Chapter 10

Testing the NMD System: Requirements and Recommendations

This study finds that the planned NMD system can be defeated by a limited ballistic missile attack using simple countermeasures such as those described in Chapters 7–9, and that such countermeasures must be expected to form a part of any threat from emerging missile states. If the planned NMD system cannot deal with these countermeasures, it makes no sense to deploy it. If the Pentagon believes the planned NMD system can deal with such countermeasures, the burden of proof is on it to demonstrate that capability in a rigorous testing program, before a deployment decision is made. A rigorous testing program that incorporates realistic countermeasures is the only way to assess the operational effectiveness of the planned NMD system.

In the Chapter 11 we review past US ballistic missile defense tests that have included decoys or other countermeasures and show that none of these demonstrated an ability to discriminate the warhead from decoys or to otherwise defeat countermeasures.

In this chapter we first discuss how the US government tests its military systems, and what some of the criteria are that determine how many and what kind of tests are needed to assess operational effectiveness. We then discuss the difficulties inherent in testing a system that will face countermeasures in the real world and the important role of "red team" efforts to develop countermeasures using the technology and information that would be available to emerging missile states.

Next, we discuss the operational requirements for the NMD system and the planned testing program. We find that, as currently structured, this testing program will not provide US planners with a basis for knowing what the operational effectiveness of the NMD system will be before it is deployed. To assess the effectiveness of any military system, field tests must be conducted under a variety of conditions that approximate as closely as possible those expected in the real world, and enough tests must be conducted to permit some confidence in the results. Neither of these conditions will be met under the flight tests planned before deployment of the NMD system, much less before the decision about deployment scheduled for fall 2000.

Finally, we make recommendations about how the NMD testing program should be restructured to permit an assessment of the operational effectiveness of the NMD system against the threats it is intended to address. In brief, we recommend that the testing program:

- accurately define the baseline missile threat that the defense must be designed and tested against, making sure that it includes realistic countermeasures of the type discussed in this report
- conduct the right kind of tests, by ensuring that the testing program includes tests against the best countermeasures an emerging missile state could be expected to build
- conduct enough tests to determine the effectiveness of the system with high confidence
- provide for objective, independent assessment of the test design and results

Testing Military Systems

Every military system requires testing, and none more so than ballistic missile defense systems, which are subject to potentially devastating countermeasures. A good testing program makes extensive use of ground testing and simulation, but these cannot substitute for field tests of the system under realistic conditions.

A testing program begins with an "operational requirements document" (ORD), which describes in some detail the system performance parameters that the users and program manager believe the system must have to justify its eventual procurement.[1] The ORD is a formal document that (ideally) specifies how the system will be used in the field and what the minimum and desired levels of performance would be.[2]

The specification of the threat that a weapons system is intended to counter is contained not in the ORD, but instead in the Systems Threat Assessment Requirement (STAR) document. The STAR defines the threat standard, that is, the threat or set of threats the system must operate against. The threat standard is validated and approved by the Pentagon's Defense Intelligence Agency, usually through intelligence gathered on a potential adversary's weapons systems.

The goal of the testing program is then to assess whether the military system meets the requirements set out for it. The testing program can be no better than the underlying requirements and STAR documents. If these documents do not accurately reflect the real world threat, the testing program will not be able to assess the operational effectiveness of the weapon system in the real world.

The STAR document for the planned NMD system is classified. However, the publicly available information strongly suggests it does not reflect the real world threat. In particular, the Ballistic Missile Defense Organization (BMDO) described the target suite used in the first two NMD intercept tests as "more than representative of the threat."[3] Yet the countermeasures consisted of one balloon "decoy" with a very different infrared signature and radar cross section than those of the mock warhead. Moreover, the defense was told in advance what the characteristics of the warhead would be, so it could easily distinguish one from the other. In no way was this target suite representative—much less "more than representative"—of the technically simple countermeasures that an emerging missile state could deploy.[4]

Within the Department of Defense is the office of the Director, Operational Test and Evaluation (DOT&E), which provides oversight of the testing programs for major military systems. The NMD system and the theater missile defense systems are included under its purview. DOT&E reports directly to the Secretary of Defense. Among other things, it writes an annual report to Congress on the testing programs of the military systems it oversees; an unclassified version is always available.[5] For the most part, DOT&E operates in an advisory capacity. However, DOT&E must approve a Testing and Evaluation Master Plan (TEMP) for the each program, as must other development and acquisitions offices within the Defense Department. In addition, under current law, a major defense acquisition program may not go beyond a low rate of initial production (LRIP) until the DOT&E issues a report (called a "Beyond-LRIP Report") stating[6]

- whether the test and evaluation performed were adequate
- whether the results of such test and evaluation confirm that the items or components actually tested are effective and suitable for combat

However, the Secretary of Defense is free to ignore the conclusions of a "Beyond-LRIP Report."

Confidence Level and Effectiveness. Although the terms "confidence level" and "effectiveness" may seem redundant, both are needed to describe the required or expected performance of a system. Effectiveness is a measure of how well a system would work in the real world. The effectiveness of a system is not known a priori, and can be determined only through extensive testing or use of the system. (For a missile defense system the effectiveness is usually expressed as a "kill probability"—the probability that the defense will successfully intercept a warhead or several

[1] Definition from Michael L. Cohen, John E. Rolph, and Duane L. Steffey, eds., *Statistics, Testing, and Defense Acquisition: New Approaches and Methodological Improvements*, report by the Panel on Statistical Methods for Testing and Evaluating Defense Systems, Committee on National Statistics, Commission on Behavorial and Social Sciences and Education, National Research Council, (Washington D.C.: National Academy Press, 1998), p. 212.

[2] The requirements document is validated and approved by the Joint Requirements Oversight Council, which is chaired by the Vice Chairman of the Joint Chiefs of Staff and includes the Vice Chiefs of the Army, Navy, and Air Force, and the Assistant Commandant of the Marine Corps.

[3] Michael C. Sirak, "BMDO: Only Three NMD Tests 'Likely' Before Next Year's NMD Review," *Inside Missile Defense,* August 25, 1999, pp. 13–14.

[4] It is entirely reasonable to begin testing a new NMD system against mock warheads with no countermeasures and to work up to more sophisticated ones. It is the description of the first test target suite as representative of the threat that indicates the STAR document has greatly underestimated the countermeasures threat.

[5] These reports are available online on the DOT&E website at *www.dote.osd.mil.*

[6] Cohen et al., *Statistics, Testing, and Defense Acquisition,* p. 21.

warheads.) The confidence level describes how much trust the user has in what he or she believes the effectiveness of the system to be, based on prior testing and use. Put differently, effectiveness is an intrinsic property of the system, and testing is used to determine what the effectiveness is to a certain degree of confidence. Even if a military system were in fact highly effective, without adequate testing the United States would have very low confidence in its effectiveness and would not be able to assume it was highly effective.

Determining the effectiveness of a military system requires conducting "operational tests" that use production or near-production components. The tests done during the development of the system cannot be used to determine the effectiveness of the deployed system since they generally do not use production components. Moreover, any significant changes to the system made during operational testing would theoretically require a new round of tests.

The number of tests needed to determine the effectiveness of a military system will depend on the level of confidence that is required in that effectiveness, with more tests required to establish a higher level of confidence (see box). The number of tests required will also depend on several other factors, including[7]

- whether the system is new or is an upgrade or modification of an existing system
- the effect of a system failure, which can range from catastrophic (a total failure of the mission) to minor (results in inconvenience or additional cost)
- whether a mission failure would result in the loss of life
- how stressful the operating environment will be
- how unpredictable or varied the operating environment will be
- whether the system will meet opposition and what the nature of the opposition might be

Thus, a military system will require more operational testing if it makes use of new technology that has not been included in a similar system with a good operating or test record; if a system failure would result in a total mission failure or seriously degrade the chance of mission success; if a mission failure would result in the substantial loss of life; and if the operating environment is expected to be stressful and varied because there will be opposition. A national missile defense has all these characteristics and should therefore be subject to extensive testing. In fact, a missile defense system would need to be tested in many different operating environments (to take into account different possible countermeasures), each of which would require its own separate set of tests to estimate the system's performance under that environment. (This is in contrast to, for example, testing ballistic missiles, where the operating environment is predictable.)

However, in practice, it is generally expensive to test weapon systems that must undergo destructive testing (in which the weapon itself is destroyed in the test). For example, the Pentagon reported that the first NMD intercept test that took place on 2 October 1999 cost $100 million.[8] Thus, weapons systems that require destructive testing (for example, ICBMs and air and missile defenses) are often not tested enough before deployment to meet the requirements of high confidence in their effectiveness. For some of these systems, additional information will be gained through training and combat experience. However, this will not be possible for the NMD system; training will involve few, if any, real engagements with ballistic missile targets, and a ballistic missile attack on the United States will be a rare event so there will be no combat experience.

As an example of how the expense of destructive testing makes it difficult to perform the needed flight tests, a National Research Council report considers a missile system for which the planned deployment is 1,000 missiles.[9] Under the assumption that the operational requirement is that the missile land within the lethal range of its target at least 80 percent of the time, and that the user have a 90 percent confidence level that this effectiveness would be met, roughly 148 missiles would need to be fired in destructive testing. Since these tests would consume 15 percent of the planned arsenal, the report states that such a testing program would almost certainly be challenged as an inappropriate allocation of defense resources.

If it is not possible to establish high confidence in high effectiveness for a missile defense interceptor through testing, it may be possible to compensate to some extent by using additional interceptors or adding

[7] Cohen et al., *Statistics, Testing, and Defense Acquisition,* pp. 194–201.

[8] Jonathan S. Landay, "Fallout from US Antimissile Success," *Christian Science Monitor*, 4 October 1999, p. 1.

[9] Cohen et al., *Statistics, Testing, and Defense Acquisition,* pp. 31–32.

additional systems that operate in different ways. In some cases, the defense can use shoot-look-shoot tactics so that additional interceptors are only used if the first ones fail. However, in some cases there will not be time for such assessment before firing additional interceptors or it may be difficult for the defense sensors to determine if the intercept was successful.

The Operational Requirements for the Planned NMD System

As we discuss in Chapter 3, the initial (Phase-1) stage of the planned NMD system is intended to defend against tens of "simple" warheads from North Korea, and perhaps five warheads from the Middle East. The final "capability-3" (C-3) stage is intended to defend against "many, complex" warheads. The dividing line

Effectiveness and Confidence Levels: An Illustration

A familiar example illustrates these concepts. Based on past experience, we can be very confident that the probability of getting heads when flipping a coin is 50%. Thus, our confidence level is essentially 100% that the "system effectiveness" is 50%, where in this example the "effectiveness" is the probability not of intercepting a warhead but of getting heads.

But what if we were handed a coin that was potentially weighted, so we did not know a priori what the odds of getting heads was? To determine the probability of getting heads, we would conduct a number of tests (in this case, coin flips). How many times we would flip the coin would depend on how confident we wanted to be of the probability of getting heads—the higher the level of confidence, the higher the number of required "tests," or coin flips.

Suppose we flipped the coin 20 times and got 12 heads. Could we conclude from this result that the odds of getting a head on any subsequent coin flip was 12/20 = 60%? No, because for any set of flips we would expect to see some fluctuation about the actual probability of getting heads. Even if the coin were not weighted and the probability of getting a head were 50%, we would expect to see 12 heads in 20 flips about 12% of the time.

Figure 10-1 shows the probability distribution of seeing 12 heads in 20 flips for different values of p_h, the probability of getting a head in a single coin flip. While the distribution peaks at p_h = 60%, it is so wide that the results give little confidence that 60% is the actual value of p_h. In fact, the results give us a 90% confidence level that the true value of p_h lies between 45% and 75% (that is, that the odds of getting a head in any coin flip is between 45% and 75%), but only a 39% confidence level that the value of p_h lies between 55% and 65%. Thus, after 20 tests, we could not say whether or not the coin was weighted with much confidence.

Now suppose we keep flipping the coin for a total of 200 times and find 120 heads. The probability distribution still peaks at 60% (see Figure 10-1) but is now much more narrow, reflecting the fact that statistical fluctuations become less significant as the number of tests increase. Based on these results, we would have an 85% confidence level that the value of p_h lies between 55% and 65%, and less than 8% confidence that it lies between 45% and 55%. Thus, at this level of testing, we would have considerable confidence that the coin was weighted, and that the probability of getting a head for any coin flip was near 60%.

