Many different approaches could be used to address the factors that could contribute to nuclear use. In this chapter, we first discuss a wide range of possible options for addressing the factors we identified in Chapter Two as contributing to the accidental or unauthorized use of nuclear weapons. Some of these approaches could be implemented unilaterally, some cooperatively, and some either way. We then focus on ten specific options for addressing the nuclear risk problem, develop them fully, and evaluate them carefully. We emphasize the details of each option as much as possible in our evaluation, because the way in which an option is implemented is likely to affect its success. We discuss our recommendations about which options to pursue and in which order in the next chapter.

FINDING SOLUTIONS TO THE POTENTIAL CAUSES OF NUCLEAR USE

The analysis in Chapter Two suggests that accidental or unauthorized use of nuclear weapons could be caused by a number of underlying factors—from nuclear forces being kept at high levels of alert, to inadequate early-warning information, to inadequate security and control of nuclear forces. But what can be done to eliminate or control these contributing factors and thereby reduce the chances of nuclear use? Or if these factors cannot be addressed directly, can something be done to mitigate the results of nuclear use to some degree?

Table 4.1 shows the wide range of possible approaches we explored as ways to address each contributing factor. For example, in the case
### Table 4.1

**Illustrative Approaches for Addressing Factors That Could Contribute to Accidental or Unauthorized Nuclear Use**

<table>
<thead>
<tr>
<th>Contributing Factors</th>
<th>Illustrative Approaches&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
</table>
| Nuclear forces kept at high day-to-day launch readiness | • Pull back SSBNs from forward areas  
• Keep attack submarines out of bastions  
• Deploy missile defenses  
• Adopt a new deterrence strategy  
• Install DAL mechanisms  
• Reduce launch readiness (for part or all of force) |
| Perceived vulnerability of nuclear forces or command and control systems | • Reduce forces  
• Pull back SSBNs from forward areas  
• Keep attack submarines out of bastions  
• Remove W-88 warheads  
• Adopt a new deterrence strategy  
• Reduce counterforce potential  
• Transfer command and control technology  
• Improve survivability of forces and command and control systems |
| Inadequate early-warning information | • Provide shared access to reliable early-warning information  
• Provide funding to fill in Russian space and radar network  
• Deploy sensors on silos |
| Short decision times | • Pull back SSBNs from forward areas  
• Keep attack submarines out of bastions  
• Reduce launch readiness (for part or all of force)  
• Adopt a new deterrence strategy  
• Install DAL mechanisms  
• Provide shared access to reliable early-warning information  
• Provide funding to fill in Russian space and radar network  
• Improve survivability of forces and command and control systems |
| Deterrence doctrine or posture reliant on launch on warning or launch under attack | • Reduce counterforce potential  
• Pull back SSBNs from forward areas  
• Keep attack submarines out of bastions  
• Transfer command and control technology  
• Adopt new deterrence strategy  
• Reduce launch readiness (for part or all of force)  
• Provide shared access to reliable early-warning information  
• Deploy sensors on silos |
| Inadequate security and control of nuclear forces | • Transfer command and control technology  
• Deploy missile defenses  
• Install DAL mechanisms  
• Improve morale and personnel reliability programs |
| Inadequate training precautions | • Conduct training exercises on isolated systems  
• Install DAL mechanisms  
• Deploy missile defenses |

<sup>a</sup>These approaches are not in any particular order.
of high levels of day-to-day launch readiness, we examined approaches that would reduce the vulnerability of nuclear forces, thereby eliminating an important incentive for keeping forces ready to launch at a moment’s notice. Two options in this case are to keep attack submarines out of ballistic missile submarine bastions and to keep ballistic missile submarines far away from their targets. We also studied ways to reduce the effects of nuclear weapon use, including deploying missile defenses and installing mechanisms on missiles that would destroy them or their warheads if the launch were in error or without authorization. In addition, we examined options aimed at changing deterrence strategies in order to reduce a country’s reliance on damage limitation, which, in turn, could reduce the need to keep large numbers of prompt counterforce weapons ready to launch quickly. Finally, we examined options for reducing the launch readiness of nuclear forces directly.

Another contributing factor—the perceived vulnerability of nuclear forces and command and control systems—could be addressed by reducing the nuclear forces that threaten them or by altering the way that the most-threatening forces are postured. Examples include reducing inequities in the numbers of deployed nuclear forces, removing the counterforce potential of nuclear forces, and keeping attack submarines and ballistic missile submarines away, as discussed above. Adopting a new deterrence strategy that does not require large, rapid reaction forces can also help, particularly if it allows changes in the way that nuclear forces are postured and operated that are visible and perceived as less threatening. Of course, perceived vulnerability can also be improved by deploying and operating forces in such a way that they are more survivable on a day-to-day basis. More-survivable forces will not help, however, if command and control systems remain vulnerable. So improvements in the survivability of these systems, including technology transfer, might be considered to improve nuclear safety.

Inadequate access to reliable and accurate early-warning information can be addressed by sharing early-warning information, taking concrete steps to fill holes in Russia’s radar and satellite early-warning systems, or developing complementary early-warning systems, such as deploying sensors outside ICBM silos that detect launches.
Short decision times can be addressed by improving access to early-warning information, increasing the survivability of nuclear forces, adopting a deterrence strategy that does not require prompt responses, or reducing the launch readiness of nuclear forces.

Another contributing factor—deterrence doctrines reliant on launch on warning or launch under attack—can be addressed by many of the approaches outlined above for improving the survivability of nuclear forces and command and control systems, particularly if having more-survivable forces encourages a country to back away from prompt launches. Improving access to early-warning information can also be helpful if it is done in ways that extend warning times.

Inadequate security and control of nuclear forces can be addressed by transferring command and control technology, improving the morale of personnel in sensitive positions, and improving personnel reliability programs. If controls fail and a launch occurs, destruct-after-launch (DAL) systems and missile defenses may be able to mitigate the effects of the launch.

The final factor—inadequate training precautions—can be addressed through programs designed to correct weaknesses in existing training programs, including conducting training exercises only on isolated systems that have been disabled or do not carry live nuclear warheads. DAL and missile defense systems could be used as a last resort to address the effects of an accidental launch.

As the preceding discussion indicates, many of the approaches we examined can address more than one contributing factor. In fact, there are only 14 different approaches in Table 4.1. These are quite general, however: “Improve access to early-warning information,” “reduce launch readiness,” and “deploy missile defenses” can, for example, each be implemented in many ways. Moreover, the specifics of how an approach would be implemented and monitored are central to its success in reducing nuclear risk. A poorly designed approach might even increase the risk of accidental or unauthorized use.

To examine these issues thoroughly, we created a set of ten specific nuclear safety options that represent concrete ways to design a number of the approaches listed in Table 4.1:
1. Provide assistance for improving Russia’s early-warning radars or satellites.

2. Establish a joint, redundant early-warning system by placing sensors outside U.S. and Russian missile silos.

3. Immediately stand down all nuclear forces to be eliminated under the 2002 Moscow Treaty.

4. Pull U.S. strategic ballistic missile submarines away from Russia.

5. Keep U.S. attack submarines away from Russia.

6. Remove W-88 warheads from Trident missiles.

7. Reduce day-to-day launch readiness of 150 ICBMs in silos.

8. Reduce day-to-day launch readiness of all nuclear forces.

9. Install destruct-after-launch (DAL) mechanisms on ballistic missiles.


These ten options were chosen for three reasons: (1) In an initial assessment, some options appeared to have a great deal of promise for reducing nuclear dangers and improving nuclear safety. In our judgment, they thus deserved further exploration. (2) Some options had been proposed by one or more analysts investigating the problem of accidental and unauthorized launch. We wanted to evaluate these approaches against our decision criteria for evaluating nuclear safety options (see Chapter Three). (3) Some options had been rejected by other studies as difficult to verify or as seeming to place Russia or the United States at a disadvantage due to the historical asymmetries in the countries’ nuclear forces.¹ In our view, these

studies seemed overly concerned with maintaining the Cold War equilibrium of Russian and U.S. nuclear forces and thus outdated considering the vast changes in U.S-Russian relations since 1991. We wanted to reconsider these options, taking the broader view offered by our criteria so as to take into account their effects on larger issues, such as U.S.-Russian relations and U.S. nonproliferation and counterterrorism goals, as well as their overall feasibility and cost.

There are three important types of options that we did not explore in detail but whose importance we do not want readers to overlook: adopting new deterrence strategies, transferring command and control technology, and improving training practices. Specific information about nuclear deterrence strategies and doctrines is a closely held secret. Similarly, information about command and control systems, their status, and the technology involved is kept secret by both countries, as are the details of training procedures. All of this makes it difficult to develop detailed options. Nevertheless, new deterrence strategies are important to achieving significant progress in nuclear safety, and their significance is discussed in general terms for several of the options. It will also be critical for both Russia and the United States to maintain very strong and survivable command and control systems and to take whatever steps are necessary, including sharing technology, to ensure these systems’ viability. And both nations must remain vigilant in their efforts to avoid training accidents.

The remainder of this chapter is devoted to describing and evaluating our 10 specific nuclear safety options. Note that many of the options are presented as two separate approaches that could be adopted, the choice of one over the other usually relating to the degree of allowable or available monitoring.

**OPTION 1: PROVIDE ASSISTANCE FOR IMPROVING RUSSIA’S EARLY-WARNING RADARS OR SATELLITES**

This option is a possible solution for two contributing factors:

- Inadequate early-warning information
- Short decision times
Table 4.2 summarizes our evaluation of Option 1 in terms of the nuclear safety criteria. For this option, two separate approaches are offered, as discussed below.

**Background**

A high-quality, reliable early-warning system can reduce the risk of unintended nuclear use in two fundamental ways. It can improve the quality of early-warning information, thereby ensuring that both countries have a clear, accurate picture of what is happening around the globe, and it can increase the warning time available to each country before it must make a decision to launch a counterattack.

Chapter Two discusses the worrisome state of Russia's satellite- and radar-based early-warning systems. There are several ways the

Table 4.2  
Evaluation of Option 1

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Approach 1: Provide funding for Russia’s radar network</th>
<th>Approach 2: Provide funding and technology for Russia’s satellite network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Very positive</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on U.S.- Russian political relations</td>
<td>Very positive</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
United States can provide funding and technology to help Russia overcome the shortcomings in its early-warning network. First, to varying degrees the United States can help fund Russian efforts to launch new satellites or to construct early-warning radars. This could range from paying Russian scientists to continue researching early-warning satellites, to fully funding the development, construction, and launch of Russian early-warning satellite systems. Second, there are various levels of technology the United States can provide. The United States is already involved in a joint venture with Russia—known as the Russian-American Observational Satellite (RAMOS) program—that involves the efforts of American and Russian scientists to improve early-warning technology for both countries.2

Specifics

Approach 1: Provide Funding for Russia’s Radar Network. Approach 1 illustrates one potential avenue for improving Russia’s early-warning system: the United States provides funding to help Russia build two new Pechora-class early-warning radars. The first would be deployed in Belarus, a close ally of Russia, to plug the hole caused by the loss of the Skrunda radar. The second would be deployed in Russia’s far east to fill the gap that would have been filled by the now disassembled Krasnoyarsk radar. In each case, the new radar would be the same as Russia’s existing phased-array radars, which are the newest type of early-warning radar Russia possesses.

The two new radars would increase the warning time for Russian leaders for a U.S. attack coming through these corridors by 5 to 15 minutes (the time range reflects the variety of possible launch locations and aim points of the attacking Trident missiles). If Russia were to deploy a global space-based system like the DSP, the radars would not necessarily add any warning time, but they would improve the quality of the early-warning information by giving more-precise

location and tracking information and adding the ability to confirm whether a possible attack is real or not.

**Approach 2: Provide Funding and Technology for Russia’s Satellite Network.** Another way to improve Russia’s access to reliable, accurate early-warning information is to provide funding and technical assistance for Russia’s early-warning satellite system. According to Russian scientists, six completed Oko early-warning satellites are sitting on the ground waiting to be launched into space.3 The United States could pay to have these highly elliptical earth-orbiting Oko satellites launched on Russian launch vehicles. If these satellites were deployed, Russia would once again have 24-hour coverage of U.S. ICBM fields (but would not have coverage of the areas where Trident submarines operate). This option would cost approximately $160 million, according to the Congressional Budget Office (CBO).4 However, it would be only a partial solution to Russia’s early-warning problems, because Oko satellites are effective for only three years due to their highly elliptical orbits.5 Thus, additional launches would be required to keep Russia’s early-warning system operational over the next 10 years.

Another possibility is for the United States and Russia to accelerate their current joint research efforts to improve the effectiveness of early-warning technology—i.e., the RAMOS program. One area of research RAMOS is investigating is how to improve a satellite’s ability to filter out reflected sunlight from clouds, snow, ice, and oceans—a major cause of clutter for space-based early-warning systems. If this research is successful, Russia will be able to deploy geosynchronous satellites with capabilities much greater than those of either its current Oko satellites or its now dysfunctional Prognoz geosynchronous satellites. Russia would then be able to achieve global coverage with only three satellites.6

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The United States could accelerate Russia’s development of next-generation geosynchronous satellites by letting Russia import sensors and other components for satellite construction from the West. This transfer of technology would allow Russia to speed up its development process by quickly making available key satellite components that otherwise will take years to develop and manufacture. To transfer the technology, the United States would have to waive certain export restrictions on sensitive space-based technologies—restrictions put in place to prevent adversaries from gaining information about U.S. early-warning system capabilities and access to sensitive technologies.

**Evaluation**

**Contribution to Reducing the Risk of Nuclear Use.** Improving the ground- or space-based portions of Russia’s early-warning system will greatly diminish the potential for an accidental launch based on incorrect or inadequate information. Enhancement of the early-warning system should provide Russian leaders with an additional 10 to 25 minutes to determine whether they are under nuclear attack by the United States. (See Table 4.3, which compares the effect of each option on decision time, time to re-alert, and time to detect cheating.) It also would provide better-quality and more-reliable early-warning information, which should give national leaders more confidence in their deterrent capability, thereby adding several more minutes to the time they have to determine what kind of response, if any, is appropriate. A global space-based early-warning system would also provide confirmation that Russia was not being attacked by countries other than the United States.

