, under bridges, etc.) until just prior to launch. The TELs will leave their hides and/or resupply bases and move to a safe distance to set up for launch. After launch, the TELs will move off as quickly as possible to a hide. Total exposure times for this cycle during prelaunch activities might range from 30 minutes to a couple of hours, with similar exposures postlaunch.[13] There will likely be no radio frequency emissions at any point when the TEL is in the open.

Within the brief prelaunch exposure period, the surveillance systems must be able to search the entire deployment area (which could be thousands of square kilometers, depending on intelligence preparation of the battlespace (IPB) for moving or stationary TELs, detect and identify them, and pass the information to the attack systems, which must then respond within minutes—a very challenging set of tasks. It implies multisource data fusion; close coordination and cueing between ground moving target indication (GMTI) and all-weather, day-and-night imaging systems, such as synthetic aperture radars (SARs); very high search rates; near-continuous deep dwell; and advances in moving target identification and high-resolution (<1 m) imagery with automatic target cueing (ATC) and automatic target recognition (ATR) processing to achieve a high probability of

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[13]There are, of course, several feasible variations on this generic enemy TBM concept of execution in which the timelines could be more or less stressing. For example, in North Korea, the TELs could be hidden in specially fortified caves (of which there are several hundred) and could be launched from just outside the portal blast doors. This would eliminate TEL travel exposure entirely, but the Koreans would have to be confident that the TELs and reload TBMs inside the caves were safe from U.S. attack after the initial launches compromised the locations.

TEL detection and recognition with manageable false alarm rates.[14] The current state of the art is not yet up to this challenge, other than under admittedly very optimistic assumptions (good IPB localization, open desert terrain, etc.). This discussion will be more explicit and quantitative about the admittedly optimistic assumptions it will use to provide an interesting point of departure in the sensitivity analyses to follow.

Postlaunch counterforce operations can take advantage of the cue from the missile launch detected by the Defense Support Program infrared satellites or by its follow-on, the Space-Based Infrared System–High (SBIRS-High). This will allow operators to immediately focus intelligence, surveillance, and reconnaissance and attack assets on a very limited area. Of course, this area might be deep in enemy territory, so the sensors, attack platforms, and command links will have to reach deep in a timely manner and/or have appropriate survivability enhancements (e.g., stealth). GMTI and SAR capabilities will need to have improved resolution and ATC/ATR capabilities for this mission, as well as for the prelaunch mission.

Active Defenses. The ABL concept employs a multimegawatt chemical laser with a lethal range of several hundred kilometers. An advantage of the this concept is that destruction of the booster during the boost phase will cause the warhead to fall short of its target—possibly impacting in the adversary's territory. In addition, engagement during the boost phase can defeat the use of decoy warheads and many other countermeasures, multiple warheads, and submunitions (a particular concern with chemical or biological threats and a real challenge to midcourse and terminal intercept defense systems, such as NTW and PAC-3).

The ABL concept consists of placing a laser-armed 747-400 in an airborne orbit at a safe standoff distance from enemy territory and above the cloud layers (which are typically below 10 to 15 km in altitude). During engagements, the ABL tracks the booster's plume signature, slews the laser in the direction of the rising TBM, and maintains the laser spot on the booster for several seconds, which heats

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[14]Hyperspectral imaging (HSI) is promising technology in this regard. Of course, the HSI sensors must be on suitable platforms (e.g., UAVs), and integrated into an effective overall C^4ISR architecture (including near–real time sensor tasking, data fusion, analysis, and dissemination).

the pressurized missile body, resulting in a catastrophic stress failure that explodes the booster.

The ABL fuel magazine is planned to be sufficient to negate about 10 to 20 missiles, depending on the dwell time required for booster destruction. Currently, a prototype 747-400 ABL system is planned to demonstrate track, dwell, and kill for a boosting missile body in 2003.

Responsive threats to an ABL defense include tactics and technology that exhaust the laser magazine or increase the attack time needed to destroy each booster. By far the most probable response is a saturation missile attack, or near-simultaneous multiple attacks. Figure 8.3 shows a notional ABL effectiveness against multiple launch threats for a laser magazine that could generate intercept attacks lasting a total of 100 seconds. The number of boosters killed is shown as a function of booster-to-booster launch delay and total laser attack times of 5 and 10 seconds. For typical Scud engagement parameters, the attack time for the first missile would be about 12 seconds; the

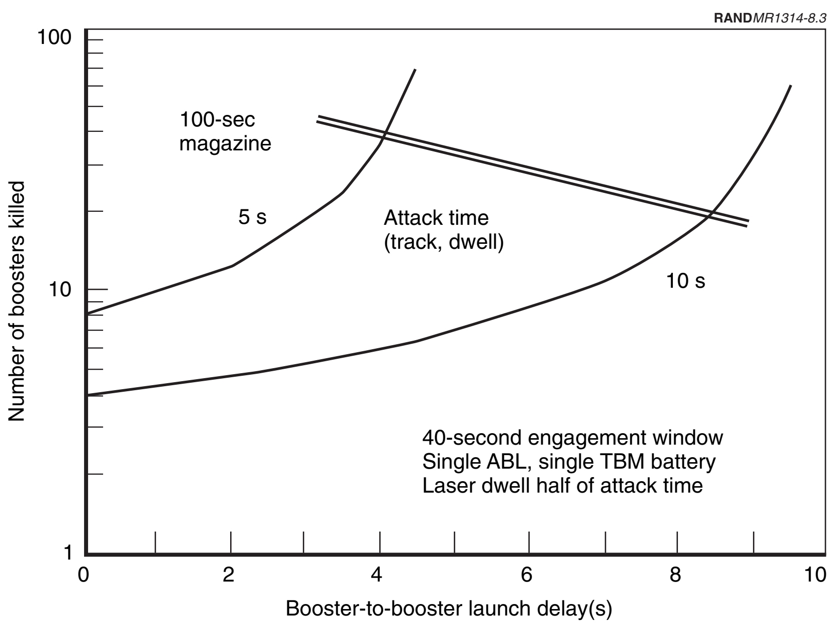

Figure 8.3—Notional ABL Effectiveness Against Saturation Attack

time would be 8 seconds for successive missiles, since course detection and turret slew times are not repeated. A 10-second attack time with a 100-second magazine can result in about 10 TBM kills.

The inherent antisatellite capability of the ABL requires a careful accounting of the ephemeris data of friendly and third-party satellites that are potentially susceptible to unintended exposure. This would be necessary to avoid accidental collateral damage and to avoid accusations that the United States conducted an antisatellite attack. This would also require keeping records of lasing directions and times to provide a format for assessing the impact of ABL operations.

Another defense concept is to employ an ABI, a missile that can be launched from a fighter or an unmanned tactical aircraft (UTA).[15] The objective would be to destroy the TBM during boost or early ascent (after burnout but before payload separation) with a kinetic kill interceptor, which has a standoff range of hundreds of kilometers. A potential advantage of this approach is that the ABI might be directed to impact and destroy the warhead; the ABL concept, in contrast, targets the pressurized booster. The intercept is, of course, slower than the speed-of-light laser, but the ABI's extended engagement window combined with the laser's requirement to lase the booster for several seconds may offset the difference.