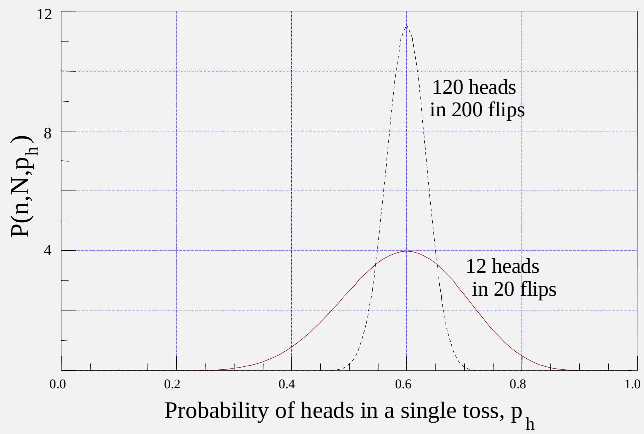

Figure 10-1: Probability distributions for 20 flips and 200 flips.
These curves show the probability distribution $P(n,N,p_h)$, which is proportional to $(p_h)^n(1-p_h)^{(N-n)}$, for two specific cases. $P(n,N,p_h)dp_h$ is the probability of getting n heads in N flips if the probability of getting a head on any single flip lies between p_h and p_h+dp_h. If someone flipped a coin N times and got n heads, then the area under the curve between two values of p_h is a measure of the confidence that the true value of p_h lies within that interval.We consider the cases: n=12 heads in N=20 flips, and n=120 heads in N=200 flips. For example, the solid curve shows the probability distribution of getting 12 heads in 20 flips for different values of p_h.

between the terms "simple" and "complex" is not well-defined (at least publicly); these terms refer to the extent to which the attacker has incorporated countermeasures to fool or overwhelm the defense, and the sophistication of those countermeasures.

Although the NMD operational requirements document is classified, the confidence and effectiveness levels required are reportedly "a 95% confidence level that a 95% kill probability will be achieved."[10] In other words, the user must be 95% confident that the system will be 95% effective against a limited attack.

The Pentagon plans to attain a 95% kill probability by firing multiple interceptors at each target using a "shoot-look-shoot" strategy. One strategy would be to fire two interceptors at the target, look, then fire another two.[11] Reportedly, the NMD designers "expect roughly an 85% probability of kill from a single shot."[12] If the failure modes of the four interceptors are independent of one another, then the United States would have 95% confidence that firing four interceptors at each target would give a 95% probability of kill. We consider both of these assumptions below.[13]

Determining the Single-Shot Kill Probability. We first note that an interceptor cannot be described by a single value of the single-shot kill probability, since the probability of interception will depend on the situation. The kill probability will depend on a number of factors, such as the geometry of the intercept, where the attacking missile is coming from, the time of day the attack occurs (since that will change the infrared and visible signal of the warhead), and whether the attacker uses countermeasures.

Thus, the single-shot kill probability is meaningless unless the conditions under which it is expected to apply (and under which it was determined) are specified.

Moreover, the single-shot kill probability for an interceptor cannot be known or asserted a priori—it must be determined through testing.[14] Thus, the kill probability cannot be stated to be 85%, it can only be stated *with some level of confidence* that the kill probability is 85% or greater, based on the number of tests in the test series and the success rate. For example, if the United States conducts 20 intercept tests and 17 of these are successful, it would have 95% confidence that the single-shot kill probability is 66% or greater, against the type of target it was testing against and under the conditions of its testing. Under the assumption that the failure modes of the interceptors are independent, a single-shot kill probability of 66% would then give the United States 95% confidence that using four interceptors would result in a system effectiveness of 80%, or a 62% confidence that the system effectiveness was 95%. This test series would *not* give 95% confidence that the system effectiveness was 95%.

To obtain high (95%) confidence that the single-shot kill probability was greater than 66%, the tests would have to have a success rate higher than 85%. For a series of 20 tests, all 20 would have to be successful to provide 95% confidence that the kill probability was 85% or greater. On the other hand, if there were three failures in a test series, a total of 50 tests (with the other 47 successful) would need to be conducted to provide 95% confidence that the single-shot kill probability was 85% or greater.

Independence of Failure Modes. Firing more than one interceptor at a target only increases the probability of interception as described above if the kill probabilities for each interceptor are independent. If instead, the failure of one interceptor implies that the others are also likely to fail, the 4-on-1 kill probability can be as low as the single-shot kill probability. In fact, if countermeasures cause one interceptor to fail, they will likely cause other interceptors to fail as well. Thus, the assumption of independent failure modes is probably not warranted for the planned NMD system, which relies on only one type of interceptor (that is, the system is a single-layer system).

[10] Michael Dornheim, "Missile Defense Design Juggles Complex Factors," *Aviation Week and Space Technology*, 24 February 1997, p. 54. The complete quote is: "Designers expect roughly an 85% probability of kill from a single shot, so multiple shots are used for a tighter shield. Kill assessment is made after the first shot and a second interceptor is fired if necessary, in a 'shoot-look-shoot' scheme. To obtain a 95% confidence that a 95% kill probability will be achieved, national missile defense plans call for a '4 on 1' scheme—fire two interceptors at the target, look, then fire another two. This supports fielding 20 interceptors to tackle the minimum threat of five warheads."

[11] Kill assessment may in practice be difficult, so that the NMD system will not know with certainty whether the first round of interceptors has been successful. The kill vehicle might hit a piece of the third stage, for example. However, an analysis of this important topic is beyond the scope of this study.

[12] Dornheim, "Missile Defense Design Juggles Complex Factors," p. 54.

[13] A similar analysis would apply if the confidence and effectiveness levels specified in the operational requirements document are other than 95%.

[14] As discussed above, these tests must use the production-quality interceptors that are intended to be deployed. It would not include tests done with prototypes during the development phase.

Testing and Countermeasures

As emphasized elsewhere in this report, missile defense programs will succeed or fail based on their ability to deal with countermeasures. Since operational testing must be conducted under *realistic* battlefield conditions, for ballistic missile defenses this requires that truly representative countermeasures be incorporated into the tests. However, many problems arise in properly integrating countermeasures into a missile defense testing program:

- The countermeasures threat is hard to define. A nation that is developing countermeasures to defeat a US missile defense system may take great care that the details of its efforts are not exposed to US intelligence-gathering efforts or may reveal deliberately misleading information. Emerging missile states may make few missile tests of any kind. And since these countries may not be in a position to evaluate the performance of their own countermeasures through flight testing (because they do not have the large radars and other sensors required to observe the behavior of the countermeasures in tests), they may simply not flight test them. Moreover, an emerging missile state could develop and gain confidence in the performance of some countermeasures through ground tests or tests from aircraft, which would be difficult for the United States to monitor.

  As a result, there may be no concrete evidence of countermeasure development and no information available about the types of countermeasures under development by the countries the missile defense system is intended to defend against. This may make it difficult to achieve consensus about what types of countermeasures should be included in tests. But it is important to recognize that the absence of evidence about countermeasures is not evidence of the absence of countermeasures.

  A related difficulty is that the defense should also take into account the ability of an emerging missile state to develop countermeasures concurrently with the deployment of an NMD system, and the potential evolution of countermeasures during the lifetime of the defense system as the technological capabilities of emerging missile states increase.

- Even if a "red team" is established to develop countermeasures, its effect may be impeded by a lack of independence, funding, or other resources, and by not being successfully integrated into the overall testing program. Thus, realistic countermeasure tests that are proposed may never be incorporated into the testing program.

- In the eyes of program managers and senior officials, the success of the testing program is measured by hitting and destroying mock warheads, not by accurately modeling the real world threat. A successful countermeasure may be seen as a threat to the success of the program. This situation creates a conflict of interest that can cripple any serious attempt to incorporate realistic countermeasures into the testing program.

Such problems are widely recognized,[15] and some efforts have been made to avoid them. Following a 1992 Defense Science Board recommendation, BMDO set up a countermeasures effort oriented to the theater missile threat. This effort, called the Countermeasures Hands-On Program (CHOP), is run out of the Phillips Air Force Research Laboratory near Albuquerque. Although it was initially intended to explore only potential countermeasures to theater missile defenses, as the program has progressed, some missions have focused on or have had some application to national missile defenses.[16] In fact, according to the 1996 Defense Science Board report, the program identified submunitions as a serious threat to US theater missile defenses.[17] As noted in Chapter 7**,** submunitions would be a serious threat to NMD as well.

CHOP's main task is to build countermeasures, not to theorize about them. The program involves young scientists, engineers, and military officers not specifically trained in missile defense or countermeasures. The team is given access to information and technology in the same way an emerging missile state might get most of its information: through the open literature and

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[15] For example, the Defense Science Board in 1992 and in 1996 has discussed difficulties with missile defense countermeasures programs. The 1996 *Report of the Defense Science Board/Defense Policy Board Task Force on Theater Missile Defense* (January 1996) is available at *www.fas.org/spp/starwars/offdocs/tmddsb.htm.*

[16] Michael Sirak, "BMDO: 'CHOP' Shop Helps Create Robust Missile Defenses," *Inside Missile Defense*, 21 April 1999, p. 1.

[17] *Report of the Defense Science Board*, p. 16.

through commercial off-the-shelf products. However, the CHOP team is prohibited from seeking the advice of outside engineers, whereas an emerging missile state that could deploy a long-range missile would have access to experienced engineers.

The CHOP team assesses how difficult it is to build and deploy a specific countermeasure by developing, building, and testing countermeasure prototypes that represent what a nation with similar resources could do. CHOP missions normally run about nine to twelve months. The watchword of the CHOP missions is simplicity, which helps CHOP programs go from concept to flight testing in months rather than years. CHOP participants usually stay on for only one mission.

It should not, of course, be assumed that the US CHOP program is representative of any particular nation's countermeasure program. In fact, the countermeasures efforts of other countries could well be larger and better funded, and would likely have more experienced personnel who worked on these efforts for long periods of time, rather than for months.

It is clear that the CHOP effort could make a valuable contribution to both theater and national missile defense programs. Nonetheless, the Defense Science Board concluded in 1996 that the theater missile defense red team efforts were not well enough integrated into the full program, and that their output was not used in overall program guidance. Moreover, it appears that since the 1996 Defense Science Board report, CHOP has become a lower priority program with diminished funding. In FY-99 its funding was about $4.5 million, roughly 20 percent of BMDO's funding for threats and countermeasures activities. CHOP's funding is planned to decrease to about $3.3 million in FY-00 and $3.8 million in FY-01.[18]

There are also fundamental problems with the CHOP program: because its funding, staff, and direction are under the control of BMDO, the program is not independent. Moreover, the program staff serve for relatively short periods; as a result, the program does not develop a permanent in-house expertise on countermeasures.

However, programs such as CHOP should play a central role in the process of threat validation, in which the United States makes its best guess as to the characteristics of the ballistic missiles and countermeasures that its defense system will face. The threat validation process usually depends heavily on the assessment of intelligence agencies, but since intelligence may be limited or unavailable, red team efforts such as CHOP provide a needed reality check on the potential countermeasure programs of other countries. Red team efforts may also be the best way to take into account the ability of an emerging missile state to develop countermeasures concurrently with the deployment of an NMD system, and the potential evolution of countermeasures during the lifetime of the defense system as the technological capabilities of emerging missile states increase.

CHOP is, in fact, an example of a new intelligence function, wryly called TRYINT because it involves *trying* to build weapons or countermeasures.[19] Since the conventional intelligence modalities of image intelligence (IMINT), signature intelligence (SIGINT), measurement and signal intelligence (MASINT), and human intelligence (HUMINT) will likely fail to illuminate the dark corners of another country's countermeasures program, the United States must instead try to emulate these countermeasures programs to determine what countermeasures emerging missile states could build with the technology and expertise available to them.

The Planned Testing Program for the NMD System

The operational requirement discussed above—that the United States be 95% confident that the planned NMD system will be 95% effective against a limited attack—may be a desirable objective for a system intended to defend against nuclear or biological weapons. However, is it reasonable to expect that this objective can be met?

Even aside from the countermeasure problem, an effectiveness of 95% is rarely achieved by a military weapons system, even after years of use. Moreover, this confidence requirement is reported to far exceed that for other major defense acquisition programs.[20] An additional problem is that an NMD system must work the *first* time it is actually used. If an ICBM attack on

[18] Michael Sirak, "BMDO: 'CHOP' Shop Helps Create Robust Missile Defenses," *Inside Missile Defense*, 21 April 1999, p. 1.