**Effect on Current U.S. Strategies and Targeting Plans.** Improvements to Russia’s early-warning system will have only a minimal effect on current U.S. strategies and targeting plans, but they will reduce the chances of Russian accidental use, which is an important part of stability. It is possible, however, that the transfer of sensitive space-based technology and U.S. help in constructing ground-based radars will improve Russia’s nuclear war-fighting capabilities.

First, a technology transfer might allow Russia to understand the limitations and weaknesses of the U.S. early-warning system. Russia also might transfer what it learns to third countries, such as China or
North Korea. This issue has become more important because of Russia's technical assistance to Iran's space program. However, the United States already shares early-warning information with key allies and has a system in place to protect sensitive information. Furthermore, the technology the United States would transfer is from the 1970s, and many of the key materials and systems will be changed in the new Space Based Infrared System High (SBIRS-High) that the United States plans to deploy within the next decade.

Second, if the United States helps Russia improve its ground-based radars, Russia may be able to devise a primitive national anti-ballistic missile (ABM) system. In fact, during the 1970s, the United States accused Russia of violating the ABM Treaty by building the Pechora-type ground radars in the first place. Although it is technically possible that Russia could develop a very limited missile defense, the cost involved seems prohibitive given Russia's economic condition, and the quality of those long-wavelength systems limits their use for missile defense. Finally, additional ground-based radars and improved data processor technology might improve Russia's air-to-air or air-to-ground missile capabilities. However, Russia already excels in this area, and any technology the United States transfers is unlikely to be an improvement.

Effect on U.S.-Russian Political Relations. Joint U.S.-Russian efforts to upgrade early-warning systems are likely to improve relations between the two nations. Greater levels of technology transfer would indicate a new level of U.S. trust and confidence in Russia, placing Russia among a select group of countries (such as Britain and France) with which the United States is willing to share sensitive information.

This option will have only a minimal effect on diminishing the importance of nuclear weapons in the U.S.-Russian relationship. In fact, in a perverse sense, it emphasizes the importance of nuclear weapons by acknowledging that an attack is possible.

Effect on Other Major International Actors (China, Europe, etc.). Option 1 will have a minimal effect on other major international actors. Its only effect is likely to be an indication that Russia and the United States are working together to limit the potential for an accidental nuclear conflict.
Table 4.3
Effects of the Options on Time to Re-alert, Time to Detect Cheating, and Decision Time

<table>
<thead>
<tr>
<th>Option</th>
<th>Time to Re-alert</th>
<th>Time to Detect Cheating</th>
<th>Extension in Decision Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Missile</td>
<td>Entire Arsenal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Entire Arsenal</td>
<td>First Missile</td>
<td>Entire Arsenal</td>
</tr>
<tr>
<td>1. Help improve Russia’s early-warning system by:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach 1: Provide funding for Russia’s radar network</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Approach 2: Provide funding and technology for Russia’s satellite network</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2. Establish early-warning system by deploying sensors on silos</td>
<td>N/A</td>
<td>N/A</td>
<td>Minutes</td>
</tr>
<tr>
<td>3. Immediately stand down all nuclear forces to be eliminated under Moscow Treaty</td>
<td>Day</td>
<td>Months</td>
<td>Month</td>
</tr>
<tr>
<td>4. Pull Tridents away from Russia:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach 1: No monitoring</td>
<td>Week</td>
<td>Month</td>
<td>—</td>
</tr>
<tr>
<td>Approach 2: Monitoring</td>
<td>Week</td>
<td>Month</td>
<td>5–10 weeks</td>
</tr>
<tr>
<td>5. Keep U.S. attack submarines away from Russia</td>
<td>Week</td>
<td>Month</td>
<td>Week</td>
</tr>
<tr>
<td>6. Remove W-88 warheads from Trident missiles</td>
<td>Day</td>
<td>Weeks</td>
<td>Months</td>
</tr>
<tr>
<td>7. Reduce launch readiness of 150 silo-based missiles:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach 1: Enhanced START monitoring</td>
<td>Day</td>
<td>Weeks</td>
<td>Months</td>
</tr>
<tr>
<td>Approach 2: Continuous monitoring</td>
<td>Day</td>
<td>Weeks</td>
<td>Minutes</td>
</tr>
</tbody>
</table>
Table 4.3 (continued)

<table>
<thead>
<tr>
<th>Option</th>
<th>Time to Re-alert</th>
<th>Time to Detect Cheating</th>
<th>Extension in Decision Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Missile</td>
<td>Entire Arsenal</td>
<td>First Missile</td>
</tr>
<tr>
<td>8. Reduce launch readiness of all forces:</td>
<td>Day</td>
<td>Weeks</td>
<td>Months</td>
</tr>
<tr>
<td>Approach 1: Enhanced START monitoring</td>
<td>Day</td>
<td>Weeks</td>
<td>Months</td>
</tr>
<tr>
<td>Approach 2: Continuous monitoring</td>
<td>Day</td>
<td>Weeks</td>
<td>Minutes</td>
</tr>
<tr>
<td>9. Install DAL mechanisms</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>10. Deploy limited missile defenses of the U.S.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

NOTES: N/A = not applicable; SSBN = ballistic missile submarine; DAL = destruct after launch.

aThis option ensures coverage of all attack corridors to Russia. It closes gaps that U.S. submarine-launched missiles could exploit. It does not, however, extend the warning time against attacks by U.S. ICBMs. Nor does it extend warning time if Russia deploys a space-based system that provides global coverage.

bThis option does not affect the launch readiness of a significant portion of the force and therefore has no effect on decision time.

cAlthough a DAL system would provide some time to abort an attack by ballistic missiles (10–20 minutes in the case of a midcourse system), it would not extend decision time in the traditional sense because no leader would launch first and plan to recall later if he were wrong—the risks would be too great.

Some defense experts have suggested that a global early-warning system be set up to provide information on ballistic missile launches around the world. This could be particularly useful in South Asia, because India, Pakistan, and China have no early-warning systems, and the possibility of misinterpreted information leading to nuclear conflict in the region is real. It might be possible for the United States and Russia to jointly provide information to an early-warning center in each country. The problem with this idea is that the countries may not believe the information, particularly during a crisis with the potential for nuclear use. Still, this is one option that would allow the United States to expand its nuclear safety efforts beyond Russia, something likely to become increasingly important as more nations acquire nuclear weapons.
Effect on Prospects for Achieving Nonproliferation and Counter-terrorism Goals. Joint U.S.-Russian efforts to improve early warning will probably have little direct effect on U.S. nonproliferation and counterterrorism goals. To the extent that the option provides funding and employment for Russian scientists, however, the United States is making it less likely that those scientists will succumb to financial pressure to work for rogue nations looking for assistance developing weapons of mass destruction.

Feasibility and Affordability. Both approaches for this option are technically feasible, since Russian scientists over the past 30 years have shown a great deal of scientific and technical ability with regard to early-warning systems. What Russia is currently lacking is the funding to implement technological fixes.

Some analysts believe Russia's fiscal problems are exaggerated. They contend that Russian leaders would find the means to fund an early-warning system if they believed it to be vital to their security. Other analysts believe Russia has put considerable effort into keeping its early-warning system operational. For example, in early 1998, Russia’s Missile and Space Forces opened a Far East satellite control center that can be used to control geostationary satellites over the Pacific Ocean. This would seem to be an indication that Russia is preparing to launch another generation of geostationary early-warning satellites.\(^7\)

If fully implemented, both approaches would cost a considerable amount of money. For example, if the United States chose to implement Approach 2 by completely funding all of Russia’s early-warning satellite programs, including launching the current Oko satellites, the total cost would be around $1.3 billion over the next five years.\(^8\)

Effect on the Incentive to Strike First with Nuclear Weapons. Improved early-warning systems should increase first-strike and crisis stability. If Russia’s leaders receive timely and accurate information during a crisis, they are less likely to launch nuclear weapons in error. Early-warning systems will not affect the number of nuclear

\(^7\)See, for example, Pavel Podvig (ed.), *Russian Strategic Nuclear Forces* (Cambridge, MA: MIT Press), 2001, pp. 577–578.

forces available for retaliation after a first strike, but they will provide additional time and information and therefore should increase national leaders’ confidence in their deterrent capabilities.

**Ability to Monitor or Verify Implementation of the Option and Effect of Cheating.** Since the purpose of Option 1 is to provide Russia with improved early-warning information, the system will be completely under Russian control. Therefore, there is no need for verification or monitoring, and it is hard to imagine how cheating could occur in either country.

**OPTION 2: ESTABLISH A JOINT, REDUNDANT EARLY-WARNING SYSTEM BY PLACING SENSORS OUTSIDE U.S. AND RUSSIAN MISSILE SILOS**

Option 2 is a possible solution for three contributing factors:

- Inadequate early-warning information
- Short decision times
- Deterrence doctrine or posture reliant on launch on warning or launch under attack

Table 4.4 summarizes the evaluation of this option.

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Option: Establish an early-warning system by placing sensors on silos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on U.S.-Russian political relations</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>Positive</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>Positive</td>
</tr>
</tbody>
</table>
Background

Option 2 takes an unconventional approach to improving access to reliable early-warning information. It establishes an early-warning network by placing sensors outside each silo so that the United States and Russia would each know immediately if the other launched its intercontinental ballistic missiles (ICBMs). The sensors would be sampled frequently to make sure the missiles were still in their silos. This system would provide nearly instant warning of an attack (or, more important, confirmation that there were no attack). In fact, the warning would arrive sooner than that from space-based sensors, which must wait a minute or so for the missiles to break through clouds. However, this approach requires a moderate degree of cooperation between the two countries.

The idea of such an instantaneous, cooperative early-warning system is not new. The concept was proposed in the 1980s by Richard Garwin, and it was revived more recently by several prominent academicians at the Kurchatov Institute in Moscow, Russia’s premier civilian nuclear science establishment. These Russians propose that a cooperative monitoring system originally conceived as a joint approach to monitoring stored nuclear materials taken from dismantled weapons be adapted for early-warning purposes. This monitoring system has been developed over the past seven years for materials storage by a collaboration of the Kurchatov Institute, Arzamas-16 (one of Russia’s nuclear weapons laboratories), and Sandia National Laboratories (part of the U.S. Department of Energy’s nuclear weapons laboratories). Most of the funding has come from the United States as part of the Materials Protection, Control and Accounting program funded by the U.S. Department of Energy. The monitoring system’s goal is to assure the safety, security, transparency, and international accountability of the materials.

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The nuclear materials monitoring system consists of a series of modules that collect data from a variety of sensors—door switches, motion detectors, fiber optic seals, and video cameras—and transmit the data to a nearby system that collects data from all modules at the facility. These data then go to two places: a monitoring center in the host country (the one being monitored) and, by satellite link or telephone line, to the country doing the monitoring. The data can be transmitted at regular intervals or by request. Sensors can also send information about their state of health. Sandia has expended significant effort to develop systems that are difficult to tamper with or fool, although more work remains to be done in this area. The system uses unique authentication codes to ensure that the sensors are not tampered with. In addition, the system itself is designed to resist tampering. To make sure that data are not tampered with, they are encrypted. The sensors attached to each data module are designed to complement each other to guard against tampering. For example, if infrared motion detectors sense a person in the room, they can trigger the video camera and send an alarm to the monitoring station. Components of this system, including the data collection and transmission modules and some newly designed sensors, have been developed and tested in a series of experiments conducted by Sandia and the two Russian laboratories. A unique feature of this program is that each country develops its own technology for application to its own storage facilities.

The Kurchatov proposal for a cooperative early-warning system is quite broad; it would adapt this system to monitor the status of all strategic nuclear forces. The advantage of this approach is that it is based on systems that have already been developed cooperatively and subjected to some field testing. A module connected to a variety of sensors would be deployed on each silo, mobile missile, submarine missile tube, and, for bomber weapons, on each magazine. It would detect that a missile is being launched or a weapon is being loaded onto a bomber. The module would collect data from the sensors and transmit those data to the central collection system every minute or so via radio. The central facility would send the data to the host and monitoring countries by either telephone line or the Internet.

The resulting system would provide current information about the status of each missile and magazine. If a missile is launched or a silo
door opened, the observing party will know about it within one minute. What is even more important in the context of avoiding accidental launches, however, is that the data will indicate that an attack has not been launched. If used to complement the traditional space- and ground-based early-warning systems that both countries operate today, the launcher-based system proposed by scientists at the Kurchatov Institute will provide important confirmations of events observed by satellite or by radar. The system will also give nearly instantaneous warning of an attack, thereby increasing the time available for decisionmakers to determine an appropriate response. A particular appeal of this cooperative system is that it can be used as the primary early-warning system, possibly providing a low-cost alternative to improving Russia’s existing early-warning systems.

**Specifics**

Option 2 applies the proposed Kurchatov system to silo-based ICBMs because they are the easiest forces to monitor. Placing monitoring equipment on mobile missiles and submarines can jeopardize the stealth that such platforms rely on for survivability. The main reason to use silo-based sensors instead of improving Russia’s space-based early-warning system is that Russia believes the United States will use its ICBMs in a first strike—a reasonable assumption given that U.S. silo-based missiles are widely viewed as powerful and accurate but vulnerable to a retaliatory strike by Russia. The United States holds the same view about the role of ICBMs in Russia’s nuclear war plans. This emphasis on U.S. ICBMs for signaling a first strike might lose some of its effectiveness in the future, however, because a larger portion of U.S. warheads will be based at sea.

The basic approach is to detect a launch by monitoring the physical signs that accompany a missile launch (see Figure 4.1). This can be accomplished by using seismic sensors that detect the strong vibrations caused by a missile leaving the silo and heat sensors that detect the hot exhaust gas from the rocket motor. The sensor suite and data collection module could protect themselves against tampering with an infrared motion detector and a video camera. The modules and sensors would be installed by inspectors during so-called baseline inspections.
If extra confidence is required, the silo door, which must open before the missile is launched, can also be monitored. This can be accomplished by placing one or more seals made of optical fiber over the door so that it cannot be opened without breaking the seal. The data module checks the state of the seal by sending a light pulse down the fiber to see if a unique pattern at the end of the fiber cable has changed. Such seals are widely used by the International Atomic Energy Agency to monitor civil nuclear programs around the world.