The effectiveness of the ABI depends on achieving a high average intercept velocity of about 3,000 to 4,000 m/s to reach the target quickly for a kinetic energy impact. Offboard sensors are needed for initial detection, for acquisition, and for tracking the TBM before passing the tracking cues to the ABI platform. The performance of the ABI will depend on the type of acquisition system used, such as radar or infrared search and track sensors. A potential advantage of this concept is that the ABI platforms may be stealthier and smaller than the ABL and could thus be fielded in much larger numbers. ABI platforms will almost certainly be better able to operate within threat areas, where the large ABL aircraft could not fly safely, and therefore may be able to exploit threat localization to allow effective shorter-range intercepts. While the technology currently exists for develop-

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[15]See Vaughan, Isaacson, and Kvitky (1996). Presently, such vehicles are called *unmanned combat aerial vehicles* (UCAVs).

ing an ABI, no effort to develop this defense concept is currently being funded, to the best of our knowledge.[16]

TMD Effectiveness Analyses

Counterforce limitations were clearly demonstrated during the Gulf War. From today's perspective, it seems clear that high levels of robust counterforce effectiveness will, with one significant exception, require advances in sensors and sensor processing that may not be achievable. Effective *prelaunch* TEL kills will be a matter of effective all-source (particularly human) intelligence data collection, data fusion, and luck. But the good news is that even a little prelaunch counterforce capability can be significant over the course of a war.

For example, assume that

1. IPB has localized the TBM threat to an area, A, of 2,500 km^2.
2. The search rate, R, is 1,000 km^2/hr (against a stationary target).[17]
3. The TEL is stationary in the open for T = 0.5 hr.
4. P_d x P_{ID} is 0.8; R_{fa} is the false alarm rate (number per km^2), e.g., 0.05.
5. If cued, the shooter can effectively engage the target (P_k = 1.0).
6. R_w is the rate targets can be attacked, e.g., 12 per hour.

Then, *prelaunch attrition* will be

$$P_A = \min\left[\frac{1,(R \text{ x } T)}{A}\right] \times \left(P_d \times P_{ID}\right) \times P_k \left[\frac{1, R_w}{\left(R \times R_{fa}\right)}\right]$$
$$= \left[\frac{1{,}000 \times 0.5}{2{,}500}\right] \times \left(0.8\right) \times 1.0 \times \left[\frac{12}{500 \times 0.04}\right]$$
$$= 0.1$$

[16]The sticky technologies tend to be homing and terminal guidance. While the state of the art in individual technologies is not inconsistent with a successful ABI (or any hit-to-kill system, for that matter), systems integration challenges are daunting.

[17]If search were for a *moving* TEL the negative exponential would apply: P = 1 – exp(–(R x T) / A). (Note that for small values of X, 1 – exp(–X) ≈X.)

This example uses very optimistic assumptions (particularly for IPB and search rates), but each time a TEL comes out of its hide to attempt to launch a missile, there is still only one chance in ten that it will be found and killed before it launches. As will be discussed later, even this limited prelaunch kill capability may be significant over the course of an entire campaign.

The exception to our generally pessimistic projections regarding counterforce effectiveness is *postlaunch* TEL kills. This is an exception simply because the game starts with a very observable event—the launch of a missile—that is impossible to mask. Within several tens of seconds of a launch, U.S. forces in the theater will likely be able to determine fairly precisely where the launch occurred, and tactical controllers, if they act promptly, may be able to direct intelligence, surveillance, and reconnaissance assets and/or shooters to find and track and/or destroy the TEL.

If we expand counterforce attack operations to include postlaunch kill attempts, as well as prelaunch attacks, Figure 8.4 presents the resulting counterforce effectiveness for the example case outlined in the box on the left.[18] Most of the kills in this example occur as the TEL runs to its hide after missile launch.

Because of this, and because the only way U.S. forces currently have to identify moving vehicles is to get fairly close to them (e.g., from a few kilometers up to about 10 km) and use a forward-looking infrared system or to have the pilot visually identify the vehicle, these results are sensitive to the total number of moving vehicles (TELs and non-TELs) in the threat area. Figure 8.5 shows this sensitivity for two representative road densities as a function of the traffic on the roads. The concepts and technologies for moving target exploitation may thus be as critical as ATC/ATR.

Since counterforce operations are unlikely to be 100-percent effective (an understatement, given our Desert Storm experience), a prudent planner must expect that a substantial number of missiles will

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[18]Note that "MTID" refers to the ability to identify moving targets. Currently MTID is limited to electro-optical and infrared systems. The JSTARS MTI radar can, however, do a rough moving target *classification* between tracked and wheeled vehicles by virtue of the double Doppler returns from the tracks.

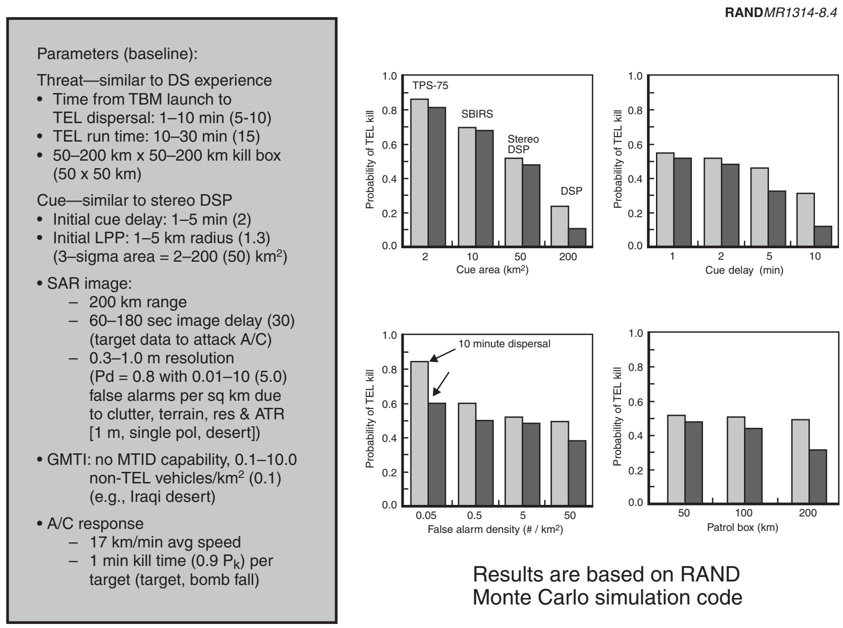


Figure 8.4—Sensitivity of Combined Prelaunch and Postlaunch Attack to C4ISR Parameters

be launched. These TBMs become a problem for active defenses. The Air Force's ABL should get the first shot during the boost phase. If enemy salvos saturate the ABL system, the "leakers" that get through must be intercepted by midcourse and terminal defenses, such as the Aegis-based NTW and Navy Area Defense (NAD) systems, THAAD, and Patriot PAC-3.