[19] TRYINT has been emphasized by William R. Graham, who served President Reagan as science adviser and head of NASA. US Senate Committee on Governmental Affairs, "The Proliferation Primer: A Majority Report of the Subcommittee on International Security, Proliferation, and Federal Services," January 1998, p. 63.

[20] Michael Sirak "DOD, Industry: NMD Countermeasures Getting Attention," *Inside Missile Defense,* 19 May 1999, p. 1.

the United States occurs, there will be no opportunity to learn on the job.

Determining the system effectiveness with a confidence level of 95% will, as discussed above, require extensive testing. Because the real-world operating environment could vary greatly depending on the types and combinations of countermeasures the attacker uses, achieving a 95% confidence level in the system effectiveness would require hundreds of tests conducted under different scenarios, costing billions of additional dollars. (As noted above, the Pentagon reported that the October 1999 NMD intercept test cost $100 million.)

However, if the tests do not adequately approximate the conditions under which the system would operate, then even a large number of successful tests will provide little meaningful information about the system's operational effectiveness. Worse, such tests could encourage a false sense of confidence in the system.

How does the Pentagon's planned testing program[21] measure up? Table 10-1 gives the schedule of the intercept tests currently planned through 2005, when the United States might complete the initial deployment of the system.

First, are there enough tests to determine the system effectiveness with a high level of confidence? Three intercept tests are scheduled prior to the Deployment Readiness Review, when the Pentagon will assess the technological readiness of the system for deployment. A total of 19 intercept tests are scheduled through 2005. However, only the last three of these tests are operational tests. The first 16 flight tests are part of the engineering and manufacturing development phase and cannot be used to assess the effectiveness of the deployed system. (The main objective of the first four flight tests is to demonstrate the capability to perform hit-to-kill intercepts. The next seven flight tests are intended to develop and demonstrate full system integration, and the following five will complete the development phase.[22])

Nothing about the system effectiveness will be known before the Deployment Readiness Review, and very little will be known by the initial deployment date. Additional operational tests will presumably be scheduled to take place after initial deployment, but many additional tests will be required for the United States to know with any confidence what the system effectiveness might be.

Second, against what type of threat (and countermeasures) will the system be tested? Even a large number of operational tests will reveal nothing about the operational effectiveness of the NMD system if it is not tested against the type of threats that will be found in the real world.

None of the 19 intercept tests planned through FY 2005 will use credible countermeasures. According to the DOT&E FY 1999 Annual Report, these tests will only assess the capability-1 (C-1) phase of the system (see Chapter 3).[23]

The three intercept tests that will have taken place before the Deployment Readiness Review will not even begin to address the question of how well the system would work in the real world. As we discussed above, these tests will be limited to demonstrating the basic functioning of the system in a relatively benign test environment. The balloon decoy used in the first two NMD intercept tests in October 1999 and January 2000, and those to be used in the next four intercept tests will help the Pentagon assess whether the kill vehicle can perform the basic task of using its infrared sensor to detect and distinguish objects of different temperatures. But the NMD system faces a vastly more difficult task: discriminating a real warhead from false decoys in a situation in which anti-simulation is used to disguise the warhead and the defense does not know in advance what the warhead will look like. The planned tests will not even attempt to demonstrate this capability.

Some of the additional 16 intercept tests that are planned before the target deployment date of 2005 will reportedly use additional decoy targets.[24] However, the DOT&E FY 1999 Annual Report indicates these tests are not intended to assess the operational effectiveness of the system against real-world countermeasures. The DOT&E report further states that "The NMD … program is building a target suite that … may not be representative of threat penetration aids…. Test targets of the current program do not represent the complete 'design-to' threat space and are not representative of the full sensor requirements spectrum (e.g., discrimination requirements). Much of this limitation is attributable, however, to the lack of information surrounding the real threat." The report further notes that "NMD

[21] The BMDO test program is described in Fact Sheet JN-99-07. The BMDO Fact Sheets and other information can be found at *www.acq.osd.mil/bmdo/bmdolink/*.

[22] Michael C. Sirak, "BMDO Plans Two NMD Flight Tests with Special Threat-Like Targets," *Inside Missile Defense*, 1 December 1999, p. 10.

[23] "DOT&E FY99 Annual Report," submitted to Congress February 2000, available online at *www.dote.osd.mil/pubs.html*. See table on page VI-8.

[24] Robert Wall, "Intercept Boosts NMD Design," *Aviation Week and Space Technology*, 11 October 1999, p. 34.

Table 10-1. Schedule of the NMD Intercept Tests Currently Planned.
All tests through FY2005 will be of only the Capability 1 (C-1) system.[a]
IFT= Integrated Flight Test

Date	Test or Decision
June 1997	IFT-1, a "fly-by" test to evaluate the ability of the kill vehicle sensors to detect a target warhead and a target cloud of decoys as it flew past them.
January 1998	IFT-2, a second "fly-by" test of the kill vehicle as described above.
2 October 1999	First intercept test (IFT-3); tested only the kill vehicle. Kill vehicle hit the target but anomalies in the test have raised questions about the relevance of the test.
18 January 2000	Second NMD intercept test (IFT-4); kill vehicle failed to intercept the target, reportedly due to a failure in its infrared sensors.
June 2000	Third intercept test (IFT-5); first planned integrated system test (IST). All NMD system elements will be tested, although as in previous tests, a surrogate interceptor booster will be used.
July 2000	Deployment Readiness Review (DRR) According to then-director of the Ballistic Missile Defense Organization Lt. Gen. Lyles, "[The DRR] will not constitute the actual decision to deploy the NMD system. It will assess whether or not the technical progress has been made which would allow more senior decision-makers to decide whether or not we should commit to deployment. At this time, the administration will also assess the threat, the affordability of the system, and the potential impact on treaty and strategic arms reduction negotiations." [b]
Fall 2000	Possible Presidential Deployment Decision The deployment decision will involve the NMD Joint Program Office in the Pentagon, the Defense Acquisition Board, the Secretary of Defense, the National Security Council (which will consult with the State Department), and the president, in consultation with Congress.
Fall 2000 (?)	NMD intercept test 4 (IFT-6).
FY2001	NMD intercept tests 5, 6, 7. Intercept test 5 (IFT-7) would be the first to use the prototype interceptor booster. First Defense Acquisition Board review of NMD will consider the initiation of production authorization for sensors and battle management, command, control and communications (BMC3)."[b]
FY2002	NMD intercept tests 8, 9, 10.
FY2003	NMD intercept tests 11, 12, 13. Intercept test 12 (IFT-14), planned for first quarter FY2003 (early 2003), would be the first test of the "production-quality" ground-based intercept—both the kill vehicle and the booster.
FY2003	Second Defense Acquisition Board review of NMD will consider granting approval to "build and deploy the weapon system—the ground based interceptor." At this point BMDO "would seek authorization to procure 61 GBI missiles—this would include deployment interceptors, spares, and test rounds." [b]
FY2004	NMD intercept tests 14, 15, 16.
FY2005	NMD intercept tests 17, 18, 19. These are Initial Operational Test and Evaluation (IOT&E) flights.
FY2005/2006	NMD initial operating capability (IOC).
2006	First launch of SBIRS Low. Final deployment of 24 low-earth orbit satellites in FY2010.
Late FY2007	Deployment expanded to 100 interceptors.

Compiled from Inside Missile Defense.

[a] *"DOT&E FY99 Annual Report," submitted to Congress February 2000, available online at www.dote.osd.mil/pubs.html. See table on page VI-8.*
[b] *Statement of Lester L. Lyles, Director of BMDO, to the Subcommittee on Strategic Forces, Committe on Armed Services, US Senate, 24 Feb. 1999 (available online on the BMDO website at www.acq.osd.mil/bmdo/bmdolink/html/lyle24feb.html)*

system performance against multiple targets is not currently planned for demonstration in the flight testing program."

Given the extremely demanding operational environment the NMD system will face, and given the need for it to work the first time it is actually used, it is implausible that the system will even approach the high levels of effectiveness claimed for it. Moreover, the inadequate testing program planned means that the United States will not have high confidence in what the system effectiveness is. In fact, US planners will have no real basis for knowing what its effectiveness will be by the time it is deployed.

An NMD Testing Program to Assess Operational Effectiveness

What can be done to improve the NMD testing program so that it can assess the operational effectiveness of the planned NMD program against the threats it is intended to address? At a minimum, the NMD testing program must

1. Ask the right question: Accurately define the baseline threat

The operational effectiveness of an NMD system will depend sensitively on the nature of the ballistic missile threat it confronts. It is therefore essential that the Pentagon accurately define the baseline threat that the NMD system must be able to address. And this baseline should be used to assess the operational effectiveness of the defense. A defense that is not designed for the real world cannot be expected to work against the real-world threat.

Because the testing program will be designed according to the threat identified in the STAR document, it is imperative that this document reflect the real baseline threat. As discussed above, the planned testing program and other evidence strongly suggest that the existing STAR document does not reflect the real world threat from emerging missile states. In accordance with its own national intelligence estimate, the US government must assume that any ballistic missiles used by emerging missile states will include countermeasures of the type discussed in Chapters 7–9.[25] Because it is so important, the STAR document should be reviewed by an independent panel of qualified experts.

2. Make it possible to get a valid answer to the question: Provide for the best in countermeasure testing

Assuming the Operational Requirements Document accurately reflects the threat from emerging missile states by requiring that the NMD system work against countermeasures such as those we discuss in Chapters 7–9, the issue still remains of what countermeasures to test the system against. To assess its operational effectiveness, the NMD system must be tested against a wide variety of countermeasures that approximate as closely as possible those that would be available to emerging missile states. Since only limited intelligence information, if any, will be available about the countermeasures programs of emerging missile states, the United States must rely on red team efforts and other "TRYINT" programs to determine what countermeasures the NMD system should be tested against.

The defense system must be tested against the most effective countermeasures that the emerging missile states could field. It is clearly important that the countermeasures that are developed and tested are not "dumbed down" to make the job of the defense easier. To insure that this does not happen, the countermeasures program must be independent and adequately funded, and its output fully incorporated in tests and evaluation.

The red team effort currently carried out by CHOP and others is potentially valuable, but is completely under the control of the Ballistic Missile Defense Organization, which has a conflict of interest in overseeing an effort that could demonstrate its planned NMD system could be defeated. To insure independence and remove potential conflicts of interest, the red team activities would need to be conducted under the auspices of a competent technical agency other than BMDO and the associated military services. For example, the Defense Advanced Research Projects Agency (DARPA) is both technically competent and independent of BMDO and the services, since DARPA reports to the Director for Defense Research and Engineering in the office of the Under Secretary of Defense for Acquisition and Technology.[26]

Moreover, to help compensate for the shortage of intelligence information on the countermeasure programs of other states, it is important that there be close

[25] National Intelligence Council, "National Intelligence Estimate (NIE): Foreign Missile Development and the Ballistic Missile Threat to the United States Through 2015," unclassified summary, September 1999, p. 16.

[26] For more information on DARPA, see its website at *www.arpa.mil*. According to this website, DARPA is "designed to be an anathema to the conventional military R&D structure and, in fact, to be a deliberate counterpoint to traditional thinking and approaches."

coordination between the US red team countermeasure programs and the US intelligence community, in both tasking and evaluating intelligence collection.

3. Answer the question well: Conduct enough tests

As the two panels headed by General Welch noted, to avoid a "rush to failure," testing must be outcome-driven and not schedule-driven.[27] There must be an opportunity to assimilate the results of one test before rushing headlong into another. Program managers must carefully distinguish testing done to learn and testing done to verify.

Thus, it is important that the NMD program be insulated from congressional and administration pressures for unrealistic testing and deployment schedules.

In addition, while extensive ground tests and simulation are essential, the only way to gain confidence in the system performance is to conduct a relatively large number of operational flight tests. The number of tests required to gain a given level of confidence in a given system effectiveness cannot be determined in advance because that will depend on the cumulative test record and on when in a test series any failures occur.

For example, if the goal is to provide 95% confidence that the single-shot kill probability was 85% or greater, then a minimum of 18 tests would be required and all 18 would have to be successful. If there were 3 failures in the first 20 tests, then a total of 50 tests (with the other 47 successful) would need to be conducted to provide 95% confidence that the single-shot kill probability was 85% or greater.

Taking into account that a different test series will be needed to assess the system effectiveness against each different type of countermeasure, it is not unreasonable to assume that the United States would need to conduct a total of *at least* 100 intercept tests to determine the system effectiveness was 95% with a 95% level of confidence. If the cost of each operational test were half that of the first intercept test—which was $100 million—then the total cost of these 100 tests would be $5 billion.[28] This is not too much to pay to gain some understanding of the operational effectiveness of the NMD system.