Each module samples its sensors several times a minute and transmits the data to a central collection system at each base. The central system collects the data from all modules at the base and transmits those data directly to the monitoring and host countries.

One requirement for any early-warning system is that it be extremely reliable. In addition to using the redundant and complementary sensors described above, the system in this approach would increase redundancy by using two transmission modes that are independent of each other. For example, the transmissions from each base to the
monitoring country would be carried by a dedicated satellite line and a dedicated land line. Each module would transmit its data via radio and telephone line to the central facility at the base. The module would get power from the electrical grid and have a battery-based power supply as a backup. The central data facilities would also have backup power for any local power failures.

Early-warning systems must also be able to minimize false alarms: a system that sounds an alarm every time the wind blows, rain falls, or a mouse walks by is not useful. It must also use redundant or complementary sensors as much as possible to reduce the chances that a wayward cow or a squirrel with a taste for optical fiber does not create a crisis. In addition, the system must allow the monitored party to conduct normal operations with only minimal disruptions.

For silos, the basic sensor suite should pose no problems. If fiber optic seals are used to monitor silo doors, the system must allow for routine maintenance on the missile, which in some cases involves opening the silo door to remove warheads, guidance components, or even the entire missile. This can be handled in one of two ways: trust the monitored country to reseal the door with new seals, or have someone from the inspecting country install the seals after maintenance is complete. In either case, any maintenance that is to take place should be announced in advance to the inspecting country. The second approach provides a higher level of system confidence but is more expensive, since it requires inspectors to have a regular presence at each base. The first approach may be acceptable, though, since the seismic and other sensors would remain, and sensors on the other silos would indicate that no large launch had occurred. In addition, door latch sensors could be added to ensure that the silo door is closed after maintenance is complete.

If the system for monitoring launches of silo-based ICBMs works well, it could be expanded to other platforms. The easiest application is to monitor nuclear weapons storage facilities for bombers. Mobile missiles and submarines are much more difficult to monitor because of the need to ensure their stealthiness and mobility, which are key to their survivability. It may be possible to devise schemes that could do this, but it would require extensive cooperation and very intrusive measures. Mobile missiles in garrison would be easier to monitor (Option 8 examines this issue in detail). As long as Russia and the
United States continue to believe that silo-based ICBMs are central to any first strike, however, the system may not need to be expanded beyond silos.

**Evaluation**

**Contribution to Reducing the Risk of Nuclear Use.** A cooperative early-warning system based on the Kurchatov proposal applied to silos will help reduce the chances of accidental nuclear use by improving the quality of early-warning information available to Russia and the United States. It also increases decision time and creates a new avenue for cooperation between the militaries in both countries. This option offers several improvements over Russia’s existing system for a relatively low price. It could even improve the timeliness and quality of the U.S. early-warning system. The Kurchatov approach could complement the early-warning data that the United States and Russia will share in the Joint Data Exchange Center in Moscow by providing confirmation that the shared data are accurate and not being manipulated. Like other approaches to improving early warning, this option has no effect on the operations of either country’s forces.

By itself, however, this approach does not provide Russia coverage of U.S. submarine launches or bombers (although the concept could possibly be expanded to include these platforms). Furthermore, it addresses only U.S. and Russian forces, not other potential sources of missile launches or false alarms around the world. Only a global, space-based system can provide such comprehensive coverage.

For Russia, the silo-monitoring system could add as much as 15 to 20 minutes of warning time during the roughly 17 hours each day that experts have estimated Russia cannot view U.S. missile fields (see Table 4.3, above). If, as discussed earlier, Russia has lost its remaining satellites because of a fire in its ground control center and thus has an early-warning system based solely on ground-based radars, the cooperative early-warning system could provide the extra 15 to 20 minutes of warning 24 hours per day.

The United States could also benefit from using such a system as a complement to its existing, well-functioning satellite and radar early-warning system. By detecting a launch before the missile rises above
Beyond the Nuclear Shadow

the clouds, the system would provide the United States with a few additional minutes of warning. And by providing another method for confirming an attack, it would improve the quality of U.S. early-warning information and help resolve false alarms. In addition, the United States could use the system to help calibrate the new SBIRS-High early-warning satellites that it plans to deploy in this decade.

For both the United States and Russia, the fact that each missile is monitored individually and by several sensors makes the system inherently robust against false alarms (such as errant messages from the occasional sensor)—perhaps even more robust than space-based sensors. Such detailed information about each silo means that indications of a launch can be viewed in the context of the entire silo-based force.


Effect on U.S.-Russian Political Relations. The cooperative nature of Option 2 presents real opportunities to improve U.S.-Russian relations. This approach could also help build each country’s confidence about the other’s intentions. In addition, it would increase the cooperation between the two countries’ military establishments by creating a requirement that they interact on a regular basis, and it could provide an important cooperative experience base and test-bed for developing techniques to monitor forces taken off alert. (This approach is explored in Options 7 and 8.)

Effect on Other Major International Actors. No effect.

Effect on Prospects for Achieving Nonproliferation and Counter-terrorism Goals. No effect.

Feasibility and Affordability. One of the appealing aspects of this option is that it builds on the experience and hardware of an ongoing cooperative monitoring experiment. In addition, it is not very intrusive. For these reasons, Option 2 can be implemented fairly quickly, particularly as a pilot project.

This approach could cost significantly less than most of the other approaches we explored for improving Russia’s access to reliable early-warning information. Perhaps most important—especially for Russia—is that the cooperative early-warning system would be inex-
pensive to operate over the years compared to any space-based system. (The notable exception is the Joint Early-Warning Center, which will also be relatively inexpensive. But this center has the disadvantage of requiring each country to trust that the other has not falsified the data.)

One issue the silo-based system would have to address is that it has not proved its effectiveness yet in an early-warning mode. Russia and the United States have devoted a good deal of work to developing and demonstrating the cooperative system for monitoring fissile materials, but it has not been tested for early-warning applications, which place extremely high requirements on accuracy, reliability, and false alarm minimization. An early-warning system that creates spurious indications of launches could be worse than nothing at all.

Finally, if the monitoring approach is expanded to mobile missiles and submarines, it may prove difficult to implement. Tricky issues arise, such as how the modules are to be attached to submarines and how to make the modules on submarines and mobile missiles resistant to tampering. It also raises important questions about how to balance the need for information with the need for submarine and mobile missile survivability. If such an approach is deemed useful, these problems might be addressed by conducting a series of joint U.S.-Russian experiments to test concepts and hardware.

**Effect on Incentive to Strike First with Nuclear Weapons.** Option 2 improves crisis stability by providing important confidence that ICBMs have not been launched. By providing the launch status of every silo individually, the system actually provides more detailed information about each silo than a space-based system does. It does not, however, provide information about submarines or launches from other countries.

**Ability to Monitor or Verify Implementation of the Option and Effect of Cheating.** Option 2 provides a good way to monitor implementation and detect cheating as long as the module and sensors are designed correctly (self-protecting and complementary) and tested for vulnerabilities. (Cheating, in this case, means tampering with the silo-based early-warning system.) Also, the system’s distributed nature makes it more difficult to spoof or to entirely disable. It would be essential to ensure that the system is not vulnerable to tampering,
however, if it is the only system Russia ends up relying on for early-warning information.

**OPTION 3: IMMEDIATELY STAND DOWN ALL NUCLEAR FORCES TO BE ELIMINATED UNDER THE 2002 MOSCOW TREATY**

This option is a possible solution for two contributing factors:

- Nuclear forces kept at high day-to-day alert
- Perceived vulnerability of nuclear forces or command and control systems

Table 4.5 summarizes the evaluation of Option 3.

**Background**

Option 3 immediately deactivates all forces scheduled for elimination under the 2002 Moscow Treaty—i.e., the Strategic Offensive Reductions Treaty (SORT) signed in May 2002 by Presidents Bush and Putin in Moscow. During their November 2001 summit in Crawford, Texas, the two Presidents agreed to cut their nuclear arsenals by

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Option: Immediately stand down forces to be eliminated under the 2002 Moscow Treaty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>N/A or negative</td>
</tr>
<tr>
<td>Effect on U.S.-Russian political relations</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>Positive</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>N/A or positive</td>
</tr>
</tbody>
</table>
two-thirds. President Bush indicated that he would cut deployed strategic nuclear weapons to between 1,700 and 2,200; President Putin said he was interested in a range between 1,500 and 2,200.

In January 2002, the Bush administration followed up on the Crawford summit by announcing the results of its Nuclear Posture Review. The review, while keeping the goal of 1,700–2,200 operationally deployed warheads, indicated that this force level would not be achieved until 2012. Before 2012, nuclear reductions would be only gradually implemented, as the United States would reduce its forces from around 6,000 strategic warheads to around 3,800 by fiscal year 2007.

Negotiations that began after the Crawford summit culminated in the Moscow Treaty, a brief one-page document that codified much of what the Bush administration presented in the Nuclear Posture Review.

Specifics

The specifics of Option 3 are rather simple. Both the United States and Russia immediately “deactivate” enough nuclear forces to reach the target of having only 1,700 to 2,200 operational deployed warheads. For the United States, these forces would include nuclear forces already scheduled to be deactivated: 50 Peacekeeper missiles, four Trident submarines, and several hundred warheads, which would be removed from both submarines and ICBMs. For Russia, these forces would probably include all 154 SS-18s, most of its SS-19s, all of its SS-24 rail-mobile and silo-based missiles, and all Delta III and older ballistic missile submarines. This option assumes that the warheads from the missiles are removed and placed in central storage. The smaller number of warheads on each missile could be verified using the on-site inspection provisions of the Strategic Arms Reduction Treaty (START) I. Reversing these procedures would take a few weeks.

There are several historical precedents for this kind of unilateral step. In September 1991, the first President Bush ordered that all 450 Minuteman II missiles and the missiles on 10 older Poseidon submarines be taken off alert. These forces were slated to be removed under START I, which at that time had yet to be ratified by the United
States or Russia. This action occurred shortly after the August 1991 coup attempt in Russia. Within a week, Russia announced that it would reciprocate by taking off alert some 500 silo-based missiles and the missiles on six ballistic missile submarines.

Evaluation

**Contribution to Reducing the Risk of Nuclear Use.** Option 3 reduces nuclear risk in three ways. First, as President Bush has said, the United States has a new and more positive relationship with Russia. In the 2002 Nuclear Posture Review, Secretary of Defense Donald Rumsfeld went further: "As a result of this review, the U.S. will no longer plan, size, or sustain its forces as though Russia presented merely a smaller version of the threat posed by the former Soviet Union." An immediate demonstration of U.S. willingness to rapidly reduce its nuclear forces will help convince a skeptical Russia that the United States is truly interested in a new relationship. Option 3 reinforces this view by rapidly increasing the pace of nuclear reductions. This lowering of the nuclear temperature should help persuade Russia that the United States has no intention of using nuclear weapons against it and could help lay the foundation for further improvements in nuclear safety.

Second, Option 3 reduces the risk of nuclear use because it helps address the poor first-strike stability between U.S. and Russian forces, a situation likely to worsen over the next decade unless steps are taken. According to one source, even without a formal arms control process, Russia's nuclear forces are likely to shrink to 1,100 operational deployed nuclear warheads by 2010 because of economic factors. If the United States continues to maintain around 3,800 such devices until 2007, the imbalance between the two countries will grow. However, if both sides mutually deactivate their forces to between 1,700 and 2,200 warheads immediately, a better balance could be restored.

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12 Podvig, *Russian Strategic Nuclear Forces*, p. 577. Estimate by 2010 is 300 single-warhead silo-based and mobile Topol M missile systems, seven Delta IV submarines with a combined total of 448 nuclear warheads, and a strategic bomber force of 30 Tu-95MS Bear H bombers, which can carry up to 360 long-range cruise launch missiles. Similar estimates have been made by other sources.
Third, by immediately deactivating the forces spelled out in this option, Russia will eliminate some of its oldest and most accident-prone forces. The SS-18s and SS-19s are both nearing the end of their service lives and were scheduled to be decommissioned under START II. If Russia decides that it needs to keep its SS-18s and SS-19s to offset a U.S. missile defense system or a larger U.S. nuclear arsenal, it might try to extend their operational lives until 2008. This could be dangerous, because older nuclear forces may be more accident prone than are newer, more modern forces. Option 3 solves this problem by immediately deactivating these forces.

Effect on Current U.S. Strategies and Targeting Plans. This approach’s effect on U.S. strategies and targeting plans is only modest. Indeed, the Nuclear Posture Review indicates that the Bush administration expects the number of forces allowed under the treaty will be sufficient by 2012. This option just accelerates that timeline.

However, the Nuclear Posture Review and the 2002 Moscow Treaty indicate that the Bush administration is uncomfortable reaching a level of 1,700 to 2,200 warheads before 2012. This could be because it thinks there is some chance Russia will revert to a more aggressive nationalist foreign policy. But a Russian buildup will likely be preceded by a sharp deterioration in U.S.-Russian relations and could be detected long before it became militarily significant, giving the United States time to change its posture.

Effect on U.S.-Russian Political Relations. Option 3 should have a very positive effect on U.S.-Russian relations. It indicates that the United States is not trying to take advantage of Russia’s economic weakness to gain a strategic advantage in nuclear weapons. It can also serve as a symbolic gesture demonstrating that the United States and Russia are no longer strategic adversaries, at least in the field of nuclear weapons. Option 3 is also an immediate step that may open the way for further improvements in both U.S.-Russian relations and nuclear safety.

Effect on Other Major International Actors (China, Europe, etc.). Option 3 will have a limited effect on other international actors. Even with the nuclear reduction outlined here, U.S. and Russian nuclear forces will still be much larger than those of any other nation.
Effect on Prospects for Achieving Nonproliferation and Counter-terrorism Goals. No effect.

Feasibility and Affordability. One of the biggest advantages of Option 3 is that it can be undertaken quickly and can save money sooner. The United States and Russia are already planning to either eliminate or move into reserve many of the forces this option deactivates. Option 3 merely speeds up the process and starts saving money 10 years earlier than now planned.