How effective might the integrated TMD elements be? This is difficult to predict, but the potential value of even rather modest (though optimistic) capabilities can be dramatic. Figure 8.6 provides a quantitative example of the potential combined effectiveness of Air Force counterforce (pre- and postlaunch) and ABL operations. The baseline case presumes a 0.1 prelaunch TEL/TBM kill probability (per launch attempt). The postlaunch TEL kill probability is assumed to be 0.3 (per launch). In addition, we have assumed that the ABL can

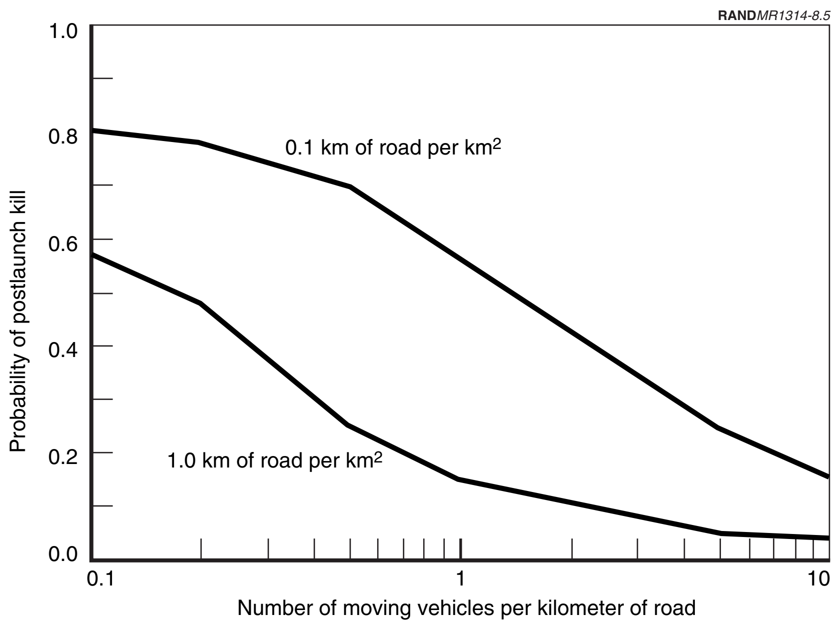


Figure 8.5—Sensitivity of Postlaunch Attack Operations to Moving Vehicle Clutter

engage up to 10 missiles launched in a salvo, achieving a 0.9 kill probability on each.

The net effect of these capabilities in a hypothetical MTW that includes TBM attacks by the adversary is shown in Figure 8.6. This discussion assumes that the enemy has 50 TELs, each with several reload TBMs,[19] and is able to launch one missile a day from each TEL. It is also assumed that these launches would occur in a salvos in an attempt to saturate the defenses and increase the number that get through to strike their targets.

The solid curve in Figure 8.6 shows the number of TBMs launched each day, assuming a maximum effort by the enemy. The first day, only 45 were launched because 10 percent of the initial 50 TELs were

[19]The intelligence community thought that Saddam had less than two dozen TELs and over 800 Scuds.

killed by prelaunch counterforce operations as they prepared to launch. Of the 45 launches, the ABL could engage only ten but killed nine. Therefore, 45 – 9 = 36 TBMs made it through the layered Air Force TMD systems (and would, therefore, have to be engaged by the Army and Navy active defense systems not modeled explicitly here). So far, this does not seem like much of an Air Force missile defense accomplishment, but the situation improves as the war progresses. As irreplaceable TELs are killed, salvo rates go down, and fewer TBMs get through. In fact, by day five, the ABL can no longer be saturated. Within a week or two, expected leakage has decreased to very low levels (e.g., <0.01 per day). In effect, all the remaining reload TBMs have been grounded, ending the TBM threat to coalition forces.

Note that this primarily resulted from successful counterforce attacks, both prelaunch and postlaunch. How sensitive are these results to the assumed capabilities? Figure 8.7 provides quantitative answers. In these graphs all the baseline parameters and scenario assumptions are the same as in Figure 8.6, except for the parameter

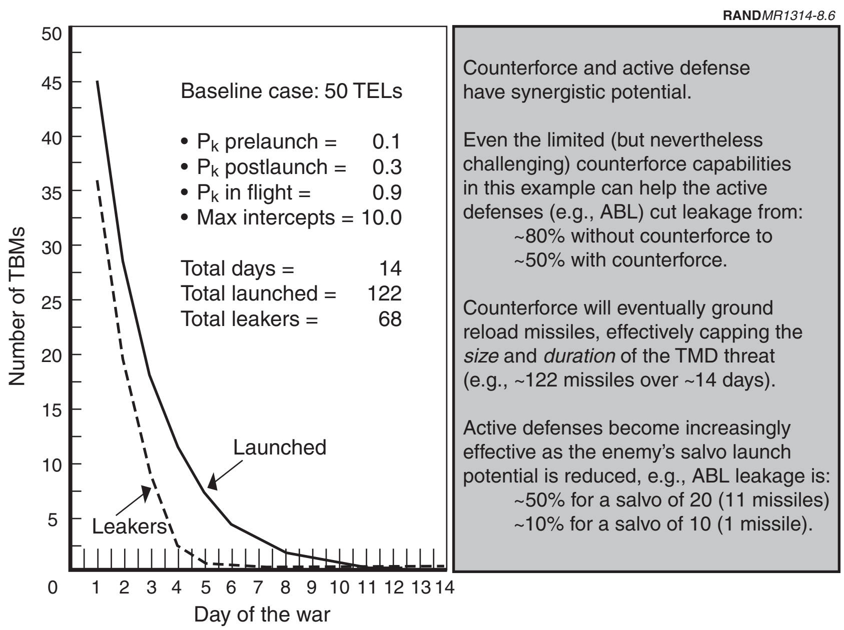
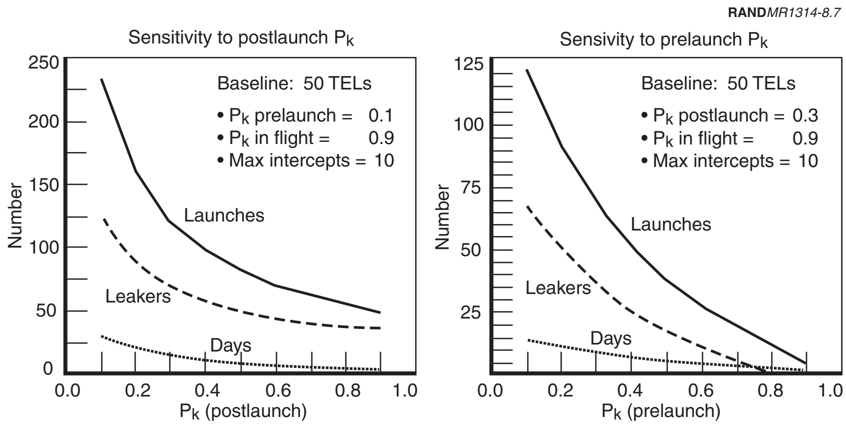


Figure 8.6—The Significant Synergistic Potential of Air Force TMD CONOPs



Postlaunch counterforce is less challenging than prelaunch counterforce due to (robust) potential to exploit TBM launch signatures.

If the threat includes multiple TBM reloads per TEL, feasible postlaunch counterforce capabilities may be much more significant than feasible prelaunch capabilities.