[27] Report of the Panel on Reducing Risk in BMD Flight Test Programs, Gen. L. Welch (ret) et al., February 1998 and November 1999.

[28] Tests against multiple ballistic missiles would be more expensive.

4. Make sure the answer is correct: Provide for objective, independent test assessment

NMD program managers will have a strong bias to find more success in a test than may actually exist since there are strong incentives to believe in a program in which one has invested a lot of time and energy. For example, the Navy termed the fourth LEAP intercept test "a clear success" with 42 of 43 objectives met, even though it failed to hit its target (see Appendix J). Moreover, political and financial support for the project will depend on the perception that the project is making progress. For military contractors, future contracts may be tied to a successful testing program. The only way to insure that such biases and conflicts of interest do not unduly affect the assessment of the operational effectiveness of the NMD system is to have an independent body that can provide objective assessments of the NMD testing program and the countermeasures included in it.

If an independent red team is created, there will also be sources of friction and conflicting motives between the red team and BMDO. There are likely to be disagreements over what countermeasures to test, and BMDO might be tempted to declare victory over countermeasures based on flight tests against less than the best countermeasures potentially available to an emerging missile state. In this situation it is especially important that there be an independent body that can provide objective assessments of the testing program. This body would essentially serve as a referee of the contest between the red team and BMDO.

The office of the Director, Operational Test and Evaluation (DOT&E) serves many of these purposes. As discussed above, DOT&E must approve the plans for operational test and evaluation and write a report assessing whether the testing program confirms that the system is suitable for military use before the program is authorized to proceed beyond a low rate of initial production. It is independent of missile defense efforts within the Department of Defense and reports to the Secretary of Defense and to Congress. Indeed, DOT&E's most recent (1999) report to Congress demonstrates that it is willing to do its job and be critical of the NMD testing program.

Unfortunately, however, missile defense programs have become so politically charged that there are strong political incentives for policymakers to ignore DOT&E's assessments. For example, in June 1999, the US House of Representatives included a measure in its version of the defense authorization bill that would have allowed the Secretary of Defense to make the decision to proceed with production of the NMD system, regardless of whether it had completed initial operational test and evaluation. The measure sought to waive the requirement discussed above that DOT&E must certify that a major defense acquisition program like NMD has successfully completed initial operational test and evaluation before it can go beyond low-rate initial production.[29] Although the measure was not part of the final defense authorization conference bill, it demonstrates the limits of DOT&E's effectiveness.

In the THAAD program, as well, the Pentagon chose to ignore a recommendation from DOT&E that the program should not move to the next stage of its development before five additional flight tests were completed. After reviewing warnings from DOT&E that THAAD intercept tests were not challenging enough and that more tests under realistic conditions were needed before committing to the missile's design, the BMDO decided to reject this advice, saying that "it's not logistically possible."[30]

Thus, in addition to the assessments provided by DOT&E, we recommend that a standing high-level independent review panel be established to review the NMD testing program and its results.

[29] Michael C. Sirak, "Measure to Ease NMD Production Requirements Defeated in Conference," *Inside Missile Defense*, 25 August 1999, pp. 1, 18–19.

[30] Gopal Ratnam, "THAAD to Stay on Schedule Despite Call for More Tests," *Defense News*, 20 December 1999, pp. 3, 50.

Chapter 11

Past US Tests Against "Countermeasures"

The United States has conducted several flight tests of missile defense components—both those for national missile defenses and for theater missile defenses using hit-to-kill interceptors—that have included decoys or other countermeasures. These have sometimes been described as demonstrating that the defense was able to discriminate the decoys from the mock warhead or otherwise defeat the countermeasures. A closer look, however, shows that these tests in no way demonstrate that the defense could address even simple countermeasures. In fact, in these tests, the defense relied on information about the differences between the mock warhead and decoys that would not be available to the defense in the real world.

While the public information about these tests is limited, we discuss below what is known about them. Appendix J gives a summary of information about all the exoatmospheric hit-to-kill intercept tests that have taken place through January 2000.

The Use of "Decoys" in ERIS Tests

On 28 January 1991, the first intercept test of the Exoatmospheric Reentry Vehicle Interceptor System (ERIS), which was intended to intercept long-range missiles, reportedly hit and destroyed a mock reentry vehicle target that was accompanied by decoys. The kill vehicle did not discriminate the warhead from the decoys, however. Instead, two balloon "decoys," each with a diameter of 2.2 meters, were tethered to the dummy warhead about 180 meters apart, and the kill vehicle was told in advance which one of the three objects it should home in on, based on their relative positions.[1] The kill vehicle also collected one-color infrared data on the dummy warhead and the decoys that would be used to tell them apart in the next test.

The second ERIS intercept attempt, on 6 March 1992, included a dummy warhead and a single balloon decoy, which were separated by about 20 meters. The kill vehicle reportedly detected the two objects and then "discriminated" between them using a one-color infrared sensor and the warhead and decoy infrared signatures collected in the first test. However, because the balloon decoy was further away from the warhead than expected, ERIS failed to hit the target, missing by several meters.[2]

There is no doubt, of course, that infrared sensors can tell the difference between objects based on their thermal signatures when these characteristics are known in advance, as was the case here. The difficulty in a real situation would be in knowing whether the real warhead is the hotter or cooler object; without knowing this, simply distinguishing hot objects from colder ones does not help.

MSX Experiment

The Midcourse Space Experiment (MSX) satellite, launched in April 1996, is designed to collect infrared and visible data for use in designing future space-based missile tracking sensors. In the MSX Dedicated Target Mission (MDT II on 31 August 1996), the premier target mission for the MSX program, a missile deployed a set of 26 objects including balloons and light rep-

[1] James Asker, "Army ERIS Interceptor Destroys Dummy Warhead in SDI Test," *Aviation Week and Space Technology*, 4 February 1991, p. 22; "ERIS Flight 2 Results," briefing slides, Lockheed Missiles and Space Company, 1992.

[2] "SDI Experimental Interceptor Misses Dummy Warhead in Final Flight Test," *Aviation Week and Space Technology*, 23 March 1992, p. 20; Vincent Kiernan and Debra Polsky, "SDI Interceptor Fails to Hit Target," *Defense News*, 23 March 1992, p. 8; "ERIS Flight 2 Results," briefing slides, Lockheed Missiles and Space Company, 1992.

Discrimination

One of the key issues in the countermeasures debate is whether the NMD system would be able to discriminate real warheads from decoys and other objects. The term "discrimination," however, is typically used in several ways and its meaning is therefore sometimes ambiguous. Because this issue is so central, we discuss it briefly here.

As we discuss in this chapter, there have been several tests of missile defense systems for which the Pentagon stated that the system was able to discriminate the mock warhead from other objects. However, in these tests, the defense system knew what it was looking for—it knew what the various objects would look like to its sensors. This type of "discrimination" is similar to telling someone that the warhead would be red and the decoys blue, then showing them a red and a blue object and telling them to point to the warhead. Demonstrating that a missile defense system can do this level of discrimination is a necessary step in the development process, but should not be confused with the full job that it would have to do to be effective in a real attack.

The situation facing a defense system in the real world would be quite different. As we discussed in earlier chapters, the attacker could readily take steps to disguise the warhead so that it would not look like what the defense would expect it to. The attacker could both prevent the defense sensors from seeing target characteristics the defense would expect to see, and add other characteristics the defense would not expect to see. In this case the defense sensors may be able to identify differences between the objects it sees, but would have no idea which of the objects was the warhead. In other words, the defense could not know in advance that the warhead would be red.

Thus, the relevant meaning of "discrimination" is not only detecting differences between objects, but also determining which object is or contains the warhead.

lica decoys along with a mock warhead for observation by the MSX satellite. In Congressional testimony, then-BMDO-director Lt. General Lester Lyles showed an MSX infrared image of these objects being deployed at a range of 1,000–2,000 kilometers from the MSX satellite and stated that, "This kind of discrimination data is absolutely crucial and essential to our sensors to be able to perform the kind of mission we have to have them do for our NMD program…"[3] It is likely that this image is similar to the long-range view seen in the kill vehicle sensor fly-by tests (see below), although the target set was somewhat different.

However, this test did not establish a discrimination capability, only that infrared sensors can distinguish between targets with different infrared signatures and identify a given target based on characteristics that are known in advance. As General Lyles went on to say, "The actual RV [reentry vehicle] in the left chart that you see is the brightest target…" In the real world, there would be no way for the United States to know in advance that the reentry vehicle would be the brightest object.

Sensor Fly-by Tests for NMD

Two sensor fly-by tests have been conducted as part of the current NMD testing program. In those tests, the infrared sensors of the kill vehicle flew past a set of objects in space and observed them. The target set reportedly included nine objects, including a "medium" RV, a large balloon, medium balloons, canisterized small balloons, small canisterized light replica decoys, and medium rigid light replica decoys.[4] A BMDO official stated that this target set "replicates a number of systems that we could face,"[5] and Maj. Gen. William Nance, NMD program manager, said in each case the target suite was "a more complex target array than we would expect from a rogue state."[6] An infrared sensor designed by Boeing was tested on 23 June 1997, in the first Integrated Flight Test (IFT), and one designed by Raytheon was tested on 15 January 1998, in IFT-2. In both cases, the sensors were reported to have imaged the targets and the clear impression given by press reports was that the sensor was able to detect the mock reentry vehicle among the decoys. However, a recent report contradicts the claim that the kill vehicle

[3] Department of Defense Authorization for Appropriations for Fiscal Year 1998 and Future Years Defense Program, Committee on Armed Services, US Senate, part 7, 27 February 1997, p. 10. The infrared image shown by General Lyles can be seen on the MSX homepage at *http://scies.plh.af.mil/Latest/dark.htm.* Reflected visible light images of the same scene are at *http://scies.plh.af.mil/Latest/mdt_ii_boost.htm.*

[4] Joseph Anselmo, "Pentagon to Spend Big on NMD Testing," *Aviation Week and Space Technology*, 22 September 1997, p. 88.

[5] Anselmo, "Pentagon to Spend Big on NMD Testing," p. 88.

[6] Michael C. Sirak, "In NMD Test, Beacon Will Help Position EKV Until Booster Release," *Inside Missile Defense*, 5 May 1999, p. 19.

successfully discriminated the mock warhead in the 1997 test. Instead, the kill vehicle apparently selected a decoy, rather than the warhead, as the target.[7]

In these tests the infrared sensor knew what signatures it was looking for and there was no attempt to disguise the warhead through anti-simulation, that is, by changing its physical characteristics so that it no longer looked like a warhead. Had anti-simulation been used, one would expect that the sensor would still have been able to image all of the objects, but would not have seen characteristics of the warhead that it could have used to identify it. The reported 1997 test failure indicates that even with advance knowledge of how the warhead would appear and no attempt to disguise it by anti-simulation, identifying the proper target can be very difficult.

Tests of Ground-Based Radar at Kwajalein

Several tests for the NMD program have been done as part of the Air Force's routine test flights of Minuteman III ballistic missiles. For example, on 20 August 1999, a reentry vehicle and several countermeasures (two rigid lightweight replicas (RLRs) and a chaff package) were launched on a Minuteman III missile toward Kwajalein to give the ground-based radar there practice in tracking these objects. (This test was named Glory Trip 170 GM-1.) The reentry vehicles and replicas were each instrumented to collect motion and attitude data to be used in an analysis of the performance of the objects and the radar. Only the reentry vehicle survived reentry.[8]

As above, there was apparently no attempt to disguise the reentry vehicle. While this test provided information on the signatures of these particular targets, this data could not be adequate for discrimination if an attacker used anti-simulation to disguise the characteristics of the targets in unknown ways.

First NMD Intercept Test

The first intercept test (IFT-3), conducted on 2 October 1999, tested only the exoatmospheric kill vehicle (EKV); none of the other system components were integrated into the test. Instead, to simulate the information that would normally be provided by the radars, a GPS (global positioning system) transmitter on the target provided the target location to the interceptor booster to allow it to dispense the EKV in the correct place.

The target suite for the first NMD intercept test (IFT-3, on 2 October 1999) consisted of a reentry vehicle less than two meters long and less than one meter in base diameter, and one balloon decoy with a diameter of 2.2 meters made of radar-reflecting material (see Figure 11-1). The bus used to release the reentry vehicle was also reportedly in the field of view of the kill vehicle's sensor and also had to be discriminated from the reentry vehicle.[9] After it was dispensed, the kill vehicle reportedly discriminated the reentry vehicle from the balloon decoy and the bus without outside assistance, and then successfully intercepted the reentry vehicle.