Effect on Incentive to Strike First with Nuclear Weapons. As noted above, Option 3 should have a positive effect on first-strike stability.

Ability to Monitor or Verify Implementation of the Option and Effect of Cheating. Option 3 can be done with or without verification. The status of nuclear forces could be monitored by the inspection regime under START I, which allows both countries to conduct 10 inspections each year of the front ends of missiles to verify they carry no more than the allowed number of warheads. For bombers, inspectors would check to make sure that nothing is stored in the nuclear weapons storage facilities at a bomber base and that nuclear-armed long-range cruise missiles are not present. With standard START inspections, it could take a month or more to detect cheating. Rapid, widespread cheating, however, should be detectable by intelligence assets and thus might be detected sooner.

The other approach is to have no inspection regime. The Bush administration has argued that formal arms control treaties and extensive verification regimes take too long to negotiate and implement and are no longer important given the reduced tension between the two countries. Therefore, the administration argues for joint steps taken by both nations without formal treaty arrangements. This also allows maximum flexibility in the event that rapid policy adjustments are required because of changes in the international security environment. However, Option 3 will lose much of its effect on relations if U.S. actions are not made somewhat transparent to Russia.

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OPTION 4: PULL U.S. STRATEGIC BALLISTIC MISSILE SUBMARINES AWAY FROM RUSSIA

Option 4 is a possible solution for four contributing factors:

- Nuclear forces kept at high day-to-day alert
- Perceived vulnerability of nuclear forces or command and control systems
- Short decision times
- Deterrence doctrine or posture reliant on launch on warning or launch under attack

Table 4.6 summarizes Option 4’s evaluation in terms of the eight criteria. Note that Option 4 offers two approaches, both discussed below.

Table 4.6

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Option: Pull U.S. strategic ballistic missile submarines away from Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Approach 1: Pull Tridents away from Russia without monitoring</td>
</tr>
<tr>
<td></td>
<td>Approach 2: Pull Tridents away from Russia with monitoring</td>
</tr>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>Negative or N/A</td>
</tr>
<tr>
<td>Effect on U.S.-Russian political relations</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>Negative</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>Positive</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
</tr>
</tbody>
</table>
Background

Russia has worried for years about U.S. ballistic missile submarines patrolling close enough to its coasts to hit their targets within as little as 10 to 15 minutes. This capability sharply reduces warning time for the Russians. During the Cold War, Russia was able to keep its ballistic submarines close to U.S. coasts. Now, however, for financial reasons and to protect its ballistic missile submarines from U.S. attack submarines, Russia operates its few operational ballistic missile submarines in bastions near Russian territorial waters.

For good reason, the operational policies of U.S. submarines are a closely held secret. So there is no proof that Trident submarines do or do not patrol within 2,000 to 3,000 kilometers of Russia. The Russians, however, continue to worry about it.

The purpose of keeping these submarines away from their targets is to increase missile flight time to at least 25 minutes and thereby reduce Russian anxiety about a very short-warning attack. The fundamental challenge here centers on the fact that submarines are designed to be extremely stealthy in order to avoid detection, which makes it difficult to verify their presence in or absence from a particular ocean region.

We examined two approaches for keeping ballistic missile submarines away from their targets. The first is simply for the United States to keep its submarines further away from Russia. No reciprocal action on Russia’s part is required: Russia could respond in kind if it chose to (although its submarines rarely venture near the United States today), but it need not do so. This approach would be a confidence-building measure without any kind of monitoring, and it could be done easily, without negotiations. Increased confidence can be gained with the second approach, but it introduces a complicated monitoring system whose establishment requires detailed negotiations and Russian agreement.

Specifics

Approach 1: Pull U.S. Tridents away from Russia Without Monitoring. The goal of Approach 1 is simple: reduce Russian anxiety by keeping Trident submarines away from Russia. This action increases
missile flight times, giving Russia’s early-warning system more time to detect a nuclear event and Russia’s leaders more time to determine whether the event was an attack. It can be accomplished either unilaterally by the United States or with an exchange of unilateral declarations, much like Presidents George Bush and Mikhail Gorbachev did when they pledged to remove battlefield nuclear weapons from Europe.

Under this approach, the United States would keep its Trident submarines about 6,000 nautical miles (11,000 kilometers) from Russia, near the edge of their missiles’ range. Figure 4.2 shows the rough areas in which U.S. submarines would be allowed to operate. From this range, it would take Trident missiles about 25 minutes to reach their targets. The United States would take this action unilaterally; no specific action is required of Russia. However, Russia could reciprocate by declaring that it will not operate its submarines outside their bastions near Russia. Because this option does not require changes to hardware or operations and does not impose monitoring or verification requirements, it has no effect on costs.

Figure 4.2—Keep-Out Areas for Trident Submarines Under Option 4
An alternative is to keep the submarines completely out of range of their targets. If Trident submarines are carrying D5 missiles loaded with the five W-76 warheads allowed under START II, however, they will have a range of roughly 6,000 nautical miles and will be within range of Russia very shortly after leaving port. To move out of range, they will have to transit to regions of the southern Atlantic and southern Pacific and patrol there (see Figure 4.2), long trips that will burn up more nuclear fuel, an important consideration when it costs about $200 million to refuel a Trident. One solution might be to place ballast on each missile to make its payload as heavy as if it were carrying eight warheads. This would reduce the maximum range of D5 missiles from about 6,000 nautical miles to 4,000, and the submarines would be out of range for several hundred nautical miles after leaving port.

**Approach 2: Pull Tridents away from Russia with Monitoring.** To increase Russia’s confidence that U.S. ballistic missile submarines are staying away from its coasts (and vice versa), Approach 2 adds monitoring provisions to the submarine pull-back described above. This requires that monitoring provisions be negotiated.

The challenge to monitoring a submarine’s location is indicating where the submarine is (or is not) without compromising the stealthiness that makes it such a valuable platform for deterrence. The basic concept adopted here is to have the submarine release a special beacon buoy when ordered to do so by the other country.14 In the case of the United States, the buoys would be launched from the three-inch ejector tubes that submarines use to launch a variety of buoys today. When inspectors ask to verify the location of a specific submarine, the submarine in question releases its buoy. The buoy floats to the surface but does not begin transmitting for 12 hours or longer, giving the submarine enough time to relocate so that the buoy does not endanger its survivability by revealing its location. The buoy transmits a signal that gives its location and a unique code

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14Richard L. Garwin has proposed a variation of this approach (see Richard L. Garwin, “De-alerting of Nuclear Retaliatory Forces,” Amaldi Conference, Paris, France, November 20–22, 1997). Another possibility is to use the existing secure communications systems to send a coded message with the submarine’s location. To preserve locational secrecy, the transmission could be delayed or an on-board information barrier would just provide a “yes” or “no.” The authors thank Frank von Hippel for this insight.
identifying the submarine as the one whose verification was requested. To ensure that the signal is received, it transmits for 24 hours.

For survivability purposes, there would be a limit on how often each country could ask to verify a submarine’s position. For our illustration here, we assume that Russia could ask for a submarine’s location only once during its 72-day patrol. And to ensure that the force remains invisible, Russia could query only one submarine each week. Thus, if the United States keeps five Tridents at sea, Russia can check for cheating once every two weeks or so, on average. This scheme makes it easier to detect widespread cheating than to detect an isolated incursion by a single submarine.

One way to add a further element of randomness to the inspections is to allow Russia to conduct one or two challenge queries each year in which it can check one submarine more than once on its patrol or two submarines within a week. The United States might also have the right to refuse a request if the submarine in question is being followed by anti-submarine warfare forces. (The numbers for the buoy delay, the numbers of queries per patrol, and the minimum time between queries would all be subject to negotiation. They are used here for illustrative purposes.)

How useful is this scheme? Russia will know that the submarine has been in a particular ocean area and, most important, that it has been far away from Russia’s coasts. But it will not be able to pinpoint exactly where the submarine has been, because wind and ocean currents can move the buoy as much as 100 miles from where it is released in the 12 hours before the buoy begins transmitting. Moreover, the submarine can move some 72 to 96 miles during the 12 hours, even traveling at the low speeds of 6 to 8 knots, where it operates most quietly. Together, the submarine and buoy movements create an area of uncertainty 400 nautical miles across. Although Russia may not be able to check another submarine’s position for another week, it will know that the first submarine was in compliance at the time of the query and would take several days to move

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15This assumes that winds and currents could move the buoy by as much as 8 knots per hour in an unknown direction, creating an area of uncertainty of 3,000 square miles about the release point.
close enough to significantly shorten its missile flight time. (At 8 knots, a submarine can move only about 200 nautical miles closer each day, or 1,400 nautical miles in one week.) Perhaps more important for reducing the risk of accidental nuclear use, over time this option will increase Russia’s confidence in the survivability of its forces.

If a detailed verification regime is used for Option 4, several other issues emerge, perhaps the most important of which is ensuring that the verification agreement includes a way to handle the case of a buoy not functioning properly. One solution is for the submarine to release a second buoy if the first one fails, but this would reveal the submarine’s location at two different points. Another solution, one that avoids this problem, is to release two buoys whenever a verification request is made.

**Evaluation**

**Contribution to Reducing the Risk of Nuclear Use.** The most significant effect of keeping Tridents away from Russia is that the shortest flight times of U.S. submarine-launched ballistic missiles are increased by 10 to 15 minutes (see Table 4.3, above). This gives Russia more time to assess the accuracy of its early-warning information before it has to decide whether to launch a counterattack, thereby reducing the chances of an accidental launch.

The extra time provided by keeping the Trident force away from Russia could also reduce Russia’s general feeling of insecurity with respect to the Trident force. This might induce Russia to take its forces off high day-to-day alert rates, as there would be less concern about the United States launching a debilitating first strike. Of course, the extra time would be wasted if Russia’s early-warning system had no ability to view Trident operating areas or if Russia did not believe that the United States had changed its deployment policies.

**Effect on Current U.S. Strategies and Targeting Plans.** For those who support current U.S. forces and the way they are operated, this option has several disadvantages. One is that keeping submarines far from Russia prohibits them from carrying out some of the missions they have been assigned in the Single Integrated Operation Plan
Options for Improving Nuclear Safety

(SIOP), the U.S. strategic plan for conducting nuclear war. The SIOP creates an orchestrated counterattack in which the timing of each warhead’s arrival at its target is critical. Option 4 thus could reduce the U.S. damage limitation capability and allow Russian forces to be launched before Trident missiles had arrived from submarines deployed 6,000 nautical miles away.

Of course, the SIOP could be changed so that the submarines are assigned to targets more appropriate to their new locations. Or the United States could reduce its emphasis on damage limitation in its deterrence strategy.

Another disadvantage is the possibility that the monitoring mechanism set up to assure Russia that U.S. ballistic missile submarines are far away from it could inadvertently reduce the stealthiness of the submarines, making them more vulnerable to attack. One potential concern about the buoy concept is that over time the United States will reveal something about its operational patterns. For example, if U.S. submarines typically leave Kings Bay, float up near England, and then return via Africa, buoys will reveal this pattern and might make it possible for Russian anti-submarine warfare forces to focus their searches in specific areas. This problem can be addressed, however, by doing more to randomize the submarines’ paths, something the Navy is already supposed to be doing. Moreover, Russia’s anti-submarine warfare capability is extremely limited these days because most of its attack submarines remain in port or have been dismantled.

**Effects on U.S.-Russian Political Relations.** Option 4 should improve U.S.-Russian relations by reducing Russia’s concern that the United States is planning a debilitating first strike against Russian nuclear forces. It gives the Russians more information about how the United States is operating its nuclear forces and therefore more confidence that the United States is not trying to take advantage of Russia’s current military weakness. Perhaps most significant, it also provides an important signal that the United States is reducing its emphasis on targeting Russia.

However, an analysis of the implications of Approach 1 or 2 of this option for U.S.-Russian relations reveals a Catch-22 often found in the more intrusive and far-reaching proposals for improving nuclear
safety. Approach 1 is a unilateral step the United States can take to indicate that it is not planning a decapitating first strike on Russia. If there were a great deal of trust between the United States and Russia, this step would be enough to reassure the Russians of the U.S. policy and therefore no verification measures would be needed. However, to the extent that suspicion and mistrust remain in the U.S.-Russian relationship, additional verification measures may be needed to reassure the Russians that the United States is actually carrying out this policy.

This leads to Approach 2’s complex verification and monitoring scheme, the need for which implies that the U.S.-Russian relationship remains hostile and that, without the scheme, neither country will be confident that the other is carrying out the agreement. However, Approach 2 requires the United States and Russia to reveal at some level how their nuclear submarine forces operate—one of each country’s most closely guarded secrets. In a hostile relationship, understanding how the other side’s submarine force operates is a great advantage if one wants to attack and destroy those submarines before they can launch their nuclear weapons. Therefore, for either country to agree to a complex verification regime such as that in Approach 2, there will already have to be a great deal of trust in the relationship. But, of course, if there were this much trust, such an agreement would probably not be needed in the first place. A mere announcement of the new policy, such as is suggested in Approach 1, would be sufficient.

**Effect on Other Major International Actors (China, Europe, etc.).** Option 4 may have an effect on the nuclear deterrents of other major international actors. Both Britain and France have small nuclear arsenals of between 200 and 450 warheads, the vast majority of which are deployed on ballistic missile submarines. In 1998, the British government announced a new policy regarding its nuclear forces, including that the number of boats patrolling at any one time would be reduced from two to one and that the number of warheads on each submarine would be reduced to 48. Interestingly, the British government also announced that its submarines would patrol in a reduced state of alert, with their missiles detargeted, which means they will take days instead of minutes to fire their missiles. According
to Britain’s Ministry of Defence, no steps were taken to provide transparency as to whether the submarines were operating per the announced changes.

France in recent years has shifted most of its nuclear forces away from land-based intermediate-range missiles and nuclear bombers to its submarine force. When the French ballistic missile submarine force is completed in 2010, it will have four submarines capable of launching nuclear attacks against Russia. French submarines carry the MSBS M4A/B missile, which has a shorter range (6,000 kilometers) than the D5 carried by British and American submarines when they are fully loaded with warheads. Very little information is available about the state of alert or operating scheme of French forces.