C^4ISR approaches to enhance postlaunch counterforce are better understood than for prelaunch—progress can be achieved quickly at the margin rather than only after unpredictable technological breakthroughs (e.g., ATC/ATR, multispectral data fusion).

Figure 8.7—The Effects of Small Improvements in Counterforce Capabilities

on the abscissa—either the prelaunch or postlaunch probability of kill (P_k). The measures of effectiveness (MOEs) here are (a) the total launches over the entire campaign, (b) the total leakers, and (c) the length of the campaign (time to achieve <0.01 expected leakers per day). Note that, for the baseline case, these values were (a) 122 successful launches, (b) 68 leakers, and (c) 14 days.

The good news from Figure 8.7 is that improvements *either* to postlaunch P_k *or* to prelaunch P_k can improve campaign MOEs dramatically. If prelaunch effectiveness proves too difficult (or too costly), the Air Force might be well advised to focus on postlaunch operations, which most likely can be more effective and robust at affordable investment levels. The costs, of course, have to be determined, but the *relative* difficulty between pre- and postlaunch missions suggests that a given level of postlaunch capability should be less costly than the same level of prelaunch capability.[20]

As noted above, postlaunch counterforce effectiveness is sensitive to the ability to locate the moving TEL in the presence of other moving ground clutter. Figure 8.8 shows the sensitivity of integrated defenses to moving vehicle clutter. Clearly, as with needed ATC/ATR advances in imagery exploitation, advances in moving target exploitation are uncertain, but their potential value suggests that aggressive research programs are warranted (as ideas permit).

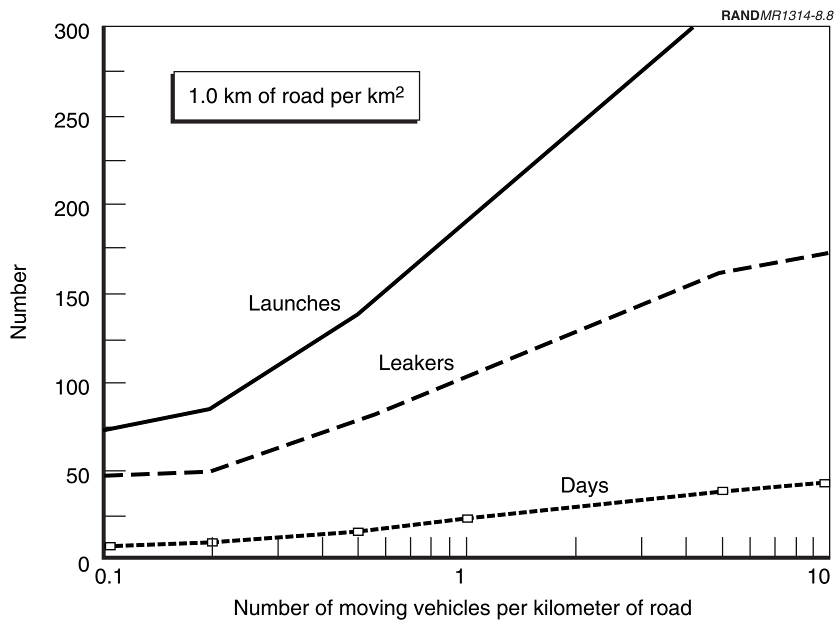


Figure 8.8—The Strong Effect of Moving Vehicle Clutter on Overall TMD Effectiveness

[20]Of course, the value of postlaunch kills depends to a great degree on the ratio of reload missiles to TELs (high for Scud systems). If TELS become one-shot "throw-aways," the main value of postlaunch kills is their negative effect on the morale and willingness to fight of missile crews. These postlaunch operations may also help us get a better idea of TEL operations, which may improve our prelaunch kill effectiveness.

Figure 8.9 looks at sensitivities to ABL performance parameters. In this case, the MOE is total TBM leakers over the campaign. The two curves are for the baseline salvo handling potential (10) and an enhanced capability (20). Note that, for either of these curves, the sensitivity to P_k (in flight) is not very dramatic within reasonable ranges.[21] For example, the top curve illustrates that the difference in total leakage between a P_k of 0.9 and 0.7 is 68 to 78, or just a 15-percent increase in leakage for a 22-percent reduction in P_k.

Finally, note that the notional layered Air Force contribution to the composite U.S. TMD system has not been able to enforce the extremely low leakage levels that might be a goal in a WMD-shadowed war. But it has greatly reduced the threats that the mid-course and terminal defenses must counter, significantly increasing the potential for near-zero leakage from the multilayered, system-of-systems TMD architecture.

As with the ABL, the effectiveness of other active defenses is enhanced as the adversary's salvo launch capability is reduced, such as by counterforce actions. The ABL system can provide early launch warning and can estimate launch and target impact points to support other TMD elements. This would include handing over track files for the missiles that get through and damaged booster and warhead debris maps to terminal defenses, such as THAAD, PAC-3, and NTW/NAD.

The ABI concept could complement the ABL defense approach by helping to fill gaps in the ABL coverage and could therefore increase the overall boost- and ascent-phase intercept potential, increasing salvo handling potential. Multiphenomenology active defenses would also improve robustness to countermeasures. The C^4ISR considerations for the ABI are similar to those for the ABL.

This layered defense theme is displayed in the trajectory chart in Figure 8.10. The box for each period briefly describes (a) the CONOPs, (b) the platforms and weapons, and (c) the C^4ISR support.

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[21] "Reasonable" should not be construed in this context as "achievable." These effectiveness numbers are "reasonable" design goals. Actual performance will depend on technological, engineering, and operational ingenuity, as well as on the creativity and effectiveness of responsive enemy countermeasures.

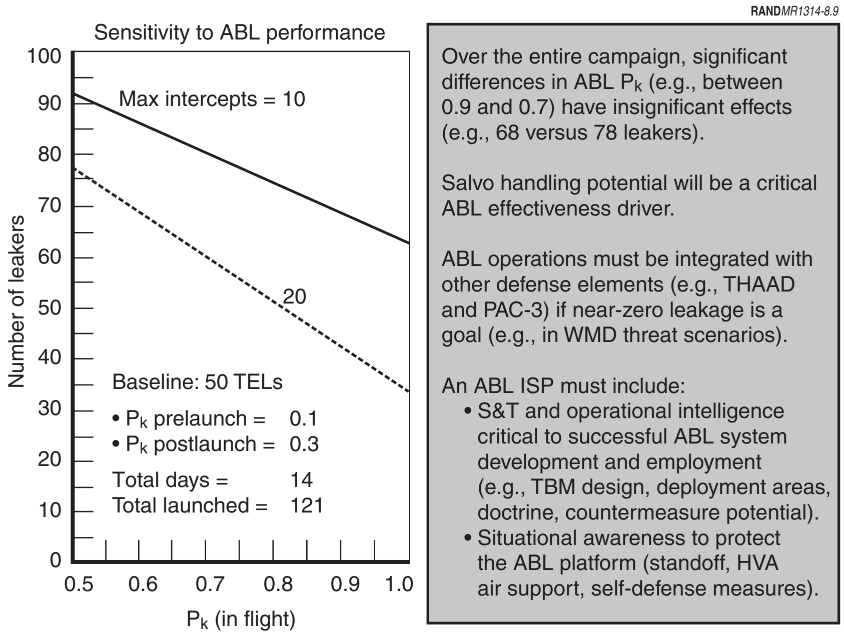

Figure 8.9—The Sensitivity of ABL Performance Salvo Handling and Lethality

Current TMD capabilities are very limited. In the near term, the principal thrust will be the addition of Army and Navy surface-based active defenses, with appropriate C^4ISR support to integrate the systems into a multilayer defense. In the far term, these defenses may be augmented with Air Force boost-phase intercept defenses and improved counterforce capabilities (as technology permits), greatly increasing the effectiveness and robustness of the overall TMD architecture.