In discussing the first intercept test, Brig. General William Nance, the NMD JPO Program Manager, "characterized the target suite as 'more than representative' of the decoys and countermeasures that a rogue state might employ."[10] John Peller, vice-president and NMD program manager at Boeing, stated that "the target suite was equal to, if not more challenging than, the current projected rogue threat."[11]

However, these claims are not valid since the test did not use anti-simulation or attempt to disguise the signature of the warhead in any way. The test was not one of discrimination since it relied on the defense knowing in advance that the reentry vehicle would be the object with the smallest infrared signal. Indeed, in a briefing the day before the test, a Pentagon official stated that the difference in thermal signature of the reentry vehicle and balloon would be "pretty significant."[12] Brig. General William Nance later described the reentry vehicle as "the least visible in the IR [infrared] spectrum of all the elements in the target array, and the smallest of all the objects in the target array."[13]

Moreover, the Pentagon admitted in January 2000 that there had been a series of anomalies in the test, which sheds additional light on the issue of "discrimination." The sensors on the kill vehicle were

[7] William J. Broad, "Ex-Employee Says Contractor Faked Results Of Missile Tests," *New York Times*, 7 March 2000, p. A1.

[8] "USAF Launch Gives NMD Radar Operators Practice For NMD Flight Test," *Inside Missile Defense,* 25 August 1999, p. 14.

[9] "NMD Kill Vehicle Performed 'Very Well' in Flight Test, Officials Say," *Inside Missile Defense*, 20 October 1999, pp. 1, 19-21.

[10] "BMDO: Only Three NMD Tests 'Likely' Before Next Year's NMD Review," *Inside Missile Defense,* 25 August 1999, p. 13.

[11] "NMD Kill Vehicle Performed 'Very Well'," p. 20.

[12] Department of Defense Press Briefing on the NMD Intercept Test, 1 October 1999.

[13] "NMD Kill Vehicle Performed 'Very Well'," p. 19.

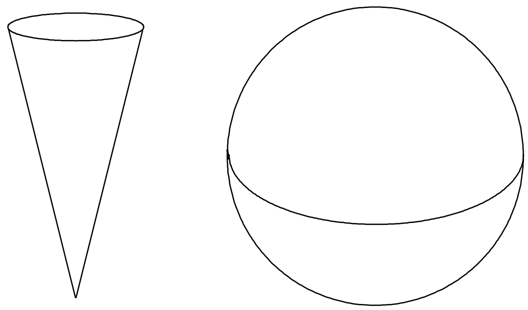

Figure 11-1. The target suite for the first two NMD intercept tests.
This figure shows a reentry vehicle that is 2 meters long and 1 meter in diameter and a spherical balloon 2.2 meters in diameter. The bus used to release the reentry vehicle was reportedly also in the vicinity of the targets during these tests.

initially unable to find the mock warhead. The sensors did see the balloon, which the kill vehicle apparently immediately recognized as the balloon rather than the warhead.[14]

Thus, the "discrimination" was not even based on relative measurements of the balloon and kill vehicle, but instead relied on the defense knowing in advance the characteristics of the targets. In a real attack, the defense would not know in any detail what the warhead would look like, especially if the attacker took simple steps to disguise it, as one has to expect it would do. Instead, the test was a test of how sensitive the sensors are and of the algorithms used by the NMD system and of the kill vehicle's ability to home on and hit a target. In the October 1 briefing, the Pentagon briefer said that "What we're testing are the algorithms… When you have multiple objects, regardless of their signature, you want to make sure you pick the right one." While it is certainly necessary to test the algorithms, it is not the same as testing the discrimination ability of the kill vehicle.

Interestingly, the ground-based radar at Kwajalein, which is a prototype of the X-band radar planned for the NMD system, exhibited a glitch during the test. The radar was not included in the test (i.e., it was not controlling the engagement or communicating with the interceptor), but it was observing the test and tracking the target objects. After initially correctly identifying the reentry vehicle, it switched and identified one of the decoys as the reentry vehicle before again switching back to correctly identify the reentry vehicle.[15]

Second NMD Intercept Test

The second intercept test (IFT-4) conducted on 18 January 2000, included more components of the system, but used the same target suite as the first test (see Figure 11-1). The intercept was not successful, reportedly due to a failure of the kill vehicle's infrared sensors.

An ERINT Test Against "Submunitions"

One occasionally sees reports that the ERINT interceptor (which evolved into the interceptor for the Patriot PAC-3 theater missile defense system) was successfully tested against submunitions carrying a simulated chemical agent. Like the NMD interceptor, the PAC-3 interceptor is a hit-to-kill weapon, but unlike the NMD system, PAC-3 operates within the atmosphere and against much shorter-range missiles. These reports refer to an intercept test conducted on 30 November 1993. Reports state the target missile carried 38 canisters filled with water intended to simulate chemical weapons submunitions, and that ERINT successfully intercepted and destroyed all of the canisters.[16]

However, it is clear from the description of this test that the submunitions were not dispersed early in flight, as would normally be done to counter a defense. Instead the canisters were all clustered together in a single package, which makes no sense from the point of view of an attacker facing a missile defense. So this test in no way demonstrated that a defense can successfully intercept submunitions.

[14] James Glanz, "Flaws Found in Missile Test that U.S. Saw as a Success," *New York Times*, 14 January 2000, p. A1; Department of Defense Press Briefing, 14 January 2000.

[15] Robert Wall, "Intercept Boosts NMD Design," *Aviation Week and Space Technology*, 11 October 1999, p. 34.

[16] David Hughes, "Army Selects ERINT Pending Pentagon Review, *Aviation Week and Space Technology*, 21 February 1994, p. 93.

Chapter 12

The Security Costs of NMD Deployment

The mission of the proposed US National Missile Defense (NMD) system, as stated in the National Missile Defense Act signed by President Clinton on 23 July 1999, is to defend "the territory of the United States against limited ballistic missile attack (whether accidental, unauthorized, or deliberate)." In this context, "accidental" and "unauthorized" refer primarily to Russia, while "deliberate" refers to China and to other potentially hostile states (e.g., North Korea, Iran, and Iraq) that might acquire a small number of intercontinental ballistic missiles (ICBMs) armed with nuclear or biological warheads.[1]

The purpose of an NMD system is to reduce the risk to US citizens of large-scale death and destruction. This is a critical mission, but it can be achieved only if the decision to deploy such a system would not trigger reactions by other states that, on balance, would result in increased risks to the United States. In short, the gains in security must exceed the losses.

Previous chapters have examined the security benefits of the proposed NMD system: its ability to protect the United States against a small number of ballistic missiles armed with nuclear or biological warheads. We have concluded that the proposed system would not provide an effective defense if the attacker employs relatively simple countermeasures, such as submunitions and balloons, which are well within the technical capacity of any country able to build long-range ballistic missiles.

In this chapter, we consider how states are likely to respond to the deployment of the proposed NMD system and how these responses would affect the security of the United States. Below we examine, in turn, the potential reactions of Russia, China, emerging missile states, and other states.

Russia

Russia's strategic missile force is the only sector of the former Soviet military complex that retains anything like its Cold War capability. Today, Russia deploys over 1,000 strategic missiles armed with more than 5,000 warheads.[2] Russia will place a high priority on maintaining this force as its only credible deterrent against the military power of the United States, an eastwardly expanding NATO, and China. Although Russia's nuclear forces are expected to decline, with or without continued progress in negotiated arms reductions, Russia is expected to be able to maintain a force of 3,000-4,000 warheads through at least the next decade (see Chapter 2).

The planned NMD system, with up to 250 interceptors, obviously would not be able to protect the United States from a Russian attack involving even 1,000 warheads. One might therefore conclude that the system would not threaten the Russian nuclear deterrent. But Russian military planners, like their US counterparts, will consider scenarios in which their retaliatory capacity might be limited by enemy attacks. For example, Russia will consider the possibility of US nuclear attacks against its nuclear forces. Today, only a small fraction of Russia's nuclear forces are

[1] As discussed in Chapter 2, a Chinese accidental or unauthorized launch is not currently a concern because China deploys its long-range missiles without fuel and with the warheads stored separately.

[2] "START I Aggregate Numbers of Strategic Offensive Arms, as of 1 July 1999 as compiled from individual data submissions of the Parties," available online at the State Department website at *www.state.gov/www./global/arms/factsheets/wmd/nuclear/start1/startagg.html*. Includes 756 ICBMs armed with 3,560 warheads and 440 SLBMs armed with 2,272 warheads.

positioned to survive such an attack—perhaps only tens of missiles carrying fewer than 200 warheads.[3] Russia would also be concerned about the possibility of US attacks intended to destroy Russia's ability to command its nuclear forces.

A US surprise attack might seem inconceivable. Any use of nuclear weapons would probably be preceded by an extended crisis and conventional combat, so that Russia would have ample time to alert its nuclear forces and improve their survivability. But Russia is likely to worry that a crisis could lead to rapid and highly effective conventional attacks by superior US or NATO conventional forces against Russian bombers, ports, and submarines at sea. Or it might be reluctant to alert its forces for fear of worsening the crisis or triggering preemptive attacks. Even if it did alert its forces, Russia might be concerned that the United States would exploit gaps in its early-warning system to launch an attack that could destroy much of its strategic forces. In any case, the proposed US NMD system looms much larger when measured against the relatively small Russian force that might survive US attack and be capable of retaliation.

Russia will also consider the possibility of the NMD system being expanded far beyond current proposals. As described in Chapter 3, the proposed system includes numerous ground-based radars and satellite-based infrared sensors, giving the United States the nominal capability to track thousands of Russian warheads with high accuracy. Once this sensor system is deployed it would be relatively easy for the United States to field hundreds of additional interceptors and greatly expand the capacity of the system. This concern is currently addressed by the Anti-Ballistic Missile (ABM) Treaty, which imposes strict limits on the location and capabilities of radars to prevent either country from providing a base for a nationwide defense.[4]

Indeed, Russia may worry that the United States could expand the capacity of its NMD very rapidly by using NMD sensors to increase the range and capability of theater missile defense systems, particularly such as the planned Navy Theater-Wide system. Although the United States has provided assurances that it will not deploy these systems "in numbers and locations so that these systems could pose a realistic threat" to Russia's strategic nuclear force,[5] this system is highly mobile and the total number of interceptors planned is very large (more than 600). And as a recent BMDO report on the potential utility of the Navy Theater-Wide system to the NMD mission acknowledges, the NMD system's X-band radars could support the Navy Theater-Wide interceptor in engagements against long-range strategic missiles.[6] The report concluded that integrating the planned Navy Theater-Wide system into the planned ground-based NMD system would result in a more flexible and robust national missile defense.

Finally, Russia may have concerns about even the nominal purpose of the proposed NMD system. Because the system is intended to protect the United States against accidental and unauthorized attacks, it must be designed to destroy at least a few Russian warheads.[7] Russia might view this as an attempt to deny its ability to use or threaten to use one or a few missiles against the United States. Although it is difficult to imagine the circumstances under which limited Russian attacks would make sense, we have little doubt that Russian attack plans include such options and that Russian planners would seek to preserve them.

Because of these considerations, it is highly likely that Russia would adjust its nuclear force posture in response to the deployment of the planned NMD system. Even if Russian leaders could be convinced that US intentions were benign and that the proposed NMD system would not threaten Russian security, Russian pride and prestige would be at stake and there would be enormous political pressure to respond militarily.

Russia could respond in several ways. First, Russia could equip its missiles with a variety of counter-

[3] Russia reportedly averages one regiment (nine single-warhead missiles) of mobile missiles out of garrison and one or two ballistic-missile submarines (16 to 36 missiles armed with 64 to 264 warheads) on combat patrol at sea. Harold Feiveson, et al., *The Nuclear Turning Point* (Washington, D.C.: Brookings Institution Press, 1999), p. 109.

[4] Lisbeth Gronlund and George Lewis, "How a Limited National Missile Defense Would Impact the ABM Treaty," *Arms Control Today*, November 1999, pp. 7-13.

[5] "Agreement on Confidence-Building Measures Related to Systems to Counter Ballistic Missiles Other Than Strategic Ballistic Missiles," 26 September 1997, available online at the State Department website at *http://www.state.gov/www/global/arms/factsheets/missdef/abm_cbm.html.*

[6] Ballistic Missile Defense Organization, "Summary of Report to Congress on Utility of Sea-Based Assets to National Missile Defense" 1 June 1999.