How might Option 4 affect British and French ballistic missile submarine forces? During the Cold War, the Soviet Union consistently viewed British and French nuclear forces as part of the much larger U.S. nuclear deterrent. However, because British and French nuclear forces were so much smaller than their U.S. counterparts, Russia was not very concerned about how they were operated. This situation could change, however, if Option 4 were implemented, since it seems likely that Russia, and perhaps domestic public opinion within Europe, will want British and French submarines to operate further away from Russia.

This call for monitoring might be controversial. Ballistic missile submarines represent a much higher percentage of Britain and France’s nuclear forces, so they may not be willing to have their forces monitored as suggested in Approach 2. They might also argue that it is less important for their submarines to be monitored because their small nuclear forces cannot mount a debilitating counterforce attack.

However, Britain has already dealerted its ballistic missile submarine forces and may view Option 4 as an important step toward reducing nuclear risk. As for France, it is difficult to gauge how willing it would be to cooperate on changing its submarines’ method of operation.

Effect on Prospects for Achieving Nonproliferation and Counterterrorism Goals. No effect.
Feasibility and Affordability. One advantage to Approach 1 is that it can be done quickly, easily, and at very little cost. The President could announce the change and see it implemented within a few weeks. It will impose no changes on the submarines or the way they are operated (other than the parts of the ocean where they patrol). Nor will it require any negotiations or intrusive inspection or verification measures. Finally, Approach 1 will not increase submarine vulnerability; there will still be huge areas of the ocean where they could hide.

Approach 2 offers most of the benefits of Approach 1 and, in addition, makes it possible for each country to monitor that submarines are kept away from their targets. In short, it provides Russia with much better confidence that the United States has pulled its submarines back. By including intrusive monitoring provisions, however, Approach 2 takes more time to implement than Approach 1 does. One solution is to implement a unilateral pull-back, as proposed in Approach 1, and follow it with negotiations to develop a verification agreement. The United States and Russia could also conduct joint experiments on just one submarine to test the monitoring concept before they negotiate a verification agreement.

Effect on Incentive to Strike First with Nuclear Weapons. Calculating the effect of this option on first-strike stability is complex and depends on one’s view of whether the option (particularly Approach 2) makes Trident submarines more vulnerable to attack.

If the option has no effect on the survivability of Trident submarines, it provides a slight improvement in first-strike stability. This is because Russian forces will be somewhat more survivable given that they have additional time (15 to 20 minutes) to disperse before a strike by Trident submarines could occur. This option could also increase stability in another, perhaps more important, way: Russia may feel less threatened if it believes that Tridents are no longer lurking close by. However, this option does not change the overall balance (or imbalance) between U.S. and Russian nuclear forces.

If Approach 2 is implemented in a way that does make U.S. Trident submarines more vulnerable to attack, first-strike stability could be significantly undermined. In this case, the United States might have an incentive to launch its missiles quickly in order to use them before
they are destroyed by Russian attack submarines. The Russians might have the same incentive, only in reverse, because they would now have a greater incentive to attempt a debilitating first strike if they could eliminate the Trident submarines, the most survivable piece of the U.S. arsenal.

**Ability to Monitor or Verify Implementation of the Option and Effect of Cheating.** One of the major disadvantages of Approach 1 is that it provides no way for Russia to verify that U.S. submarines are being kept at least 6,000 nautical miles away from its coasts. U.S. submarines are very stealthy and are rarely detected by Russian anti-submarine forces, so it would probably take many months for Russia to detect widespread cheating. Given that there is no verification, it is difficult to argue that this approach will help reduce Russian anxiety about surprise attacks by Tridents. There may be some merit to adopting Approach 1, however, if it serves to demonstrate that the United States is placing less emphasis on nuclear weapons in its relations with Russia.

Approach 2 is an attempt to deal with the verification problem by allowing each country to monitor whether the other’s submarines are actually staying away from their targets. This proposal could be effective, but it introduces its own complications and difficulties, particularly the concern that it could compromise submarine survivability. Nevertheless, submarine monitoring should not be rejected out of hand in today’s environment. Russia’s anti-submarine warfare capability is virtually nonexistent today, and tensions between the two countries are low. Moreover, nuclear safety concerns may be considered more important today than the risk that Russia may gain indirect information about U.S. operational doctrine from a well-designed monitoring system.

**OPTION 5: KEEP U.S. ATTACK SUBMARINES AWAY FROM RUSSIA**

This option is a possible solution for four contributing factors:

- Nuclear forces kept at high day-to-day launch readiness
- Perceived vulnerability of nuclear forces or command and control systems
- Short decision times
- Deterrence doctrine or posture reliant on launch on warning or launch under attack

Table 4.7 summarizes the evaluation of this option.

**Background**

Another step the United States could take to reduce Russian insecurities about the survivability of its nuclear forces is to keep U.S. attack submarines out of the Barents Sea and the Sea of Okhotsk, where Russia operates its ballistic missile submarines. The United States routinely deploys attack submarines in these regions to trail Russia’s naval forces, including its ballistic missile submarines, and to collect intelligence. In the most recent public incident, at least one U.S. submarine was monitoring a Russian naval exercise in the Barents Sea when the Russian submarine Kursk exploded and sank. Russia has complained about U.S. operations in the past. Since Russian ballistic missile submarines can be tracked by U.S. attack submarines, Russia keeps them in the seas near its coasts where they can be protected by other ships and submarines.

**Table 4.7**

**Evaluation of Option 5**

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Option: Keep U.S. attack submarines away from Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>N/A or negative</td>
</tr>
<tr>
<td>Effect on U.S.- Russian political relations</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>Positive?</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>Negative</td>
</tr>
</tbody>
</table>
Some Western analysts believe that the aggressive posture of U.S. attack submarines is dangerous and unnecessary.¹⁶ They argue that keeping attack submarines away from Russia will improve Russia’s confidence in the survivability of its submarines, thereby reducing the pressure on Russia to launch its nuclear forces before they are destroyed. But U.S. submarines operating in Russia’s coastal waters perform other functions as well, such as collecting various types of intelligence—a mission that some people believe the United States should not give up entirely. Moreover, since Russia can operate attack submarines near U.S. ports for the same purposes, it could reciprocate by keeping its attack submarines away from the United States.

### Specifics

The specifics of Option 5 are very similar to those of Option 4: the United States unilaterally states that it is halting all patrols of its attack submarines in the Barents Sea and the Sea of Okhotsk, where Russian ballistic missile submarines generally operate. Unlike Option 4, however, no monitoring mechanism will be used to verify the location of U.S. attack submarines. Instead, Russia should gain confidence over time that the United States is keeping its attack submarines away from the designated areas as evidence mounts that U.S. submarines are not being detected while tracking Russian submarines or collecting intelligence.

### Evaluation

**Contribution to Reducing the Risk of Nuclear Use.** By keeping U.S. attack submarines away from Russia’s ballistic missile submarine bastion areas in seas near Russian territory, Option 5 will have a significant effect on decision time. It gives Russia some confidence that the United States will not try to destroy the Russian retaliatory force, which gives Russia additional time, perhaps hours or even days, to assess the accuracy of its early-warning information before launching a counterattack. This significantly increases decision time.

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relative to other options (see Table 4.3, above). The result is a significantly reduced chance of a Russian launch based on bad information.

The extra time provided by keeping the attack submarines away from Russia can also reduce Russia’s general feelings of insecurity about its ballistic missile submarine force. This might induce the Russians to take their forces off high alert during day-to-day conditions, since there would be less concern that the United States could launch a debilitating first strike.

**Effect on Current U.S. Strategies and Targeting Plans.** For those who support current U.S. forces and the way they are operated, this option has two major disadvantages. First, keeping attack submarines away from Russian coasts will reduce their capability to carry out one of their key missions—destroying Russian ballistic missile submarines before they have a chance to launch their missiles. For those who believe that the damage limitation mission is necessary to deter Russia, Option 5 presents problems, because Russian forces could be launched before U.S. attack submarines could arrive to attack the Russian ballistic missile fleet.

Second, attack submarines perform other functions, such as collecting various types of intelligence. The United States continues to collect intelligence on Russia, and attack submarines, because of their stealthy nature, are a key part of this mission. By agreeing to stop operating submarines near Russia’s coasts, the United States will limit its ability to collect this information.

**Effect on U.S.-Russian Political Relations.** This option should improve U.S.-Russian relations by reducing Russia’s concern that the United States is planning a disarming first strike against its nuclear forces. Over time, it could give the Russians more information about how the United States is operating its forces and therefore more confidence that the United States is not trying to take advantage of Russia’s current military weakness. It also removes a long-standing source of tension between the two nations, which was highlighted by the initial Russian reaction to the Kursk accident: the sinking was said to be caused by the Kursk colliding with a U.S. submarine.
Effect on Other Major International Actors (China, Europe, etc.). No effect.

Effect on Prospects for Achieving Nonproliferation and Counter-terrorism Goals. No effect.

Feasibility and Affordability. Option 5 can be implemented quickly, easily, and at very little cost. The President could announce the change and see it implemented within a few weeks. It will impose no changes on the submarines or the way they operate (other than restricting them from patrolling in the Russian ballistic missile submarine bastions). Nor will it require negotiations or intrusive inspection or verification measures. Finally, Option 5 would not increase submarine vulnerability.

Effect on Incentive to Strike First with Nuclear Weapons. This option should improve first-strike stability, but only if Russia believes that U.S. submarines are staying out of its bastions. It will increase the survivability of Russian submarines in two ways. First, they will no longer be in danger of attack by U.S. attack submarines within Russian coastal areas. Second, Russia had such severe economic problems in the 1990s that it reduced the number of ballistic missile submarines it kept at sea. It now keeps its ballistic missile submarines in port, where they are vulnerable to attack, and reportedly compensates for this vulnerability by keeping some of them on high alert. This means they are prepared to launch their missiles within a matter of minutes without leaving the wharf, making them capable of completing their missions prior to the arrival of a U.S. missile strike. With Option 5, Russian submarines will be more survivable when operating in coastal areas. This may encourage Russia to put additional submarines at sea and to reduce or cease the practice of maintaining ballistic missile submarines in port on high alert.

Ability to Monitor or Verify Implementation of the Option and Effect of Cheating. This option provides no way for Russia to directly verify whether the United States is halting its patrols in Russian coastal areas. However, over time Russia will gain confidence that the United States is keeping its attack submarines away from the designated areas, because evidence will mount that the United States is not tracking Russian submarines in these areas.
OPTION 6: REMOVE W-88 WARHEADS FROM TRIDENT MISSILES

Option 6 is a possible solution for three contributing factors:

- Perceived vulnerability of nuclear forces or command and control systems
- Short decision times
- Deterrence doctrine or posture reliant on launch on warning or launch under attack

Table 4.8 summarizes the evaluation of Option 6 in terms of the eight nuclear safety criteria.

Background

Option 4, above, offers one way to address Russia’s concern about the Trident force’s ability to quickly attack Russia’s forces and command and control systems: keep Trident submarines far away from Russia. Option 6 offers another way: remove the Trident missile warheads that can destroy hardened ICBM silos and command bunkers.

Table 4.8
Evaluation of Option 6

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Option: Remove W-88 warheads from Trident missiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>Negative?</td>
</tr>
<tr>
<td>Effect on U.S.- Russian political relations</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>Positive</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>Positive</td>
</tr>
</tbody>
</table>
Trident submarines carry D5 missiles, which can deliver either powerful W-88 warheads or less-powerful W-76 warheads. Although each D5 missile can carry up to eight W-88 warheads, the total number that the Navy can deploy is limited because the United States built only about 400. The combination of the W-88’s power (reported to be 475 kilotons) and the D5’s accuracy (reported to be less than 100 meters when combined with the Mark 5 reentry body that protects the warhead during its fiery reentry into the atmosphere) is what makes this weapon so potent.\textsuperscript{17} According to standard calculations of lethality, two W-88 warheads delivered by D5 missiles have at least an 80 percent probability of destroying an extremely hard target, one that can withstand a blast of 5,000 pounds per square inch.\textsuperscript{18} (The comparable figure for an attack by two W-76 warheads delivered by D5s is only about 50 percent.) Such high lethality is equaled in U.S. forces only by the Peacekeeper missile, which is scheduled to be retired in 2003. Along with being lethal, the D5 can be launched close to Russia and can strike its targets within 10 minutes, which places a great deal of pressure on Russia’s dilapidated command and control systems.

\textbf{Specifics}

To reduce Russia’s concern about surprise Trident submarine attacks on important hardened targets, Option 6 reduces the Trident’s explosive power by removing and placing in storage the W-88 warheads deployed on its D5 missiles. The W-88s will be replaced by the smaller, less accurate W-76s, reducing the missile’s ability to destroy a hardened command center or silo by nearly half.

Since the United States does not want to reveal sensitive information about its reentry bodies and warheads, Russian inspectors will not be able to observe the warheads being removed from the missiles or in storage. Instead, to confirm that the W-88 warheads have been removed, Russian inspectors can look at the front ends of D5 missiles in the same manner they routinely do under START to confirm that the number of warheads on a missile does not exceed treaty limits.

\textsuperscript{17}Congressional Budget Office, \textit{The START Treaty and Beyond} (Washington, DC: CBO), October 1991, p. 148.

\textsuperscript{18}Ibid.
During the START inspections, the United States removes the missile’s nose cone and puts a hard plastic cover over the missile’s front end to hide sensitive details about the warheads and the final missile stage, called the bus. The cover has a number of bumps on it corresponding to the maximum number of warheads allowed for that type of missile, eight under START I and five under START II. The covers are designed so that inspectors can see that there are no more warheads than the allowed number, but inspectors are not shown the actual number or the details of the warhead shape. For START inspections, the U.S. Navy uses two different covers for D5 missiles, one for missiles that carry W-88s, the other for missiles that carry the smaller W-76s. The two different covers are required because the two types of warheads are mounted on the missile in different places.