Table 8.3 summarizes some first principles for TMD. Prelaunch counterforce is very challenging. It will require new enabling C^4ISR capabilities, such as deep dwell GMTI/SAR systems with enhanced ATC/ATR processors on survivable platforms with search rates and resolution much greater than currently achievable (for "reasonable" assumptions about IBP effectiveness), in combination with CONOPs

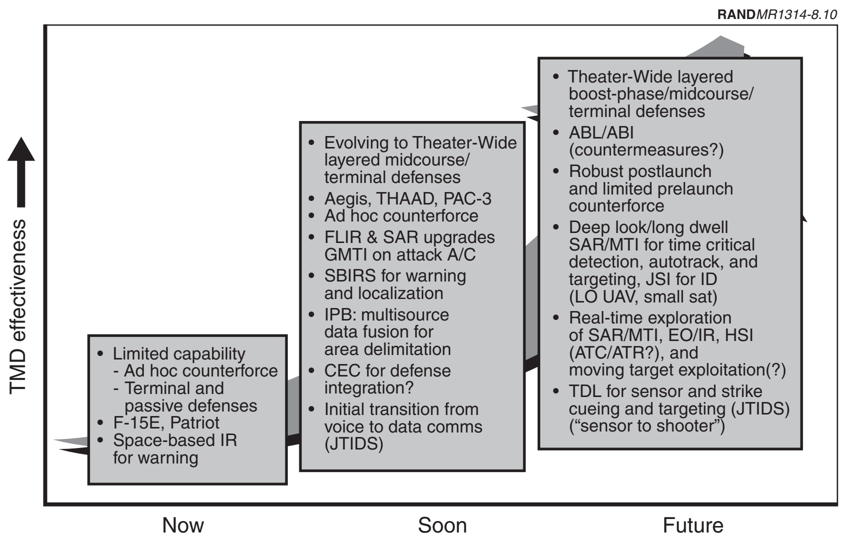

Figure 8.10—Air Force Capabilities for Shaping the Potential TMD Trajectory

that allow controllers to bring attacks to bear while the TEL is in the open. However, commitments to specific prelaunch counterforce CONOPs and system elements may not be appropriate until required advances in the state of the art (e.g., ATR) have been demonstrated under realistic operational conditions.

The same caution, of course, applies to postlaunch counterforce CONOPs, but the near-term potential is greater there. The Air Force does not yet have well-developed postlaunch counterforce operations, but has fielded or is fielding some critical C^4ISR investments (e.g., Attack and Launch Early Reporting to Theater, SBIRS-High). In addition, similar, but more modest, GMTI/SAR improvements than for prelaunch counterforce above will be required for effective and robust postlaunch attack operations. A significant unknown at this point is the moving target clutter problem, which may necessitate advances in moving target exploitation that are difficult to forecast.

The ABL development program is well under way. It is essential to develop C^4ISR architectures to support the ABL, recognizing that it

Table 8.3

New C^{4}ISR Capabilities Needed for TMD

	Capabilities	What the analysis has shown:
Counterforce against TELs	Find and kill deployed TELs prelaunch	This is very challenging.
		"Hiders and finders" favors hiders.
		Key C^{4}ISR issues are deep dwell/increased search rate at <1-m resolution and orders of magnitude advances in ATC/ATR Pd/Pfa and near-real-time shooter redirection (Joint Tactical Information Distribution System [JTIDS]. SAR/GMTI/HSI sensors on low-observability UAVs or satellites? Unattended ground sensors [UGSs]?).
	Find and kill deployed TELS postlaunch	This is less challenging.
		Enemy cannot hide launch signature.
		Key C^{4}ISR issues are time-urgent exploitation of SBIRS cues using deep dwell SAR/GMTI sensors to image, identify, and track TELs, redirect sensors and shooters (JTIDS+, SAR/GMTI/HSI sensors on observability UAVs or satellites? UGS?).
Active defense against TBMs	Kill missiles during powered flight with a high-power laser	The ABL will require significant C^{4}ISR support.
		Intelligence (science and technology on TBM design and signatures, countermeasures?).

Table 8.3—Continued

Capabilities	What the analysis has shown:
	Operations support (e.g., IPB and situational awareness interface (Cooperative Engagement Capability–like) with other defense elements (THAAD, PAC-3 and Aegis).
Kill missiles/warheads(s) in boost/ascent with a kinetic kill vehicle	ABIs may complement ABL.
	C^4ISR issues probably less stressful than for ABL (CONOPs and systems to be determined).

will be part of a layered TMD architecture. The ABL concept can engage a limited number of TBM boosters *autonomously* but cannot operate effectively in *isolation*. To be effective, the ABL needs to be integrated with the other TMD elements—particularly if the overall multitier TMD system seeks to achieve near-zero leakage with high confidence. The ABL system requires significant C^4ISR support in science and technology areas and in IPB. For science and technology, it is important to know the technical characteristics of the threat missiles, such as burn time, booster material and thickness, plume characterization (relative to the booster body), and possible countermeasures. IPB includes intelligence on potential locations of TBM launchers and air defense threats to the ABL to allow establishment of a safe but effective standoff distance and orbit parameters. As with other weapon systems under development, these issues must be addressed early for the ABL in an evolving intelligence support plan.

ABI concepts are less well developed than those for the ABL. If ABI systems are pursued, it would seem that the required C^4ISR support will be similar to that for ABL, but differences may emerge due to (1) different lethality mechanisms (kinetic kill of the missile payload versus laser kill of the booster), (2) different defense platform characteristics and operations,[22] and (3) different IPB and situational awareness needs (associated with intercept range and overflight differences).

These TMD programs have exciting potential, but this potential can only be achieved through focused developments in enabling C^4ISR systems.

POTENTIAL AIR FORCE NMD INITIATIVES

Deploying NMD, also referred to as antiballistic missile (ABM) defense, to protect the United States from long-range ballistic missile attack[23] seems, on the surface, to be a good idea. In fact, many

[22]ABI may be based on a relatively small and survivable fighter aircraft or UCAV rather than on the large ABL aircraft. but ABI will likely depend on offboard battle management, cueing, and intercept support. ABI may overfly hostile territory (depending on the size of the country and the location of the TBM launchers), but ABL will stand off.

[23]These missiles may be launched intentionally, accidentally, or without leadership authorization by a rogue commander. Of these possibilities, this chapter focuses on the first.