[7] According to US officials, the planned NMD system "would also provide some residual capability against a small accidental or unauthorized launch of strategic ballistic missiles from China or Russia" (Jacques S. Gansler, Under Secretary of Defense for Acquisition And Technology, Testimony before the House Armed Services Subcommittees on Research and Development and Procurement, 25 February 1999).

Russian Statements on NMD

It is difficult to over-estimate the ABM treaty's "tremendous significance as a factor of strategic stability and international security.… Implementation of existing plans for deployment of national anti-missile defense systems would constitute a violation of fundamental obligations under the ABM treaty—not to deploy ABM systems for the defense of national territory—and will lead to actual abolition of the treaty. Such a development would inevitably upset the whole system of international treaties in the disarmament field, it can trigger a new round of a strategic arms race including in outer space, and undermine the existing non-proliferation regime."

—Vasily Sidorov, Russian Ambassador to UN Conference on Disarmament
("Russia and China Warn of New Arms Race in Space," Reuters, 5-11-99)

"[T]he very direction of the current actions of the US Senate is in itself a step towards destroying the ABM Treaty and with it all agreements on limiting strategic missiles.… [The ABM Treaty and START Treaties] are composite parts of an integral whole.… We are talking here of a serious threat to the whole process of limiting nuclear weapons and to the stability of a strategic situation which has taken decades of international agreements to build up."

—Russian Foreign Ministry Statement
(*Agence France Presse*, 3-18-99 and *Reuters*, Moscow, 3-18-99)

"… all agreements that have been signed or are being prepared will come under threat—namely START I, START II, and consultations on START III."

—Col. Gen. Vladimir Yakovlev, commander of Russia's strategic rocket forces
(Barry Renfrew, "Russia Fears US Proposal Could Lead to Arms Race," *Pacific Stars and Stripes*, 10-19-99)

"We will fully withdraw from all inspection measures and will not let anyone close to our arms. Russia will not know what is going on in the United States. Americans will not know what is going on in Russia."

—Col. Gen. Vladimir Yakovlev, commander of Russia's strategic rocket forces
("Russia Warns of US Arms Race," Associated Press, Moscow, 10-5-99)

"Problems have cropped up now with the Russian–American 1972 ABM treaty; for this reason, we are forced to build in into our new missiles a capability for penetrating anti-missile defenses."

—Col. Gen. Vladimir Yakovlev, commander of Russia's strategic rocket forces
("But We Make Missiles," *Izvestia,* 6-5-99, p. 1)

If the United States deploys a missile defense system, Russia "will be forced to raise the effectiveness of its strategic nuclear armed forces and carry out several other military and political steps to guarantee its national security under new strategic conditions. … We see no variants which would allow the United States to set up a national ABM system and still preserve the ABM treaty and strategic stability in the world."

—Gregory Berdennikov, director of the Russian Foreign Ministry's Security and Disarmament Department
(David Hoffman, "Moscow Proposes Extensive Arms Cuts," *Washington Post*, 8-20-99, p. 29)

measures (decoys, chaff, jammers, etc.), to ensure that its warheads could penetrate the NMD system with high probability. Indeed, recent statements indicate that Russia plans to deploy countermeasures on its Topol-M ICBM in response to the planned NMD system.[8] While such countermeasures would not make the Russian nuclear arsenal more dangerous or lethal, they would negate any protection the NMD system otherwise would have afforded against accidental, erroneous, or unauthorized Russian attacks.

Second, Russia could rely more heavily on its ability to launch its missiles on warning of an attack. Because only a small fraction of the Russian nuclear force could survive a US attack, Russia reportedly maintains an option to launch most of its vulnerable

[8] David Hoffman, "Russian Rocket Called Invincible," *Washington Post*, 25 February 1999, p. 19.

missiles—silo-based ICBMs, garrisoned mobile ICBMs, and pierside submarine-launched ballistic missiles—on warning of attack. This is particularly dangerous given the fragmentation and degradation of Russia's attack warning system, the generally poor state of military training and morale, and the potential for a serious political crisis. Deploying an NMD system would only reinforce Russian plans to launch its missiles on warning. Thus, on balance, deploying an NMD system could actually *increase* the risk of accidental, inadvertent, or unauthorized launch.

Third, Russia could maintain a larger number of ballistic-missile warheads that it otherwise would have. Although Russia's economic difficulties preclude a major missile-building program, Russia could maintain a much larger number of warheads at relatively low cost by renouncing the START II Treaty (which it has signed but not ratified), which prohibits multiple-warhead land-based missiles. Russia could, for example, extend the life of its existing large, multiple-warhead ICBMs or fit its newer land-based missiles with multiple warheads. As we discuss in Chapter 2, Russia can likely maintain 3,000 to 4,000 strategic warheads for the next decade or more.

Fourth, Russia could emphasize alternative means of delivering nuclear weapons. For example, Russia could rehabilitate its strategic bomber force, or it could redeploy long-range land-attack cruise missiles on ships or submarines. (All US and Russian nuclear sea-launched cruise missiles are currently in storage as a result of coordinated US and Russian unilateral reductions of nonstrategic weapons in the early 1990s.) This option is less likely than those presented above, given Russia's historical emphasis on land-based ballistic missiles, but risks to US security could increase if Russia goes down this path. These forces are more vulnerable to theft or unauthorized use than are ICBMs, which are under tight central control.

Finally, Russia could deploy an NMD system of its own, partly for reasons of parity and prestige. Although many analysts would dismiss this possibility, given Russia's economic situation, Russia's experience with missile defense is comparable to that of the United States, and it would be able to deploy an NMD system at a cost far below that of the planned US system. Russia almost certainly would use nuclear-armed interceptors in such a system, which would have a higher kill probability and would be less susceptible to countermeasures than the hit-to-kill interceptors planned by the United States. Although a Russian NMD system would not threaten the United States directly, it undoubtedly would trigger US countermeasures and Russian counter-countermeasures that would renew the nuclear arms race and leave both countries less secure. The ABM Treaty's prohibition on nationwide defense was intended to prevent this sort of action-reaction syndrome.

In addition to its effect on Russia's nuclear force posture, a US NMD system would affect US-Russian relations more generally. The Clinton administration's stance on missile defenses and the hostile or dismissive attitude towards Russia expressed by factions in the US Congress has strengthened xenophobic forces in Russia. A US decision to deploy an NMD system, whether accompanied by US withdrawal from the ABM Treaty or by exploiting Russia's weak position to compel its agreement to treaty modifications that are contrary to its interests, is bound to lead to a deterioration of US-Russian relations. It can be expected that reactionary forces in Russia would use this issue to advance their agenda.

A deterioration of relations could curtail or reverse cooperative efforts to reduce nuclear risks. This could include failure to implement the START II Treaty and the collapse of the START process, renunciation of unilateral agreements to reduce nonstrategic nuclear weapons, and termination of a variety of existing assistance programs, officer exchanges, transparency measures, and inspection arrangements. Russia's massive stockpile of nuclear materials, weapons, and delivery systems and its numerous scientists and engineers with expertise in sophisticated military technology will continue to pose a risk of proliferation of both materials and expertise to other countries as long as Russia's economy remains poor and its political climate turbulent. A deteriorating US-Russian relationship would preclude the cooperation essential to reduce this proliferation risk, which poses a vital threat to US security.

A deteriorating US-Russian relationship could also make Russia more willing to sell missile components, missiles, and countermeasures to emerging missile states, resulting in an increased missile threat to the United States from other countries. Indeed, as the 1999 National Intelligence Estimate (NIE) notes, the likelihood that China or Russia would transfer an ICBM to another country in the next 15 years depends in part on their "perceptions of US ballistic missile defenses."[9]

[9] National Intelligence Council, "National Intelligence Estimate (NIE): Foreign Missile Development and the Ballistic Missile Threat to the United States Through 2015," unclassified summary, September 1999, p. 12.

Chinese Statements on NMD

"If a country, in addition to its offensive power, seeks to develop advanced TMD or even NMD, in an attempt to attain absolute security and unilateral strategic advantage for itself, other countries will be forced to develop more advanced offensive missiles. This will give rise to a new round of arms race, and will be in nobody's interest.... After the Cold War, with the world moving rapidly towards multi-polarity, the significance of ABM Treaty has increased rather than decreased."

—**Ambassador Sha Zukang**, **Director-General, Department of Arms Control and Disarmament, Ministry of Foreign Affairs of China**
(Statement at Carnegie Endowment 7th Annual International Nonproliferation Conference, Washington, D.C., 1/11–1/12/99)

"Any amendment, or abolishing of the [ABM] treaty, will lead to disastrous consequences. This will bring a halt to nuclear disarmament now between the Russians and Americans, and in the future will halt multilateral disarmament as well."

—**Ambassador Sha Zukang**, **Director-General, Department of Arms Control and Disarmament, Ministry of Foreign Affairs of China**
(John Pomfret, "China Warns of New Arms Race," *Washington Post*, 11-11-99, p. 1)

"Progress in nuclear disarmament cannot be achieved without a global strategic equilibrium and stability. The research, development, deployment and proliferation of sophisticated anti-missile systems and the revision of, or even withdrawal from, the existing disarmament treaties on which global strategic equilibrium hinges will inevitably exert an extensive negative impact on international security and stability and trigger off a new round of arms race in new areas, thereby seriously obstructing or neutralizing international efforts of nuclear disarmament and nuclear non-proliferation."

—Chinese President Jiang Zemin
(Speech at Conference on Disarmament, Geneva, 3-26-99)

"This decision [to proceed with plans for ballistic missile defenses] will have profound negative influence on the global and regional strategic balance and stability and trigger a new round of arms race to the detriment of the international disarmament process."

—Li Changhe, Chinese Ambassador to the UN Conference on Disarmament
("Russia and China Warn of New Arms Race in Space," Reuters, 5-11-99)

China

As discussed in Chapter 2, China deploys some two dozen single-warhead silo-based missiles and one submarine capable of carrying ballistic missiles. China has no intercontinental bomber force. It does not maintain its strategic nuclear forces on alert, ready to launch on short notice. Thus, China does not have a truly survivable deterrent force, as that concept is understood by the other nuclear powers. China apparently believes that ample warning of an attack would be available and that the mere possession of nuclear weapons, together with the fact that an attacker could not be confident that it could destroy all of China's weapons and prevent retaliation against one or more of its cities, is sufficient to deter nuclear coercion by the United States and Russia.[10]

Given the size and the vulnerability of China's strategic nuclear forces, any concerns that might be aroused in Russia by a US NMD deployment would hold far more strongly for China. Although a nation that possesses a thousand nuclear warheads for delivery by long-range missile might tolerate the planned NMD system, a nation with two dozen warheads is highly unlikely to do so. Moreover, while the Clinton administration is seeking to assure Russia that the planned NMD system would not threaten the Russian nuclear deterrent, the system is designed and intended to be able to defend against an attack by tens of missiles, which is the size of China's ICBM force. It is reasonable to expect that China would respond to the deployment of an NMD system so as to maintain, in the eyes of US political

[10] For a discussion of China's nuclear doctrine, see Alistair Iain Johnston, "China's New 'Old Thinking': The Concept of Limited Deterrence," *International Security*, Vol. 20, No. 3 (Winter 1995-96), pp. 5–42; Yang Huan, "China's Strategic Nuclear Weapons," *Defense Industry of China, 1949–1989* (Beijing: National Defense Industry Press, 1989), available at *www.fas.org/nuke/guide/china/doctrine/huan.htm;* and Paul Godwin and John J. Schulz, "Arming the Dragon for the 21st Century: China's Defense Modernization Program," *Arms Control Today* (December 1993), p. 6.

and military decision makers, the deterrent capability of China's nuclear forces.

In fashioning its response, China has two basic options: deploying countermeasures or increasing the size of its nuclear force by deploying more missiles and/or deploying multiple warheads on missiles. A launch-on-warning posture is not a realistic option for China because it has no attack warning system and because even a full-scale Chinese attack would be unable to overwhelm the proposed NMD system unless China also employed countermeasures or increased the number of warheads. Given China's historical emphasis on ballistic missiles, it is also unlikely that China would develop alternative means of delivery, such as long-range air- or sea-launched cruise missiles.