In theory, if the United States uses the W-76 cover, Russian inspectors will be able to confirm that no W-88s are on a missile—a simple inspection shows that the geometry is different. However, Russia has complained about the hard cover for years, arguing that more warheads could be hidden beneath it. (The United States has raised similar concerns about some of Russia’s covers.) Furthermore, the design of the covers does not permit the sizes of the two warheads to be compared. The Navy is unwilling to change the covers because it contends that they must be hard to protect sensitive details about the missiles and reentry bodies. Given this debate, Russia is very unlikely to agree that use of the W-76 cover will confirm that the W-88s are gone.

However, since warhead removal will be done unilaterally by the United States expressly to reduce Russian anxiety, this option assumes that soft flexible covers (similar to those the Air Force uses during reentry vehicle inspections of its ICBMs) will be used to allow the Russians to confirm the absence of W-88s. Alternatively, the United States can continue to use the hard covers and hope that Russia begins to believe over time that the W-88s have been removed. This latter approach, however, probably would reduce this option’s effect as a confidence-building measure.

**Evaluation**

By removing the W-88s, Option 6 sharply reduces the hard-target counterforce potential of the Trident force. Tridents will no longer be
able to destroy very hard targets with high probability. This option will have no other effect on the operations, survivability, or structure of U.S. nuclear forces.

**Contribution to Reducing the Risk of Nuclear Use.** By removing the hard-target counterforce capability of the Trident force, Option 6 increases the decisionmaking time available to Russia’s leaders—a key goal of those who worry about Russia launching an accidental attack. Russia’s decision times will be extended from less than 15 minutes to roughly the 30 minutes it takes U.S. ICBMs to reach their targets (see Table 4.3, above). As with Option 4, the extra time provided—in this case, by removing the W-88 warhead—may reduce Russia’s general feelings of insecurity with respect to the Trident force, and this reduction may reduce the chance that another factor, such as inadequate early-warning information, will lead to nuclear use.

**Effect on Current U.S. Strategies and Targeting Plans.** This option represents a sharp shift for the United States, away from maintaining a prompt counterforce capability in its submarine force. Those who believe that the U.S. deterrent is enhanced by the ability to destroy Russian command and control centers, ICBM silos, and other hardened targets quickly will disagree with this approach. It may also raise concerns for those who believe that the W-88 is an important capability for deterring other countries.

However, this option may not affect U.S. capabilities all that much if, as some have argued, the Trident W-76 warhead has significant potential to destroy hardened targets when delivered by the already accurate D5, particularly if the D5 could be made even more accurate by adding global positioning system (GPS) guidance on its warheads.19 In that case, the only way to reduce the Tridents’ first-strike potential will be to keep them away from Russia or reduce the accuracy of all their warheads.

**Effect on U.S.-Russian Political Relations.** Option 6 can play a major role in improving U.S.-Russian relations. By removing the W-88 war-

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head from its missiles and retiring the Peacekeeper missile, the United States will be removing its two most capable counterforce weapons. This provides an important signal that the United States is moving away from a nuclear strategy based on counterforce, which greatly decreases Russia's reasons for continuing with its launch-on-warning nuclear strategy and will, it is hoped, lead to Russia adopting a more relaxed nuclear posture. Unlike Option 4, Option 6 will be reasonably easy to verify and monitor, something the Russians are likely to consider important in building trust and confidence.

**Effect on Other Major International Actors (China, Europe, etc.).** Unlike Option 4, this option will have no effect on how British and French ballistic missile submarines are postured.

**Effect on Prospects for Achieving Nonproliferation and Counterterrorism Goals.** No effect.

**Feasibility and Affordability.** One major advantage of this option is that it can be done quickly: it is a unilateral measure that requires neither negotiations nor changes to the submarines or the way they are operated. As a result, it does not increase the vulnerability of the Trident force. Furthermore, it is a low-cost option. The only additional expenses would be the Navy's costs to develop and test soft covers for D5s and perhaps some extra funding for an increased number of START inspections each year.

**Effect on Incentive to Strike First with Nuclear Weapons.** This option increases first-strike stability if Russia's commanders end up being more confident that they and their forces will survive a U.S. first strike long enough to launch a counterstrike. And this, in turn, will make them less likely to launch on warning.

Furthermore, this approach may be able to improve stability without introducing the concerns some have raised about reducing launch readiness or verifying that submarines have been pulled back. It can also be combined with other measures to reduce the risk of accidental nuclear use, including keeping submarines away from their targets, improving early-warning information, and reducing the launch readiness of nuclear forces.

**Ability to Monitor or Verify Implementation of the Option and Effect of Cheating.** One of the major questions in terms of verifying
Option 6 is how the frequency of Russian inspections of the front end of Trident missiles compares with the time it will take the United States to replace the W-76s with W-88s. Under START, Russia is allowed to conduct up to 10 inspections of ballistic missile warhead loading every year, with no more than two inspections at any one base. Since the United States has only two Trident bases, Russia can view at most four missiles each year, or one every three months, on average. Russia could always conduct another inspection before the three months were up if it were suspicious and had not used up its annual quota at both bases.

Unfortunately, the United States needs only about one day to return W-88s to one missile, and about a week to equip all 24 missiles on one submarine if work continues around the clock. Reloading W-88s on the entire fleet would take longer—from one to two months—because the submarines would have to return from their patrols to be loaded. Submarines can return more quickly, but a sharp change in operational patterns might raise suspicion in Russia and lead to an inspection.

Since the United States presumably is interested in demonstrating that the warheads have been removed, this option makes two changes to START inspection procedures. First, the United States would permit a series of baseline inspections over six months in which Russian inspectors are allowed to look at the front ends of all, or at least a significant portion of, the deployed D5 missiles. Second, the United States would voluntarily increase the number of reentry vehicle inspections allowed each year at a Trident base from two to four, although it could be even more frequent than that.

If the United States were to cheat, it would return its capabilities to current levels. This would not increase Russia’s vulnerabilities unless Russia postured its forces so they were more vulnerable than they are today.

OPTION 7: REDUCE DAY-TO-DAY LAUNCH READINESS OF 150 ICBMS IN SILOS

Option 7 is a possible solution for four contributing factors:

- Nuclear forces kept at high day-to-day launch readiness
• Perceived vulnerability of nuclear forces or command and control systems
• Short decision times
• Deterrence doctrine or posture reliant on launch on warning or launch under attack

Table 4.9 summarizes our evaluation of Option 7. Note that two approaches are presented for this option.

**Background**

The most straightforward method for increasing decision time is to make it more difficult for both the United States and Russia to launch their nuclear forces quickly. This can be done by immediately remov-

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Approach 1: Reduce launch readiness of 150 ICBMs in silos with enhanced START monitoring</th>
<th>Approach 2: Reduce launch readiness of 150 ICBMs in silos with continuous monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Effect on U.S.- Russian political relations</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>Negative</td>
<td>Positive</td>
</tr>
</tbody>
</table>
ing nuclear forces from alert, either by shutting the systems off in some way, removing warheads, or, in the case of ballistic missile submarines, moving them out of range of their targets. This approach is sometimes called de-alerting.20

The fundamental goal of reducing launch readiness is to increase the time that both countries have available before they must make a decision about retaliating in response to a possible nuclear attack. Ideally, a reduced-launch-readiness force would be completely survivable and require at least a few days or weeks to re-alert in ways that would be very visible to the other country. Because neither country has designed its forces with reduced launch readiness in mind, the challenge is to make today’s deployed forces come as close to the ideal as possible.

**Historical Experience with Launch Readiness Reduction.** There are several historical precedents for reducing launch readiness. In September 1991, the first President Bush unilaterally removed portions of the U.S. nuclear force from alert. He ordered that bombers be taken off strip alert, where they stood loaded with nuclear weapons, ready to take off within 15 minutes. He also ordered that all 450 Minuteman II missiles and the missiles on 10 older Poseidon submarines be taken off alert (these forces were all slated to be removed under START I, which had not yet been ratified by the United States or Russia). This action occurred shortly after the August 1991 coup attempt in Russia. Within a week, Russia announced that it would reciprocate by taking off alert some 500 silo-based missiles and the missiles on six submarines.

In 1994, Presidents Bill Clinton and Boris Yeltsin agreed to stop aiming ballistic missiles at each other’s country by programming the missile guidance systems to hit the oceans. This type of action may reduce the damage from an accidental launch, but since the missiles

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can be reprogrammed within seconds, it does nothing to reduce the chances of an unauthorized launch or an intentional launch based on inaccurate or incomplete information.

Two other countries have had some experience with reduced-launch-readiness forces. China keeps its missiles off alert during peacetime—their warheads are removed and their rockets unfueled. And Britain, in response to changes in the world, recently decided to put its entire nuclear force, which is deployed on Trident submarines, on what it calls reduced alert. Although the British government has not described how this is accomplished, it has stated that days rather than minutes will be required to launch missiles.

The Challenge of U.S. and Russian Force Asymmetries. As discussed in Chapter One, U.S. and Russian forces and postures have significant asymmetries that will continue for the foreseeable future. These asymmetries not only create many of the problems analyzed in our study, they also make solutions more difficult. Techniques for reducing launch readiness and verifying compliance are highly dependent on the specific technical and operational details of each system. As a result, the asymmetries can matter.

For example, Russia has based most of its alert forces in silos, the United States on submarines; and changes made to silo-based missiles are easier to verify than those made to submarines. So if there were a proposal to reduce the launch readiness of all U.S. and Russian nuclear forces, verifying the launch readiness of the bulk of the other country’s forces would be easier for the United States than for Russia. Russia also operates mobile ICBMs that can drive around the countryside on trucks.\textsuperscript{21} And although Russia keeps most of its ballistic missile submarines in port, they can launch their missiles from alongside the pier. By contrast, the United States keeps only about one-third of its submarines in port, but they cannot launch their missiles unless submerged.

There are mechanical differences as well. Russian and U.S. silos are opened by different mechanisms, and the accessibility of batteries

\textsuperscript{21}Russia also operates roughly 60 SS-24 missiles on railcars. These missiles were supposed to be dismantled under START II, but with the future of that treaty in doubt, it is not clear when they will be eliminated.
and guidance systems—items commonly removed in schemes to reduce launch readiness—often differs in Russian versus U.S. ICBMs. In fact, there are even differences in the ICBMs deployed by one country.

Asymmetries also make it difficult for one solution to affect both countries in a similar and reciprocal fashion. For example, Russia already keeps its few deployed submarines close to Russian waters, where they can be better protected from U.S. attack submarines. So an approach requiring each country to keep its submarines several thousand miles away from the other would affect the United States disproportionately. That does not mean that such an approach should be eliminated, however, since it may be a reasonable approach if the goal is to reduce Russia’s anxiety. It just means that easy, symmetric solutions will be elusive. The various asymmetries mean that options for reducing launch readiness must be viewed in the context of a broad strategy for improving nuclear safety when choosing which, if any, to pursue.

**Possible Approaches for Reducing Launch Readiness.** Because of the enormous complexity of reducing launch readiness and the vast array of possible approaches, we chose to explore two options, one at each end of the spectrum. The first proposes that the United States and Russia reduce the launch readiness of an equal number of ICBMs (150, which is approximately one-third of the U.S. ICBM fleet) through unilateral declarations and without verification procedures. This approach, which is the basis for our Option 7—the option under discussion in this section—is very much like the one Presidents Bush and Gorbachev used when they removed forces from alert in 1991. The second option, at the other end of the spectrum, proposes a complete reduced-launch-readiness regime accompanied by complex, intrusive verification measures. That approach is the basis of Option 8, which is discussed in the next section.

Two commonly discussed methods for reducing the launch readiness of ballistic missiles are (1) remove a key component, such as the batteries or some other component of the guidance system, and (2) remove the actual nuclear warhead. We examined both of these methods, but then chose to investigate the effects of only the first one because we had two major concerns about separating warheads from missiles.
Our first concern was that removing a warhead and placing it in a separate facility could increase the risk of its being stolen, particularly given current worries about the security of Russian warheads. Some Russian officials have expressed similar concerns to us. It is more difficult to steal a warhead from a missile in its silo than from a separate facility, because the heavy silo door has to be opened and the warhead removed from the missile. Our second concern was that the storage facilities containing separated nuclear warheads would make a very inviting first-strike target during a crisis. If one country could secretly reassemble its ballistic missiles, it could easily disarm the other by attacking its nuclear storage facilities, completely eliminating the ability to retaliate. This might even be possible using non-nuclear precision-guided weapons.

Removing a key missile component rather than the warhead limits both of these concerns. Theft of a key nuclear component is, of course, a serious problem, but it is far from the calamity that a stolen nuclear warhead would be. Also, it is much easier to store such things as batteries and guidance systems in a large number of separate facilities, making it far more difficult to destroy a country’s ability to retaliate.

Specifics

Option 7 reduces the launch readiness of 150 U.S. ICBMs (one-third of U.S. silo-based missiles) and an equal number (or perhaps an equal proportion) of Russian missiles. This could be a first step toward reducing launch readiness for all forces, because silo-based missiles are the easiest to monitor through START inspections and by satellite. Such an approach has been suggested by several analysts in the United States and Russia, although none has suggested reducing launch readiness for these forces without some verification.

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22If Russia’s future force has fewer than 500 silo-based missiles, perhaps a reduction by one-third would be more appropriate. Alternatively, missiles carrying 150 warheads could be subject to the agreement.

Both countries would disable their silo-based missiles in a way that takes some time to reverse. Silo-based missiles can be removed from alert in various ways, each with its own strengths and weaknesses. The most frequently discussed measures are installing safing pins, disabling the opening mechanism for the silo door, removing the batteries or other components of the guidance system, putting something heavy and large over the silo missile door, and removing the warheads or the entire front section containing the warheads. The details of specific measures may differ for the two countries and even for different types of missiles in one country, because different types of missiles and silos may not be engineered the same way.

This option assumes that the United States will take two steps to reduce the launch readiness of its missiles. First, it will insert a safing pin in each missile. These pins are inserted when the missile is serviced in order to avoid accidents: the missile cannot be launched unless the pin is removed. The United States took its Minuteman II missiles off alert in 1991 over a period of three days by inserting safing pins. The pin is accessed through the silo’s service hatch, which is distinct from the silo’s main door, through which the missile is fired. Second, the mechanism that opens the main silo door will be disabled by removing the piston that opens the door during a launch. Russia would take similar steps: inserting safing mechanisms and removing the piston that opens the door.