Americans evidently believe that this capability already exists. When told the actual situation, most favor developing and fielding an NMD system. Unfortunately, however, as this section tries to show, the NMD decision is much more complex than "the conventional wisdom," as expressed by polls, would seem to suggest.

It is, of course, a basic purpose of governments to protect their people from foreign threats. Countries, like individuals, have a "moral imperative" for self-defense. Many see the proliferation of WMD and long-range delivery systems, particularly ballistic missiles, as a threat to our national security, if not now, then surely in the future. So, in turn, many see NMD as a moral imperative.

But an NMD system is only one of several approaches to countering WMD threats to the United States. Not all approaches are compatible or certain to succeed. All compete for resources. This section outlines some of the NMD and related TMD issues, culminating with some impressions on the nature of possible solutions to these problems—solutions that will require the United States to recognize that NMD and TMD issues cannot successfully be resolved "on their own" but rather must be considered in a broader national security context, which will require debate on matters that are much more troublesome and morally uncertain than the self-defense imperative.

Background: The Cold War

One aspect of the moral dilemma was clear in the Cold War years. As delivery systems advanced from bombers to cruise missiles and then to ballistic missiles with increasing ranges, accuracies, and explosive yields, the offensive nuclear threat reached the point that the United States and the Soviet Union could "destroy" each other several times over.

The destructive potential of thousands of megatons of nuclear yield is difficult to grasp—there is obviously no historical precedent. But our limited vision was clear enough: Unconstrained nuclear war between the United States and the Soviet Union would surely be a catastrophe of unprecedented scale. While much intellectual capital was expended debating concepts of nuclear deterrence and the nuclear balance, survival, warfighting, and even "victory," it became clear that the most fundamental common goal had to be avoiding war. Given the ideological differences and inherent tension between the protagonists, war, in particular nuclear war, was avoided through deterrence, which, when stripped bare of the "details," came down to a very understandable concept: Mutual deterrence came from both sides having the assured capability to inflict massive, "unacceptable" damage on the other, even after absorbing a would-be disarming first strike. Most people considered this standoff, with both sides vulnerable to "assured destruction," to be morally justified because its goal was to avoid war—if it failed, there would be hell to pay.

The primary strategic tension in the Cold War was between defensive and offensive concepts.[24] The offense won because the defenses conceivable at the time could not fundamentally change the vulnerability of both sides to devastating retaliation under any circumstance of war initiation. This was so despite the fervent desire President Ronald Reagan articulated in 1983 to make nuclear-armed ballistic missiles "impotent and obsolete." To see this, however, defense planners had to take the long view. That is, the development and deployment of NMD systems was not something that could, in effect, eliminate the nuclear balance of terror between two determined and capable adversaries. It takes time to develop and field NMD systems. The adversary will react to any change in a way that avoids putting himself in a position of inferiority.

Thus, the quest to develop and deploy a highly effective NMD should be viewed as part of a strategic chess game, which suggests that strategists and planners should look ahead for as many moves as they can before acting. When leaders on both sides did this during the Cold War, they saw dangerous instabilities that might emerge and the potential for an offensive *and* defensive arms race, both of which seemed to increase the risk that deterrence might fail. Moreover, the offense-defense balance seemed to continue clearly to favor the offense, so heavy investments in defenses would not only consume vast resources but also might prove counterproductive in the

[24]Defenses included civil defense measures (e.g., warning, evacuation plans, and fallout shelters), air defenses, and eventually limited BMD. Offensive capabilities were also referred to as "damage limiting"—a kind of "defense" that reflects the old adage that the best defense is a good offense (unfortunately, to work best, the offense has to preempt, which is not comforting from the perspective of stability in a crisis). Note that these various elements of a defensive strategy (passive, active, offensive, and BM/C^{4}ISR) are the so-called "four pillars" that the Strategic Defense Initiative Office (SDIO), Ballistic Missile Defense Organization, has discussed in their architectural efforts, which have, so far, emphasized the active defense pillar.

long run. Since deterrence was the U.S. strategic nuclear cornerstone, anything that could conceivably weaken it (no matter how well intentioned or "moral," e.g., "defensive") was rejected.

So, while technologists continued to study strategic defenses in the hopes that "advanced technology" could change the conclusions about the inadequacy of NMD relative to offensive threats, the policy focus shifted toward arms control solutions with the conclusion of the SALT I agreement and the ABM Treaty of 1972. Since then, the SALT II, START I, and START II agreements have clearly reduced the risk of superpower nuclear war. Today, no one questions the cliché that "the Cold War is over." But that does not mean that the lessons the competition between offensive and defensive capabilities taught have been overturned.

Post–Cold War Issues

Setting aside, for now, such residual Cold War issues as "minimum" deterrence, the ABM Treaty, and the risks of accidental or unauthorized launch, as well as the lessons learned, let us turn to the contemporary rationale for the pursuit of a limited NMD capability: proliferation of WMD and intercontinental ballistic missiles (ICBMs) to deliver them.

Again, there seems to be a moral imperative connecting NMD to TMD: How can the United States justify the expense of protecting its troops, friends, and allies with TMD while not providing protection to its own homeland with NMD that can cope with a relatively limited long-range missile attack? The NMD arguments in this context, pro and con, tend to be driven by assessments of the *urgency of* (rather than the *rationale for*—which is seldom debated) deploying a limited NMD, which, in turn, is directly related to assessments of "the threat."[25] The threat, of course, is the seemingly inevitable acquisition of the appropriate hardware systems (e.g., WMD mated to ICBMs) by potentially hostile so-called "rogue states" or "states of

[25]The "threat" discussions tend to focus on hardware rather than how and why that hardware might be used. This is natural because hardware is tangible; intent is not. Nevertheless, while some elements of intent can be inferred from the hardware (e.g., missile range determines potential targets), the "threat" descriptions and uncertainties here should be treated much less simplistically—the missiles, per se, are not "the threat."

concern" (e.g., Iran and North Korea).[26] The pro-NMD supporters recommend getting started now, while the people who argue against NMD deployments say that, since the threat is still a ways off, the United States should pursue R&D efforts to assure that it will be able to deploy the most cost-effective limited NMD possible when the time comes.

One side argues that NMD is most certainly not "an ABM system" in the old Cold War sense, but the opposition wonders whether effective NMD deployments against proliferation threats can be consistent with the requirements of nuclear deterrence, given the deep reductions both sides are debating in informal "START III" discussions.

What about the ABM Treaty? Can it be modified to accommodate layered NMD systems that protect all 50 states? Can treaty-compliant NMD concepts be responsive to emerging threats? Must the United States withdraw from the treaty, or can the treaty be modified to permit the deployment of a limited NMD system with nationwide coverage that can address these emerging security needs? Many NMD proponents see the old Cold War problems and new proliferation problems as separable and as having solutions that are not necessarily incompatible.[27] The opponents of near-term NMD deployments may agree about this but, in any event, do not see the urgency. Certainly, some who argue for a "go slow" approach to NMD see the potential for conflict between historical lessons learned and new concerns about proliferation. However, as time has passed since the breakup of the Soviet Union, the Cold War issues have seemed less relevant and the new emerging threats have become more pressing for people on all sides of the debate. The United States must do *something* about proliferation—why not NMD?