We believe that a buildup and modernization of China's ICBM force is a likely consequence of a US decision to deploy NMD. China may already plan to modernize its force to improve its survivability and lethality, but the timing and scale of the buildup would almost certainly be affected by a US NMD deployment. If, as seems likely, China's strategic arsenal would remain significantly smaller than those of the United States and Russia, a buildup would not materially alter the existing strategic balance. However, those who believe that the proposed NMD would fundamentally shift the strategic balance in favor of the United States, freeing the United States to act with impunity against China's perceived vital interests, are engaged in wishful thinking. China has the resources, knowledge, and incentive to maintain a credible strategic deterrent into the foreseeable future, and there is every indication that it will do just that.

To maintain an ability to increase the size of its arsenal, China may refuse to agree to end the production of fissile material for nuclear weapons. China may also fail to ratify the Comprehensive Test Ban Treaty, particularly given the rejection of that treaty by the US Senate, or may even resume nuclear testing in order to develop countermeasures to the NMD system or warheads for multiple-warhead missiles.

As with Russia, US deployment of an NMD system would strain US-China relations. Because the United States needs China's cooperation in limiting missile proliferation, a deterioration in US-China relations may also lead to an increased missile threat from other countries.

Emerging Missile States

The primary mission of the NMD system is to defend US territory against a small number of ICBMs armed with nuclear or biological warheads launched by emerging missile states, such as North Korea, Iran, and Iraq. As discussed in previous chapters, any such state could employ one or more effective countermeasures to defeat the NMD system if it wanted to use long-range ballistic missiles. Here we consider other possible responses that an emerging missile state could take to an NMD system. Several of these are elaborated in Chapter 2.

One possibility is to use ship-launched cruise missiles to deliver a nuclear or biological weapon. As the Ballistic Missile Defense Organization has disclosed in considerable detail, the United States does not have anything approaching a reliable defense against ship-launched cruise missiles.[11] Indeed, the Rumsfeld Report noted that cruise missiles have a number of characteristics that make them increasingly attractive to emerging missile states.[12] Today dozens of developing nations own tens of thousands of conventionally armed anti-ship cruise missiles, which could be converted to land-attack missiles and armed with a small but deadly payload of biological agent.[13] It would be easier to develop or acquire short-range ship-launched cruise missiles with a large enough payload to deliver a nuclear weapon than it would be to develop or acquire ICBMs.

Another reason a nation might choose to use cruise instead of ballistic missiles is the difficulty of establishing the identity of the ship from which a cruise missile was launched with sufficient confidence to permit retaliation. There are over 100,000 merchant ships with a displacement of over 100 tons, and every day about 1,000 such ships cross into the area of the Atlantic Ocean within 1,000 miles of US shores. Low-flying cruise missiles are difficult to detect and track. By contrast, the launch point of any ballistic missile, whatever its range, would be identified by US satellite sensors.

A second alternative is to launch short-range ballistic missiles from ships off the US coast—a possibility that is mentioned in both the Rumsfeld Report and the 1999 NIE. Any state that could deploy an interconti-

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[11] R. Ritter, National Cruise Missile Defense Briefing, May 1998.

[12] Executive Summary, *Report of the Commission to Assess the Ballistic Missile Threat to the United States*, July 1998, p. 2. Referred to hereafter as the Rumsfeld Report. The summary is available online on the Federation of American Scientists website at *www.fas.org/irp/threat/bm-threat.htm.*

[13] See, for example, David M. Gormley, "Hedging Against the Cruise Missile Threat," *Survival*, Vol. 40, No. 1 (1998), pp. 92–111.

nental-range ballistic missile would be capable of launching shorter-range missiles from ships at a much earlier date. Ship-launched ballistic missiles could reach large portions of the continental United States on trajectories immune to interception by the planned NMD system or air defenses, and such missiles could be considerably more accurate than an ICBM.

A third possibility is to use covert delivery methods, such as sailing a merchant ship into a harbor, using civilian aircraft, or smuggling a weapon into the United States. As the 1999 NIE notes, such delivery options would be more reliable and accurate than ICBMs deployed by emerging missile states and would probably "be more effective for disseminating biological warfare agent than a ballistic missile."[14] In addition, a first-generation nuclear weapon may be too large and heavy for delivery by a long-range ballistic missile available to an emerging missile state, but would be suitable for delivery by ship, truck, or airplane. And because an emerging missile state would likely have only a few nuclear weapons, it would want a reliable means of delivery.

In short, ICBMs are not required to attack the United States with nuclear or biological weapons. For developing countries in particular, ship-launched cruise or ballistic missiles or clandestine delivery present a far easier and surer road to such a capability than do ICBMs.

Proponents of NMD agree that other modes of delivery are possible, but they maintain that this does not negate the value of an NMD system. Deploying an NMD system would, however, exact an opportunity cost. Defense spending is limited; spending money on one thing means that money will not be spent on something else. If, as seems likely, deploying an NMD system would preclude the large expenditures required to defend against non-ICBM modes of delivery, while simultaneously increasing the likelihood that an attacker would choose one of these alternative modes, then an NMD system would leave the United States more vulnerable to attack.

Other States

The effects of a US decision to deploy an NMD system would reverberate throughout the international system. For example, if China responds by building up its nuclear force, this could trigger the deployment of nuclear-armed missiles by India and, in turn, Pakistan. Similarly, a decision by China to reject a fissile-material cutoff or the Comprehensive Test Ban Treaty would preclude participation by India and Pakistan and would doom these agreements.

If the deployment of a US NMD system resulted in a halt in US-Russian arms control efforts and a Chinese buildup, as seems likely, this would undermine the nuclear nonproliferation regime. States that agreed not to acquire nuclear weapons under the Non-Proliferation Treaty (NPT) did so under the condition, in Article VI of the treaty, that the nuclear weapon states would pursue negotiations leading to nuclear disarmament. The nuclear weapons states reiterated this commitment in connection with the indefinite extension of the treaty in 1995. The first post-extension review of the treaty, scheduled to take place this year, is expected to focus almost exclusively on the extent to which the nuclear weapon states are meeting their Article VI commitments.

Even key US allies, such as the United Kingdom, France, and Germany, are uneasy about US plans to deploy a national missile defense. European leaders have reportedly told US officials of their concerns that deploying NMD would decrease international security by prompting Russia and China to pull out of arms control treaties. They have also warned that it would complicate relations within NATO.[15] (See box on Allied Statements on NMD.)

Conclusions

The proposed US NMD system would decrease the security of the United States. Russia and China would respond to the deployment of such a system by deploying a greater number of warheads than otherwise planned. In addition, Russia would likely increase its reliance on launch-on-warning to ensure that any retaliatory strike would be large enough to overwhelm the NMD system. A decision to deploy an NMD system would also have a generally negative effective on US relations with Russia and China and would threaten cooperative efforts to decrease the number of nuclear weapons, improve controls on weapons and weapon materials, and combat proliferation. Finally, an NMD system could prompt emerging missile states to concentrate on other modes of delivery.

[14] National Intelligence Council, "NIE: Foreign Missile Development," p. 15.

[15] See, for example, William Drozdiak, "Possible US Missile Shield Alarms Europe," *Washington Post*, 6 November 1999, p. 1.

Allied Statements on US NMD Plans

"If you start this [NMD], you're starting the arms race back up."

—NATO official
("A Case of the Jitters," Paul Bedard, *US News & World Report*, 12-13-99, p. 12)

"If only one side, the United States, begins to step up [defense capabilities], a Cold War atmosphere will be created."

—Jonathan Motzfeldt, prime minister of Greenland's home rule government
("Greenland Says Russia Must Back US Missile Plan," Reuters, Copenhagen, 11-3-99)

"Great care should be taken not to damage a system that, for almost 30 years, has underpinned nuclear restraint and allowed nuclear reductions."

—Lloyd Axworthy, Canadian Foreign Affairs Minister
("Canada Stuck in Nuclear Squabble,"Mike Trickey, *The Ottawa Citizen*, 11-17-99, p. A13)

"The Americans are obviously prepared to take advantage of Russia's present weakness to realize their own national interests.... America's current arms policy is nothing less than an affront: The ABM treaty is being called into question, spending for the NMD anti-missile system is being more than doubled. This means that Russia is no longer accepted as a partner in security policy. And this thoughtlessness on Washington's part hurts Russia's self-esteem, which ultimately only strengthens the nationalists and national communists.

—Gernot Erler, Deputy Chair of the SPD Group in the German Bundestag
(Deutsches Allgemeines Sonntagsblatt, 2-5-99, p. 8)

"We already went through this debate during the 1980s with Ronald Reagan and the idea of a 'Star Wars' anti-missile system. We learned how dangerous and divisive it can be when you tamper with the ABM treaty, and that is one thing that has not changed since the end of the Cold War."

—Senior NATO official
("Possible US Missile Shield Alarms Europe," William Drozdiak, *Washington Post*, 11-6-99, p. 1)

"This project destabilizes the present situation. By questioning the ABM Treaty, we are moving directly from non-proliferation to counter-proliferation.… But where are the potential aggressors? Why should rogue states not be persuaded by the logic of deterrence?… Might this system not trigger a new arms race, raising the risk of proliferation in unstable regions of the world?… We would like this project to be studied quietly, and without any premature decisions. But it concerns the whole world."

—Gen. Jean-Pierre Kelche, French chief of defense staff
("French Army Chief Rejects Washington's Fears of a NATO Split," Carey Schofield, *London Daily Telegraph*, 11-23-99)

"We must avoid any questioning of the ABM treaty that could lead to disruption of strategic equilibria and a new nuclear arms race."

"If you look at world history, ever since men began waging war, you will see that there's a permanent race between sword and shield. The sword always wins. We think that these systems are just going to spur swordmakers to intensify their efforts."

"China, which was already working harder than we realized on both nuclear weapons and delivery vehicles for them, would of course be encouraged to intensify those efforts, and it has the resources to do so. India would be encouraged to do the same thing, and it, too, has the resources. And it would also increase tensions within NATO, which would be too bad."

—French President Jacques Chirac
("US and NATO Allied Divided Over Defense Needs," Craig R. Whitney, *New York Times*, 12-3-99, p. A6, and "With a 'Don't Be Vexed' Air, Chirac Assesses US," Craig R. Whitney, *New York Times*, 12-17-99)

"We are worried the Americans are going to ruin the Anti-Ballistic Missile treaty, and then the whole deck of cards would tumble down."

—European defense official
("Europe Disputes Need for Ballistic Missile Defense," Colin Clark and Luke Hill, *Defense News*, 12-13-99, pp. 3, 28)

Chapter 13

Deterrence and Diplomacy

Previous chapters have shown that the planned NMD system would be ineffective at defending the United States against even limited attacks by long-range ballistic missiles, whether launched by emerging missile states, Russia, or China. Nor would any national missile defense address the threats posed to the United States by other means of delivering nuclear, biological, or chemical weapons. As discussed in Chapter 2, several other means of delivery are far less demanding technically and more accurate than are long-range missiles, and would therefore offer an attacker with limited technical resources a simpler and more reliable means of attacking US territory.

The threat that the planned NMD system is intended to counter is not new. For decades the United States relied on deterrence to cope with the far graver threat to its very survival posed by Soviet nuclear-armed missiles. Deterrence will continue to be the ultimate line of defense against attacks using weapons of mass destruction.

The harsh truth that the planned NMD system would not be effective means that the United States must continue to respond to the threat of missile attack in other ways. The United States, in concert with other countries, can continue to reduce the missile threat through a combination of export controls and various cooperative measures and agreements. If preventive policies fail, and a hostile emerging missile state obtains intercontinental-range missiles armed with nuclear, chemical, or biological weapons, the United States could deter the use of such weapons through the threat of overwhelming retaliation. If such a state makes an explicit and credible threat to launch a missile attack against the United States, it may be possible to destroy its missiles before they are launched, in accord with the right of self-defense.

In addition, a rational approach to national security would impel the United States to pursue research and development programs that would address the most plausible means that emerging missile states could use to deliver nuclear, biological and chemical weapons—not just long-range ballistic missiles.

In this study, we do not examine in detail alternative means of addressing the missile threats that the NMD system is intended to defend against. However, for completeness, in this chapter we briefly review some of the other means by which the United States can address the missile threat from emerging missile states such as North Korea, Iran, and Iraq, and from Russia and China.

Emerging Missile States

For the emerging missile states, a major barrier has been the acquisition of long-range missiles or the technology to build them.