Missile status could be monitored two different ways: Approach 1 uses slightly modified START inspections; Approach 2 uses the same inspections plus baseline inspections and continuous silo monitoring via the silo-based sensors described in the second approach for Option 2 (see Option 2 section, above). Approach 1 is the easier of the two to implement, but inspections could occur too infrequently to catch cheating. Approach 2 addresses this problem by increasing the frequency and thoroughness with which forces are monitored, but it is more difficult to implement.

Approach 1: Monitoring Using Modified START Provisions. Approach 1 monitors the launch readiness of the missiles using an enhanced version of the inspections allowed under START. The treaty

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24Option 8, discussed in the next section, also uses these two approaches for monitoring compliance.
allows both countries to conduct 10 inspections each year of the missiles’ front ends to verify that they carry no more than the allowed number of warheads. Only two inspections may be conducted at any one base, however. During an inspection of a silo-based missile, inspectors observe the silo door being opened on the missile that they designate. The treaty requires the missiles to be located not more than 50 meters from the silo for this procedure. The inspectors are then allowed to look down the missile tube to count the warheads, which are usually shrouded so as to protect sensitive information while allowing the warheads to be counted. Russia also shrouds the entire opened silo door, the opening mechanism, and most of the top of the silo. Inspectors get two indications that the door has been disabled. First, they see that the door is opened manually, although this does not prove that the door-opening mechanism has been disabled. Second, this option assumes that the party being inspected will allow inspectors close enough to look at the silo’s door-opening mechanism so that they can see that the piston has been removed. This would be an ad hoc confidence-building measure that goes somewhat beyond START protocols. It is not required by the treaty, but it is not prohibited either.

The fact that a missile has been disabled by installing a safing pin cannot be verified under Approach 1 unless inspectors are allowed access to the inside of the missile silo. Likewise, verifying that batteries have been removed from the guidance system can be done only by going into the silo or removing the missile from the silo, both of which require significant changes to the START inspection protocols. Neither of these intrusive measures has been assumed in Approach 1.

**Approach 2: Continuous Monitoring.** Approach 2 improves the monitoring by using an improved version of Option 2’s silo-based sensor system (presented earlier). The primary modification is the use of fiber optic seals on the main silo door and access door to provide continuous monitoring of each silo and confidence that each missile has not been re-alerted. Any time a silo door is opened to reinstall the opening mechanism, the sensors will detect it.

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25For details, see START I, Section VII of the Protocol on Inspections and Continuous Monitoring Activities and Annex 3 of that Protocol (U.S. Department of State, *START*).
Approach 2 also improves confidence that the missile has been disabled in the first place by allowing each country to inspect each silo after its disabling via the modified START inspections discussed above. Since the goal of this option is to increase the confidence of both countries, it seems reasonable that the United States and Russia will both be willing to increase the number of inspections over what START currently allows.

Evaluation

**Contribution to Reducing the Risk of Nuclear Use.** Reduced launch readiness can reduce the risk of nuclear use in two fundamental ways. First, by taking forces off alert and increasing the number of steps necessary to launch a nuclear weapon, it greatly reduces the chances that rogue forces or terrorists will be able to launch nuclear weapons. For example, a several-hour delay before an ICBM can be launched could be enough to prevent missiles from being launched accidentally, either by a rogue actor or through an error in the command and control system. Option 7 will have only a modest effect on reducing these risks, however, because only 150 silos are affected.

Second, reduced launch readiness can give each country additional time to reach a decision about retaliating in response to a possible nuclear attack. Option 7 will have only a fairly limited effect on decision time, however, since it applies only to one-third of the silo-based missile force. Only a day or so would be needed to re-alert the first missile, and a week or more for all 150 silos, but all the other silos and submarines would continue to operate at current levels of alert.

In sum, Option 7’s immediate gains in reducing the risk of nuclear use would be limited. However, its real significance is that it would be a first step in the long, complicated process of reducing the launch readiness of nuclear forces, which, if properly implemented, could significantly reduce the risk of accidental or unauthorized use.

**Effect on Current U.S. Strategies and Targeting Plans.** Option 7 should have no more than a small effect on current U.S. strategies and targeting plans because it concerns such a small number of forces.
Effect on U.S-Russian Political Relations. The effect of Option 7 on U.S.-Russian relations is likely to depend in large measure on the details of the option and the state of relations when it is implemented. If relations have improved to the point where standing down nuclear forces becomes an important symbol of progress, the effect on relations is likely to be positive. If the deterrent strategy and mindset have not changed much from those of today, any significant step is likely to be viewed negatively.

Option 7 requires less improvement in relations than the more far-reaching approaches do, since it affects only part of the force, but it still requires some progress from where the two nations stand today.

Effect on Other Major International Actors (China, Europe, etc.). As noted earlier, both Britain and China already have some experience in keeping their forces at reduced levels of launch readiness.

Among the major powers, China has gone the furthest in keeping its small nuclear forces off alert. During peacetime, China reportedly keeps its missiles off alert, their warheads removed and their rockets unfueled. Because of its current nuclear posture, China is likely to react positively to steps by the United States and Russia to reduce the launch readiness of their forces. However, the Chinese are unlikely to join any monitoring scheme that requires them to reveal sensitive information about their nuclear forces. The Chinese have traditionally been unwilling to engage in arms control discussions, their argument being that they are currently at a disadvantage because the United States and Russia have much larger nuclear forces. According to the Chinese, any arms control discussion based on the current global nuclear balance would leave them in a permanently inferior position.

Britain, during its last nuclear review, changed the posture of its forces, announcing that its submarines would take days instead of minutes to fire their missiles. However, no steps were taken to allow anyone to verify or monitor whether the submarines had changed the way they operate. Britain is therefore also likely to react favorably to a U.S.-Russian launch readiness reduction proposal, since it would have little effect on Britain’s nuclear posture. It also seems likely that Britain will be willing to incorporate its nuclear forces (including allowing monitoring) if launch readiness reduction is turned into a
global proposition. And if the United States, Russia, and Britain were to reduce the launch readiness of their forces, France, with its small nuclear force, may join the effort as well.

Effect on Prospects for Achieving Nonproliferation and Counterterrorism Goals. By taking forces off alert and increasing the number of steps necessary to launch a nuclear weapon, launch readiness reduction could greatly reduce the chances that rogue forces or terrorists will be able to launch nuclear weapons. However, if not done carefully, it could have exactly the opposite effect. If the measures instituted to stand down the forces include removing warheads from missiles, the separated warheads could be stolen if not protected properly.

Specifically, though, Option 7 will not affect U.S. nonproliferation goals, because it will not remove warheads. This choice was made because of concern in the West about the security of separated warheads in Russia.

Feasibility and Affordability. One of the biggest advantages of Option 7 is that it can be implemented relatively quickly and focuses on the forces that are the easiest to verify—silo-based ICBMs. No formal negotiations are required, and the modest deviation from the START I inspection protocol (allowing inspectors to view the mechanism for opening the silo door) can be done informally and unilaterally. Taking advantage of the silo-based early-warning system outlined in Option 2 for continuous monitoring would not add complications beyond those discussed for Option 2.

Effect on Incentive to Strike First with Nuclear Weapons. Because it concerns such a small portion of the U.S. and Russian forces, Option 7 will probably not have a direct effect, positive or negative, on the incentive to strike first. Taking this small part of the ICBM force off alert will not appreciably affect force survivability, and cheating will not increase one country’s force by very much.

Ability to Monitor or Verify Implementation of the Option and Effect of Cheating. Option 7 offers two different methods for monitoring: using modified START inspection protocols, and supplementing those protocols with sensors that provide continuous monitoring. In general, START procedures alone will only be able to detect cheating within a month or so. Sensors can provide nearly
instantaneous information about cheating, but they are more difficult to negotiate and implement.

**Approach 1: Monitoring Using Modified START Provisions.** The disabling of 150 silo-based missiles can be monitored by the START on-site inspections mentioned above (with modifications). Each country could check the status of a single silo 10 times each year, or an average of once every five weeks, which allows far more time than a country would need to re-alert its force either by jacking silo doors open or fixing the opening mechanism. If half of the 10 reentry vehicle inspections allowed by START were devoted to missiles on submarines, however, ICBM inspections would take place only every 10 weeks on average.

If cheating were conducted on a broad scale, it might also be detected by photoreconnaissance satellites. Large numbers of open silo doors would be unusual and noticeable from space. So might the activity of large numbers of ground crews working to open the silo doors or repairing the opening mechanisms. Whether such activity could be detected quickly enough would depend on how often the satellites were tasked to look at the missile fields, what the weather might be, and how carefully the activity is disguised. Attempts to disguise cheating would slow down the work process, however, and increase the chances that it would be discovered during an inspection. For example, suppose that the United States decided to cheat and to avoid detection by satellite by opening only two silos a day at each base, fixing the mechanism, and closing the door. This activity might be indistinguishable from normal maintenance activities, but at such a slow rate, it would take the United States 100 days to repair the doors to all 200 of its Minuteman III silos at Malmstrom Missile Complex, and 75 days to repair all 150 silo doors at each base in the F. E. Warren and Minot Missile Complexes. In both cases, the required time is longer than the average time between inspections if five reentry vehicle on-site inspections are conducted on ICBMs each year, which increases the risk of getting caught. Russia could re-alert its missiles more quickly, because it has more bases with fewer missiles deployed at each.

**Approach 2: Continuous Monitoring.** Early-warning sensors placed on silos as outlined in Option 2 will provide the means to have nearly instantaneous information about the alert status of the missiles. This
information would allow each country to target its START reentry vehicle inspections to silos whose opening mechanisms were suspected of having been tampered with. It could also significantly increase confidence that cheating is not occurring.

In sum, the risks of cheating are relatively small for Option 7 because only 150 silos are involved.

**OPTION 8: REDUCE DAY-TO-DAY LAUNCH READINESS OF ALL NUCLEAR FORCES**

Option 8 is a possible solution for four contributing factors:

- Nuclear forces kept at high day-to-day launch readiness
- Perceived vulnerability of nuclear forces or command and control systems
- Short decision times
- Deterrence doctrine or posture reliant on launch on warning or launch under attack

Table 4.10 summarizes the evaluation of this option.

**Background**

The background for Option 7, presented in the last section, applies to Option 8, as well.

**Specifics**

Under Option 8, the United States and Russia reduce the launch readiness of all three legs of their nuclear forces and agree to extensive verification and monitoring provisions. This option combines the measures taken in Options 4 and 5 (keep submarines back), Option 6 (remove W-88 warheads), and Option 7 (reduce launch readiness of silo-based missiles), although, in contrast to Option 7, it affects all silo-based missiles rather than just one-third of them and also removes mobile missiles, bombers, and submarine-based missiles from alert.
Table 4.10
Evaluation of Option 8

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Approach 1: Reduce launch readiness of all nuclear forces with enhanced START monitoring</th>
<th>Approach 2: Reduce launch readiness of all nuclear forces with continuous monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Positive or negative</td>
<td>Positive or negative</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Effect on U.S.-Russian political relations</td>
<td>Positive or negative</td>
<td>Positive or negative</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>Positive or negative</td>
<td>Positive or negative</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>Negative</td>
<td>Positive</td>
</tr>
</tbody>
</table>

*Silo-Based Missiles.* Option 8 reduces the launch readiness of ICBMs the same way Option 7 does, disabling the silo doors and safing the missile either by installing safing pins or by removing the batteries from the guidance system.

*Mobile Missiles.* The launch readiness of missiles that Russia has deployed on railcars and trucks will be reduced by removing the batteries from their guidance systems and disabling the mechanisms that raise the missiles to their launch position. Returning the batteries and fixing the erector mechanism should take a few hours for each missile. Russia keeps its 360 SS-25 road-mobile missiles at nine bases, an average of 40 missiles per base. If two crews worked around the clock at each base to re-alert the missiles, it would take about two and one-half days for all 360.
Bombers. Bomber launch readiness will be reduced by removing the nuclear missiles and bombs at their bases, as well as equipment unique to nuclear weapons, and storing both the weapons and the supporting equipment in bunkers at least several hours from the nearest bomber base. At least one week would be needed to return all of the weapons to the bomber bases. This approach is similar to the one taken in START II for the B-1B bomber, a nuclear bomber that has been converted to a nonnuclear role primarily by keeping nuclear weapons at least 100 kilometers from its bases.

Submarines. The launch readiness of submarines will be reduced in two ways. First, each country’s submarines will be kept far away from the other country’s coasts and, for the United States, their W-88 warheads will be removed (as in Options 4 and 6). Second, both countries’ submarines will remain on what the United States refers to as modified alert while deployed at sea. The United States does this for safety reasons every time submarines return to their base from patrol. Sailors on the submarine remove an electronic component in each D5 or C4 missile so that no missile can be accidentally launched while the submarine is at sea. The United States does this for safety reasons every time submarines return to their base from patrol. Sailors on the submarine remove an electronic component in each D5 or C4 missile so that no missile can be accidentally launched while the submarine is at sea. This electronic component is returned to the missiles after the submarine leaves port and before it reaches its patrol area. Access to this electronic component is through the access panel on the missile’s equipment section. An access hatch in the submarine’s missile tubes allows sailors to enter the equipment section while the submarine is at sea.

According to Bruce Blair and several naval experts, sailors need about 90 minutes to install this electronic component in each missile, and submarine crews typically do two missiles at a time.26 This means that the first two missiles could be readied within 90 minutes and that about 18 hours would be needed to restore all 24 missiles on a Trident to full alert using normal procedures.27 (This time could be cut in half, though, if enough sailors were assigned to ready four missiles at a time.) It would take roughly a week for the U.S. submarines to sail from areas at least 6,000 nautical miles from Russia to areas within 2,000 nautical miles, and about the same time for all of


the W-88 warheads to be returned to the D5 missiles on two submarines.