It may be that the essence of the current NMD rationale is, in actuality, indistinguishable from the TMD rationale. The two will, at some

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[26]Note that this discussion does not include the "established" long-range missile threats from Russia and China.

[27]The United State's French allies have strong feelings about these matters. They see even limited NMD as potentially undermining their "minimum deterrent" nuclear forces. This should be a reminder that the NMD and TMD issues are distinctly multipolar and are hence even more complex than the ABM issues were in the bipolar Cold War context.

point in the development of these "regional threats," become logically inseparable as the reach of the rogue states becomes intercontinental. This simple point needs no further development (there is still the timing issue noted above, however).

It is paradoxical but conceivable that the old Cold War instability argument that was used *against* substantial U.S. and USSR missile defenses will be the principal argument *for* defenses in the future. The Cold War concern was that ABM defenses were destabilizing (bad) because, while they could not offer substantial protection against a well-conceived and executed massive first strike, they might be very effective against a much smaller, more ragged retaliatory strike. Therefore, in a crisis, the argument went, ABM defenses tended to favor the superpower that struck first—not a desirable situation from a crisis-stability perspective.

It could be argued that current U.S. moves toward the deployment of a limited NMD to counter proliferation of long-range missiles armed with WMD is turning this logic on its head. At least for the foreseeable future, the United States is not threatened with annihilation by a WMD-armed rogue proliferant. In a future regional crisis in which vital U.S. interests are at stake, the United States need not fear a preemptive strike by a proliferant armed with a handful of ICBMs.[28] It is much more likely that the rogue state will try to use its missileborne WMD to *deter us* from intervention in "its region" by threatening *retaliatory* strikes against us. Of course, for the same reason that it seems incredible that the rogue state would strike first against us, it also seems incredible that it would attempt to retaliate against us—its fate would surely be sealed by such a move, while the United States would survive (albeit somewhat bloodied). But unlikely as it seems in absolute terms, this sort of retaliation is *relatively more likely*, either as a last, vengeful act before being destroyed in a war against a U.S.-led coalition, or as an attempt, by marching up the

[28]The underlying assumption is that the United States will have the physical means and the national will to respond "appropriately" and that the potential attacker appreciates this. There is no doubt, as history demonstrates, that, if provoked, the people of the United States can be ruthless in response. Nevertheless, this area deserves much more careful thought and preparation so that the country can live with its actions (the moral issues) and so that the actions do not create a legacy of hatred, revenge, and alienation. The United States might be able to destroy a regional aggressor but may not be able to control the long-term repercussions.

escalation ladder, to stop that coalition short of total victory (even though its first step might be its last). If the rogue state's leadership were desperate enough or mad enough, it could strike out. Unfortunately, there is a good chance that the United States and its allies would be forced to put the rogue state into this position.

The logic behind this assertion runs as follows. If the United States backs down in a crisis with a rogue proliferant, the proliferant wins. If the rogue wins, proliferation will likely increase. If proliferation increases, risks of WMD use will increase. Clearly, the United States and other status quo powers would like to avoid that. So, if the vital interests of the United States are even *perceived* to be at stake, it cannot back down—it must prevail.

The United States could prevail in several ways. First, it could avoid the problem if its nonproliferation policies succeed, but that seems highly unlikely. Second, the United States could deny potential enemies a WMD capability through "preventive" attacks,[29] but this seems even more unlikely. Finally, the most likely scenario is that a would-be regional aggressor would provoke the United States, which would in turn apply decisive force to defeat him on the battlefield. But if the United States pushes such countries too far into a corner, they may strike back. Limited NMD is designed to be our hedge against desperation attacks.

NMD Systems Implications

If this perspective rings true, the kinds of limited NMD systems the United States might need to defend against attacks on the homeland by regional aggressors may resemble what the United States needs for TMD—in fact, some of the same systems *may* be able to do double duty.[30] The NMD system(s) need not be deployed and on high

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[29]"Preventive" attacks include such actions as the air strikes the Israelis carried out against the Iraqi Osirak nuclear reactor to prevent them from using it to produce nuclear weapons. The United States is most unlikely to take serious *overt* preventive military actions, although reputable senior people have discussed such actions (most recently with respect to the North Korean nuclear program). *Covert* actions may be another matter, however.

[30]The defense architecture to protect both theater and continental U.S. targets from attack could consist of conventional ground or ship-based radars and interceptors

alert every day, because a surprise attack is not credible. The NMD system also need not be sized to defeat "large" missile threats.[31] The issue of balance of defenses is less troublesome in these scenarios than it was during the Cold War and than it would be if the United States were concerned about surprise or "terrorist" attacks.[32] Mobile missile defense systems (which are not permitted under the ABM Treaty) would be desirable (assuming different threats had distinct coverage limits). Finally, the edge the United States has in technology and our relative wealth make an offensive-defensive arms race very unlikely—the United States ought to be able to keep up easily with any conceivable regional adversary. Of course, this may change at some point, which should be reason to think more seriously about "preventive attacks" than U.S. planners evidently have to date.

Returning to nuclear deterrence issues, missile defenses, both TMD and NMD, can conceivably be different enough in character, operation, size, and performance from robust NMD systems to allow superpowers to continue reducing offensive arms, whether negotiated or accomplished through parallel unilateral cuts. This is the problem that the United States should be pursuing in any ABM Treaty discussions with the Russians, instead of drawing technical distinctions between TMD and NMD, which are, at best, artificial and, at worst, seriously constraining. The most worrisome issue is China, since the Chinese are likely to attempt to increase their regional influence and may even have superpower pretensions. Their

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deployed in the theater and in or near the continental United States to provide layered engagement opportunities (e.g., midcourse, high-end, and terminal). Alternatively, TMD and/or NMD capabilities could, to use an example from colleague Glenn Kent, be provided by advanced boost-phase intercept systems deployed as a barrier over the threat region.

[31]This could be one way out of the strategic deterrence conflict, but the multipolar issues and concerns about verification and inherent potential for abuse (e.g., breakout) make success far from certain.

[32]The deficiencies in current U.S. defenses against cruise missiles, manned bombers, and even "suitcase bombs" relative to proposed NMD capabilities should be less an issue for the most worrisome retaliation scenarios discussed above. If ballistic missile threats exist and if the United States can react to them, it probably should, even though a vengeful enemy might also be able to plant nuclear "suitcase bombs" (or other, more likely, terror weapons) in U.S. cities. The underlying issue, of course, is affordability and balance in defense expenditures. There is no avoiding the need for difficult decisions that, in the end, must be based on informed judgments rather than precise calculations.

current strategic nuclear arsenal is quite small (two orders of magnitude below the Russian and U.S. arsenals, even at START II levels). That will make the distinction between theater and strategic ballistic missile defense more difficult to sell to the Chinese, possibly fueling an arms race like that of the Cold War. The Bush administration seems to be trying to link NMD with deep cuts in U.S. offensive nuclear forces. For China, the appeal of further force reductions as a NMD sweetener would seem to be minimal. Let us look at a simple example "calculus." To illustrate this point, consider the following.