Export Controls. The centerpiece of efforts to prevent the acquisition of missile technology is the Missile Technology Control Regime (MTCR). The MTCR is a voluntary arrangement to control the export of missiles and missile technologies, components, and production facilities. The regime began in 1987 and today 29 countries are members.[1] There are also

[1] As of March 1998, members were Argentina, Australia, Austria, Belgium, Brazil, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, the Russian Federation, South Africa, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Nonmember states that have agreed to adhere to MTCR guidelines include Bulgaria, China, the Czech Republic, Israel, Poland, Romania, the Slovak Republic, South Korea, and Ukraine.

export control regimes to limit the spread of nuclear, chemical, and biological weapons.

Export controls have slowed proliferation substantially over recent decades, reducing to a handful the number of countries that might acquire intercontinental-range missiles and nuclear weapons. Export controls deter countries from attempting to build missiles and buy time against those that try.[2] Nevertheless, export controls have not prevented proliferation altogether: North Korea, Iran, and Iraq are believed capable of developing long-range missiles in the near future, and India, Israel, and Pakistan have nuclear weapons. In some cases, supplier governments are unwilling or unable to enforce controls. For example, there is strong evidence that Iran received advanced missile technology from firms in Russia, despite Russia's membership in the MTCR and repeated assurances by the Russian government that it would prevent such transfers. Iraq also demonstrated that a determined country can develop weapons of mass destruction through a combination of indigenous programs and circumvention of export controls.

Export controls cannot be effective without the cooperation of Russia and China, and their willingness to cooperate will be undermined by the US deployment of a national missile defense system.

Cooperation. Cooperative policies, such as security assurances and various economic or diplomatic measures, can give countries powerful incentives to voluntarily abandon, curtail, or reorient their weapons programs or deployments, or never to begin such programs. This strategy has often been successful in the past, and its future potential is substantial.[3]

Even countries that are hostile to the United States may be willing to reduce the threat they pose to the United States, given the proper incentives.[4] For example, in 1994 North Korea agreed to verifiably freeze and ultimately eliminate its plutonium-production program in exchange for two nuclear power reactors and other assistance. According to press reports, North Korea has indicated on several occasions its willingness to end missile exports in exchange for aid.[5] North Korea might also be persuaded to end the development and testing of new, longer-range missiles. Following former Secretary of Defense William Perry's trip to North Korea in the spring of 1999 and the US announcement that it would ease some economic sanctions, North Korea agreed to observe a moratorium on missile flight tests as long as discussions on these issues with the United States were continuing.

Deterrence. Despite the best efforts of the United States, it may not be able to prevent or dissuade some countries from acquiring long-range missiles. Nevertheless, if any emerging missile state were to use, or threaten to use, such missiles against the United States, it would have to disregard the fact that the United States is by far the world's strongest military power with an unquestioned ability to destroy the government of such a state.

Indeed, the United States has made it clear that it will exploit its power as a deterrent against emerging missile states. For example, during the 1991 Persian Gulf War, General Colin Powell threatened to destroy Iraq's ports, highways, railroads, airlines, oil facilities, and, if necessary, the dams on the Tigris and Euphrates rivers if Iraq used chemical and biological weapons.[6]

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[2] In the cases of Argentina and Brazil, for example, export controls hindered the development of long-range missiles and nuclear weapons, allowing time for civilian governments to come to power in 1983–85 and put an end to these weapons programs.

[3] For example, in exchange for compensation from Russia and various incentives from the United States, Belarus, Kazakhstan, and Ukraine returned former Soviet nuclear weapons to Russia following the breakup of the Soviet Union. Also, South Korea and Taiwan abandoned their nuclear weapons programs (in the late 1970s and 1980s, respectively) when it became clear that continuing them would jeopardize continued US economic engagement and security cooperation.

[4] Such incentives are sometimes characterized as "bribery" or "rewards for bad behavior," but it is better for the United States to be pragmatic than sanctimonious. In fact, the United States has a long history of attempting to modify the interests of other states through a variety of incentives and disincentives.

[5] See, for example, David Wright "The Case for Engaging North Korea," *Bulletin of the Atomic Scientists*, March/April 1999, pp. 54–58, and Korean Central News Agency (KCNA) commentary, "Nobody Can Slander DPRK's Missile Policy," 16 June 1998.

[6] On the eve of the Persian Gulf War, General Colin Powell sent the following warning to Saddam Hussein: "Only conventional weapons will be used in strict accordance with the Geneva Convention and commonly accepted rules of warfare. If you, however, use chemical or biological weapons in violation of treaty obligations we will: destroy your merchant fleet, destroy your railroad infrastructure, destroy your port facilities, destroy your highway system, destroy your oil facilities, destroy your airline infrastructure." He added that, if driven to it, "we would destroy the dams on the Tigris and Euphrates rivers and flood Baghdad, with horrendous consequences." Colin L. Powell, *My American Journey* (New York: Random House, 1995), p. 504.

Some NMD proponents, including Secretary of Defense Cohen, argue that the United States needs an NMD system because emerging missile states might threaten to attack the United States with long-range missiles to deter it from using conventional forces to intervene in a regional conflict.[7] For example, North Korea might threaten to attack the United States if it moved to defend South Korea against an invasion by the North. In the Cold War, however, even the massive Soviet nuclear arsenal did not deter the United States from promising to defend its European allies against a Soviet conventional attack. Although this promise was never put to the test, Soviet and European leaders alike considered it credible.

Nevertheless, there may indeed be situations in which such a threat of attack would influence US decision-making, and it would be preferable if such situations never arose. However, a US NMD system would not ease this problem because US leaders could not be confident that the NMD system would be effective. If US leaders were unwilling to take action that might prompt a ballistic missile attack on the United States without an NMD system, they would also be unwilling to do so with this NMD system.

Prelaunch Destruction. During a pre-existing state of war, or if an emerging missile state made an explicit and credible threat to attack the United States with long-range missiles carrying weapons of mass destruction, the United States could try to destroy the missiles and their launchers before they could be used. A first-generation intercontinental-range ballistic missile would be liquid-fueled and large. Such missiles would not be mobile. Their location would likely be detected by US satellites and other intelligence-gathering means. While the United States failed during the 1991 Gulf War to locate and destroy any of Iraq's mobile launchers for its short-range Scud missiles, this failure does not indicate that the United States could not destroy long-range missiles deployed by emerging missile states on receipt of strategic warning of their launch. Moreover, while the Rumsfeld Commission judged that the *development* of long-range missiles could escape detection for a longer period than had previously been assumed, that does not mean that US intelligence satellites could not detect the *deployment* or launch preparation of such missiles.

Of course, prelaunch destruction would be an act of war, and it might be difficult for the United States to decide to preempt even if hostilities had broken out. The ambiguities that always attend decisions in a crisis would, in this circumstance, be dominated by the uncertainty about the reliability of intelligence and would not be resolved by a missile defense of dubious effectiveness. If a credible threat was made to launch weapons of mass destruction at US territory, preemption would be a serious option—one that an emerging missile state could not ignore and which would be a strong deterrent in itself.

Boost-Phase Defenses. A boost-phase defense system designed to destroy missiles very early in their flight would be less vulnerable to countermeasures than the planned US NMD system.[8] By destroying missiles in their boost phase before submunitions could be released, such defenses could also be effective against missiles carrying biological or chemical agents.[9] However, it should not be assumed that planned US theater missile defenses could provide a basis for a boost-phase defense against long-range missiles.

A boost-phase missile defense could use very fast interceptors deployed in underground silos or on offshore platforms. Because an interceptor would only have a short time to reach the missile during its boost phase, a boost-phase defense could only intercept missiles that were launched from points relatively close to the interceptor sites (perhaps within a distance of a thousand kilometers) and from over a relatively small area. Consequently, the system might work against geographically small emerging missile states, but could not provide a boost-phase defense against missiles launched from large countries such as Russia or China.

[7] See, for example, Secretary of Defense William B. Cohen, Testimony to the Senate Armed Services Committee, 8 February 2000. See also, Jim Garamone, "Missile Defense Would Counter Nuclear Blackmail," American Forces Press Service, 7 February 2000, and William Safire, "Team B vs. CIA," *New York Times*, 20 July 1998, p. A15.

[8] Countries seeking to defeat a boost-phase defense could try to reduce the duration of the boost phase of their missiles, but doing so would require developing advanced solid-fueled missiles, which are quite different from the liquid-fueled missiles that are now the foundation of the missile programs in North Korea, Iran, and Iraq.

[9] Richard L. Garwin, "The Wrong Plan," *Bulletin of the Atomic Scientists*, March/April 2000, pp. 36–41, and Richard L. Garwin, "Cooperative Ballistic Missile Defense," presented at the US State Department Secretary's Open Forum on National Missile Defense Against Biological and Nuclear Weapons, 18 November 1999 (available online on the Federation of American Scientists website at *www.fas.org/rlg/991117.htm*).

Deploying such a system would likely face significant policy obstacles. Deployment could raise significant concerns in Russia and China, which might be concerned that the United States could retrofit the fast interceptor boosters with kill vehicles intended for midcourse interception, making the system capable of engaging long-range missiles launched from anywhere in Russia or China. Moreover, basing the defense close enough to some emerging missile states would be a challenge, although this would not be the case for North Korea.

Russia and China

Nuclear-armed Russian missiles on rapid-launch status are a real and present danger to the security of the United States. China also has a small force of nuclear-armed missiles capable of striking US territory. In the case of Russia, the threat of deliberate attack has receded, but this has been superseded by the danger of accidental, erroneous, or unauthorized launch. Moreover, as noted in the previous chapter, US deployment of an NMD system may lead Russia and China to react in ways that increase the threat that their missiles pose to the United States. For example, Russia may increase its reliance on a "launch-on-warning" policy, and China may deploy many more warheads than it otherwise would have.

Russia. Only cooperation can reduce the risk of accidental, erroneous, or unauthorized launch of Russian missiles. Accidental launch cannot be deterred. US security is inextricably linked to the proper management of Russia's nuclear forces. US-Russian cooperative programs are needed to prevent unintended launches, and to reduce the risk that Russian nuclear weapons, weapon materials or weapon know-how might be stolen or sold. However, US NMD deployment is likely to make such cooperation much more difficult.

The risk of accidental, erroneous, or unauthorized launch of Russian missiles could be reduced through a variety of cooperative measures to reduce the size and launch-readiness of missile forces. The current situation, in which both countries stand ready to launch thousands of nuclear warheads in a few minutes, is exceedingly dangerous. Deterrence requires the ability to retaliate, not the ability to retaliate instantaneously. To reduce the risk of accidental, unauthorized and erroneous attack, both countries could take their vulnerable forces (silo-based missiles, garrisoned mobile missiles, and pier-side sub-launched missiles), or all their nuclear missile forces, off rapid-launch alert status.

In the case of the United States, which has a large number of invulnerable sea-based warheads, nuclear deterrence would be robust even if all of its nuclear weapons were incapable of immediate launch. This is less clearly so for Russia, which has a smaller number of warheads survivably deployed at any given time. Thus, even more so than for the United States, Russian willingness to take weapons off rapid-launch status would depend on the state of relations between the two countries. The US deployment of an NMD system would not only damage such relations, but would likely be viewed as a threat to the utility of Russia's survivable nuclear forces. Its deployment may, therefore, lead Russia to increase the fraction of its forces ready for immediate launch.

Another cooperative approach for dealing with accidental, erroneous, or unauthorized launches would be to install postlaunch nuclear-warhead destruction devices on all ballistic missiles.[10] Such destruction devices are used in tests of US missiles for safety purposes. In this case the devices would be installed on the warheads rather than the missiles so that they could be used even after the warhead was released from the missile.

China. As with Russia, the only practical way to deal with the Chinese missile threat is through a combination of deterrence and cooperation.

Cooperative measures can reduce the Chinese missile threat. China has at times in the past been reluctant to engage in arms control negotiations because its nuclear force is much smaller than those of the United States and Russia and less capable than those of France and Britain. But China joined the other nuclear-weapon states in signing the Comprehensive Test Ban Treaty and submitted it to the National People's Congress for ratification even after the US Senate voted the treaty down in October 1999.[11] China also joined the four other nuclear-weapon states in an informal freeze on the production of fissile material for weapons, pending the negotiation of a formal convention. China may also be willing to join in other arrangements that the other four original nuclear-weapon states found mutually agreeable.

[10] Sherman Frankel, "Aborting Unauthorized Launches of Nuclear-Armed Missiles Through Postlaunch Destruction," *Science and Global Security*, Vol. 2 (1990), pp. 1–20.

[11] "China Submits N-Test Ban Treaty to Parliament," Reuters, 1 March 2000.