In the current situation, the United States has several thousand nuclear weapons that threaten China, but no NMD. China has a couple tens of weapons that could reach (some part of) of the United States. Here, the bottom line is that neither side seems terribly troubled by this "correlation of strategic nuclear forces." While China would probably not mind if the numbers were a bit more balanced, it does not seem to be working very hard to achieve this sort of "essential equivalence," so its leaders must not be too concerned about the status quo. In this scenario, it is assumed that China considers 20 or so nuclear weapons enough to hold the United States at risk, for the sake of deterrence.

But what if in, say, 20 years, the United States has made significant reductions (e.g., much less than half of today's nuclear force) and has deployed a "thin" (e.g., 100 interceptor) NMD system. While China would certainly not mind the reductions in U.S. offensive forces, the reductions would probably not affect China's strategic planning greatly one way or another. After all, U.S. offensive forces would still be much larger than those of China, without a dramatic Chinese buildup. But in this scenario, maintaining the same level of deterrence in the face of U.S. NMD as today would require the Chinese to have about five times as many long-range missiles. That would be a reasonably significant increase if China really believes that 20 would otherwise be sufficient. This means that, with a limited U.S. NMD and if China is self-consistent, it will instead need to be able to throw about 120 weapons at the United States. The first 100 would either hit the targets the Chinese care about or would exhaust the defenses. The next 20 would finish the job.

So, China ought to be expected to complain about NMD. Even unilateral reductions of U.S. offensive arms (as long as it is not down to hundreds) would not matter to the Chinese. They will have to increase their offensive capabilities significantly—but not, it seems, enough for the United States to really be concerned.

But what if China has bigger plans, such as a vision of reaching some sort of strategic nuclear parity with the United States within, say, 20 to 30 years.[33] In this hypothetical situation, China ought to welcome U.S. NMD and force reduction initiatives. In an "arms race," defensive investments are a loser. A modest 100-interceptor system could surely be overtaken by threat technological advances and numbers in 20 years. So, in the Chinese view, such an NMD system would, at worst, sponge up a few percent of their much larger parity force. At best, it would allow them to catch up with the United States offensively years earlier than they might have otherwise.

NMD would not seem, therefore, to be much of a problem as far as China is concerned. If it builds up its forces in response, to restore the previous status quo, the net result is a wash. NMD, per se, is not likely to spawn an "arms race" between the United States and China (other things might, but it would seem the United States would have to be fairly inept to make that happen). Does the United States really care whether China can throw 20 or 120 weapons at it (particularly if, in the latter case, the United States has a chance of shooting some of them down)? But if an arms race is inevitable between the United States and China, NMD probably will not matter much one way or the other. And the United States should not worry too much about the "growth potential" of near-term deployments because NMD (for all the reasons found during the Cold War) will rapidly become unattractive (at least with respect to China) once the arms racers leave the starting line.

Protection against accidental or unauthorized launches of strategic missiles from Russia or China is impossible to address with any precision. The kinds of NMD the United States may want to support its regional power projection capabilities could, however, fill this niche at the price of adopting a day-to-day alert posture for the limited NMD system. This would, however, require additional costly capabilities, particularly sensors, as well as BM/C^{4}ISR that would provide the capability to defend around the clock, day in and day out. If the

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[33]Although, from a nuclear perspective, just why they might want to do this is hard to imagine, considering the small benefits and high costs and risks relative to just maintaining something like the current status quo.

additional costs could be kept low enough, the U.S. national leadership may decide that NMD is a prudent investment.

SUMMARY

The potential for the use of ballistic missile–delivered WMD warheads is likely to shadow any future major regional conflict in which the United States is involved. WMD threat scenarios can be conceptualized (with varying degrees of credibility), as this chapter did earlier. But these WMD threat systems are largely untested in battle, and exactly how and to what extent they will change the future of warfare is highly uncertain. As shown earlier, some of the WMD lessons learned during the Cold War no doubt still apply, but the WMD calculus of the proliferant rogue states could also be quite different from the bipolar Cold War calculus in significant ways—particularly with respect to the potential value of defenses. This chapter has argued that

- The primary purpose of U.S. TMD and NMD systems is not only to deter *enemies* from striking the United States or its allies with WMD but also to *prevent the United States from being deterred* in a future regional crisis fought under a WMD shadow.
- To achieve this purpose, acceptable counterproliferation strategies could require both TMD and, eventually, limited NMD capabilities to support U.S. *offensive* campaign strategies, to minimize the damage from possible retaliatory strikes against the United States that cannot be suppressed completely by offensive actions.[34]
- The distinctions between TMD and NMD systems may be artificial. Some of the same hardware systems might even satisfy both missions; examples include space-based launch detection, tracking, and kill, as well as use of an ABL or an ABI for boost-phase interception.

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[34]The key word here is *eventually*. We would argue that this eventuality should be delayed for as long as we can comfortably delay it because of the technological, engineering, and operational challenges involved in making an NMD system work and because of the continuing long-term commitment (and expense) implied by a deployment decision. Zealots should reflect on lessons learned from Safeguard, which was operational for a *very short time* (accounts vary from days to weeks) before it was decommissioned.

- TMD and/or NMD systems can be deployed on strategic warning of a theater war with a state possessing WMD-equipped TBMs or ICBMs. These defense systems need not be maintained on high alert every day, since surprise attacks or even preemptive attacks by proliferants on the United States are highly unlikely.
- Effective TMD and NMD systems (in limited numbers) need not conflict with the *intent* of the ABM Treaty or with continuing progress in superpower strategic arms reductions, but there is work to be done here. TMD and NMD are now multipolar issues, and the effects on China, in particular, may be significant.

If these views are accepted (and many are admittedly quite contentious), they suggest that the effects on the Air Force and its role in addressing these threats could range from relatively minor to quite significant. Critical issues for the Air Force to consider include

- developing CONOPs and systems initiatives to hold time-critical mobile targets, such as TBM TELs, at risk[35]
- further developing and integrating the ABL (and, possibly, an ABI) into the TMD system-of-systems architecture
- determining the Air Force's role in NMD to support or augment the roles played by the Army and Navy.[36]

Over the longer term, if missileborne WMD threats evolve beyond the relatively manageable levels the discussions in this chapter imply, Air Force responses may have to go beyond defensive overlays to current power projection concepts and systems. Sanctuary basing, long-range force application, migration of surveillance systems from aircraft to space, and even space-based weapons (e.g., space-based laser) may be required to counter more-aggressive WMD threats. The implications for doctrine and force structure could be substantial.

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[35]These will involve the sorts of BM/C^{4}ISR capabilities and weapon developments described in the TMD effectiveness analyses above.

[36]At a minimum, the Air Force satelliteborne launch detection and tracking systems and terrestrial radars will provide warning and cueing. At the other extreme, the Air Force may be able to offer a backup or growth option (e.g., Minuteman—possibly employing a nuclear intercept) for the Ballistic Missile Development Office's kinetic kill systems, if technical or operational problems emerge (e.g., threat object discrimination).

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