The Russian Navy has no equivalent to modified alert that it practices routinely. Indeed, its submarines are designed to launch their missiles from port. At least some of these missiles are routinely kept at a high state of readiness, able to launch within minutes.\textsuperscript{28} To provide a level of reduced launch readiness similar to that of U.S. submarines, this option will require that the Russian Navy remove batteries or some other component from its SS-N-20 and SS-N-23 missiles, which, like the electronic components in U.S. missiles, can be installed at sea, if necessary. If such components cannot be installed at sea, a new approach would have to be taken when the submarines are at sea. This represents a large operational change for Russia, though. It counts on having some of these missiles ready to launch in port to compensate for the small number of submarines and warheads that would be at sea and for the vulnerability of Russia’s at-sea submarines to U.S. anti-submarine forces.

The approaches just described will reduce the launch readiness of the forces if fully implemented, but confidence in the reliability of these approaches will require additional monitoring. By adding tags and seals to the existing monitoring provisions of START, both countries can be made more confident that force launch readiness has been reduced and will remain that way. However, force monitoring is complex and should be done in a way that increases confidence and transparency without increasing force vulnerability or encouraging cheating, particularly during a crisis. Reconciling these two goals can be very difficult; indeed, it is often the reason why proposals to reduce launch readiness are rejected out of hand. Any provisions for monitoring forces will require negotiations to establish mutually acceptable procedures.

We examined two monitoring approaches for Option 8, similar in philosophy to the two monitoring approaches for Option 7. Approach 1 uses an enhanced version of the current START monitoring scheme that goes further than the changes suggested in Option 7. Approach 2 augments the enhanced START inspections of

\textsuperscript{28}Ibid., p. 110.
Approach 1 with additional measures that allow continuous monitoring of nuclear forces. This proposal, made by scientists at the Kurchatov Institute in Moscow, was introduced in the discussion of Option 2 and applied to continuous monitoring of silo-based missiles in Option 7. In Approach 2 for Option 8, this scheme is expanded to continuously monitor all nuclear forces.

**Approach 1: Enhanced START Monitoring**

**Silo-Based Missiles.** As in Option 7, the launch readiness status of missiles is monitored by the inspections allowed under START. That is, some of the 10 inspections of missile front ends allowed each year will be used to verify that silo door mechanisms have been removed.

This option goes beyond Option 7 by introducing three significant additions to the monitoring regime. First, it permits baseline inspections in which inspectors can observe that the pistons have been removed from the door opening mechanisms of all silos. After confirming that the pistons have been removed, inspectors place tamper-resistant fiber optic seals on the silo doors and access hatches. Any attempt to open a door breaks a seal. Seals such as this have already been developed in the United States and elsewhere and are widely used in commercial activities and in the monitoring activities of the International Atomic Energy Agency (IAEA). Second, this option allows inspectors to check the status of the seals during regularly scheduled START reentry vehicle inspections. Third, because workers must enter silos periodically to work on their missiles, each country is required to notify the other in advance of any maintenance work that will break a seal. Inspectors can then check these silos during the next reentry vehicle inspection at that base, confirm that the piston has been removed, and reseal the door. Inspectors can also check the seals on a significant fraction (perhaps 20 percent) of the silos at each base, which they are allowed to select. Additional inspections, beyond the two per base per year allowed under START, could be added each year to increase the frequency with which the silo door opening mechanisms are checked, although that is not assumed here.

**Mobile Missiles.** To monitor mobile missiles, inspectors confirm that the erector mechanisms have been disabled by having their hydraulic components removed and that the batteries have been re-
moved from the missiles. They then seal the missile access doors to
the battery compartments. They also place a seal over the hydraulic
connection on the mobile missile launchers where the removed parts
must be reattached. At the garrisons, inspectors will be able to see
that the launching doors in the roofs of the mobile missile garages
have been welded shut and will be able to place a seal on them from
the inside.

**Bombers.** For bombers, inspectors check to make sure that nothing is
stored in the nuclear weapons storage facility at a bomber base and
then seal the door. At bases where the storage facility is being used
for conventional weapons, inspectors will only be able to check for
the presence of nuclear-armed long-range cruise missiles, as is the
case today under START.

**Submarines.** For submarines, Russian inspectors confirm to the
extent possible during reentry vehicle inspections that the W-88 war-
heads have been removed. But they will not be able to confirm that
the launch readiness of the Trident missiles has been reduced. They
could confirm that submarines are staying away from the coasts by
using the buoy verification system described in Option 4, Approach
2.

**Approach 2: Continuous Monitoring.** If the START inspections are
supplemented with seals, as described above, the measures for re-
ducing launch readiness outlined in Approach 1 will increase the
confidence that forces are remaining off alert during peacetime. But
the improvements will not address what is perhaps the biggest cri-
tique leveled at launch readiness reduction: it reduces stability dur-
ing a crisis because neither country can be sure that the other has not
re-alerted its forces.

Approach 2 tackles this problem by using a continuous monitoring
system similar to the one discussed in Option 7 for monitoring the
alert status of ICBMs in silos. Although the system must be adapted
slightly for launch readiness monitoring, the concept is the same:
provide near-real-time information about the status of the forces.
However, in this case the concept is expanded to encompass all nu-
clear forces, not just silo-based missiles. If such a scheme can be
applied successfully to launch readiness monitoring, it will make any
attempt to re-alert forces much more visible. Most important, it will
make the time needed to detect cheating much shorter than the time needed to cheat—the key to stability for any significant effort to reduce launch readiness.

The early-warning system discussed in Option 2 is derived from a cooperative system being developed by the United States (Sandia National Laboratories) and Russia (the Kurchatov Institute and Arzamas-16) for monitoring storage areas for fissile materials. The system consists of a series of modules that collect data from a variety of sensors and transmit those data to a nearby system that collects data from all modules at the facility (see section on Option 2 for details). The data then go to a monitoring center in the host country (the one being monitored) and by satellite or Internet to the country doing the monitoring. The parts of the system that have been developed so far are designed to make tampering difficult. In addition, the monitoring system uses unique authentication codes to prevent the sensors from being tampered with. Components of this system—including the data collection/transmission modules and some newly designed sensors—have been developed and tested in a series of experiments involving Sandia and the two Russian laboratories. The advantage of using this system for Option 8 is that both countries already have some experience with it and with cooperating to design, build, and operate such a system. They have worked with each other to develop and test it, sharing designs, experience, and test data.

Only a few changes are needed to convert the cooperative early-warning system to the mission of monitoring the alert status of forces. Moreover, if the system is already in use on silos as part of Option 2’s cooperative early-warning system or Option 7’s continuous ICBM readiness monitoring system, both countries will have had several years of experience with it. Data modules would be attached to every silo and bomber weapons storage facility. They would collect data from a suite of sensors, including fiber optic seals, door switches, motion detectors, and video cameras where applicable. The system’s primary function will be to monitor the fiber optic seals to ensure they have not been broken or tampered with. The other sensors will act together to reduce the chances that the seals or the data module could be tampered with. They would also provide alternative sources of information about the missiles’ alert status to help resolve any ambiguities or false alarms.
Seals and other sensors will be applied to each launcher during baseline inspections. The status of the data modules and the sensor suites will be checked during START inspections. They will also be checked during the routine maintenance visits this option allows to service the monitoring system, change the batteries, and replace defective components. In addition, this option will allow each country to permanently base a few small teams in the other country in order to check the alert status of and reseal the launchers after any maintenance is done on them and to provide emergency repairs. Both countries will have to announce in advance any maintenance activities that require a seal to be broken.

**Silo-Based Missiles.** For silo-based missiles, the difference between the cooperative early-warning system in Option 2 (see Option 2, details on monitoring silo-based missiles) and the launch-readiness monitoring scheme is slight. The only change is that fiber optic seals will be placed on the main silo doors and the access launch, as discussed in Option 7, Approach 2.

**Mobile Missiles.** Russia’s road- and rail-mobile missiles are tougher to monitor than silos because their value comes from their ability to hide, which makes continuous monitoring impractical. (The United States has no mobile missiles.) The same issue arises with submarines.

When the missiles are in garrison, the data modules collect and transmit data continuously, just like they do for silo-based missiles. Data modules will be installed on the missile transporter (truck or railcar). Infrared sensors that can detect when a missile motor is burning could also be included. And the module might also have logic embedded in it that would allow it to transmit an alarm if it is removed from its launcher or tampered with in other ways. Seals will be placed (1) on the access door to the battery compartment and on the connection where the hydraulic components would be reattached to the launcher, (2) on the erector mechanism that would break if the missile were erected in preparation for launch, and (3) on the welds that keep the roof door closed in the garages for mobile missiles.

When the missiles are in the field, however, the data modules are switched to a dormant mode: they collect data on the status of the
missile every minute or so, but they transmit those data only if any of the three seals on the transporter are broken. Once back in garrison, the data collected during deployment could be downloaded and sent to the monitoring country. The module on a mobile missile will have to transmit its data via communications satellite. To ensure redundancy, two different satellite systems can be used from vendors such as Inmarsat and Iridium. Power will be provided by batteries inside the module.

One of several issues raised by mobile missiles that must be addressed for a launch-readiness monitoring system to be effective is how to make the system tamper resistant without the self-protection afforded by video cameras. One solution is to allow each country to randomly check the status of one mobile missile per week or month to increase the chances that tampering will be detected. Another issue is how to allow maintenance on the missile and launcher without creating false alarms. Since maintenance is mostly done in garrison, the same system used for silo-based missiles could be used for mobiles: prenotification of the activity followed by an on-site inspector who reapplies the seal. That inspector could also check the missiles coming in from the field to make sure the seals and modules have not been tampered with.

**Missiles Based on Submarines.** Submarines raise many of the same monitoring issues as mobile missiles do: issues concerning how to monitor compliance without compromising stealth. In addition, submarines operate under water, where satellite communications are impossible. The basic approach adopted here is the one adopted for mobile missiles: the sensors deployed on submarines transmit only when the status of the missiles changes, either because the lid (hatch) to a missile tube opens or motion consistent with a missile launch is observed.

In port, inspectors confirm the absence of the missile’s electronic components or guidance cans by looking through the missile access doors on the submarine. Then they place seals on the access doors to the missile tube. The status of the seals is monitored by a data module somewhere inside the submarine. That module is connected to the buoy-launching mechanism outside the submarine.
At sea, the buoys are launched only if the seals are broken. The module for the launch-readiness monitoring system allows two missile access doors to be opened on each patrol. The alarm sounds if a third door is opened. This feature is necessary because sailors sometimes have to open the access door during a patrol to service parts of the guidance system. Although this is not a common occurrence, it can sometimes happen once or twice per patrol.

To overcome the problem of transmitting through water, the system launches two buoys to transmit the alarm. (The second buoy broadcasts the same information as the first to improve the system’s reliability.) The buoys rise to the surface, begin transmitting immediately, and continue to replay the message for 24 hours or more to ensure the signal is detected. As in the case of mobile missiles, the signal is sent by military or civil satellites. One issue that must be addressed is how to make the modules and sensors able to function in the harsh sea environment and at depths of 1,000 feet or more. The buoys and a tamper-resistant mechanism must also be developed.

To increase the system’s resistance to tampering, each country will be allowed to randomly check the status of one submarine per week. This check will also indicate that the submarine has kept away from its targets (see Option 4, Approach 2, for details). In this case, though, the buoy released for the check will not start transmitting for up to 12 hours to ensure that the submarine has time to relocate and thus avoid detection. In addition, an inspector at each submarine base can check the seals when the submarine returns to port. That same inspector can also reseal any tubes that were opened for maintenance or arms control inspections. Whether the system should regularly broadcast the missiles’ status when a submarine is in port is an open question. It might not be useful for U.S. Trident submarines: they cannot launch from port and most of them are kept at sea. It would be more useful for Russian submarines, which are rarely at sea and can launch from port. In their case, a supplemental module could be attached to the existing one when the submarine is in port. The supplemental module could then transmit data regularly to a central facility at the base and on to the monitoring country.

Once submarines are back in port, inspectors will have to confirm the absence of guidance components and reseal any tubes that have been opened. They might also need to service the data module or the
buoys and could download data collected during the patrol. Accommodating these visits will require a regular presence at submarine bases. Inspectors could be located at or near the base or somewhere else in the region.

**Bomber Weapons.** Because bombers can be used for both nuclear and nonnuclear missions, this option seals the storage facilities for nuclear weapons after inspectors confirm that they are empty. It also monitors the buildings where the launchers (such as rotary launchers, pylons, and bomb racks) associated with nuclear weapons are kept. The data modules at each storage location rely primarily on fiber optic seals for the doors and possibly on motion detectors and video cameras. In all other respects, the system works the same way as the system for silo-based missiles.

**Evaluation**

**Contribution to Reducing the Risk of Nuclear Use.** Reduced launch readiness can reduce the risk of nuclear use in two fundamental ways. First, by taking forces off alert and increasing the number of steps necessary to launch a nuclear weapon, it greatly reduces the chances that rogue forces or terrorists will be able to launch nuclear weapons. For example, a several-hour delay before an ICBM can be launched could be enough to prevent an accidental launch, either by a rogue actor or through an error in the command and control system.

Second, reduced launch readiness can add to the time each country has before it must decide whether to retaliate in response to a possible nuclear attack. It also forecloses the option to launch quickly in response to an erroneous warning of attack—an event that may be increasingly likely if Russia’s early-warning system continues to degrade. In addition, the more confident that Russia is that U.S. forces remain off alert, the less likely Russian leaders are to mistake a sounding rocket, or some other benign event, for a Trident missile.

The comprehensive approach in Option 8 can have a significant effect on decision time. A day or so would be needed to stand up the first missiles, and weeks would be needed to bring the entire force to full launch readiness (see Table 4.3, above).
The significance of this added time depends fundamentally on how much confidence each country has that the other is not cheating and how sensitive each country’s deterrent is to cheating by the other country. This raises an important dilemma with respect to reducing launch readiness: If either country feels it will be at a disadvantage if the other country cheats and is not confident that it can detect cheating soon enough, launch readiness reduction can have the opposite of its intended effect—i.e., it can create intense time pressures to re-alert forces quickly. This dilemma is discussed further below.

**Effect on Current U.S. Strategies and Targeting Plans.** Option 8 can have a significant effect on current U.S. strategies and targeting plans in two ways. First, if the U.S. deterrence strategy continues to emphasize a tightly choreographed, rapid response to destroy Russian nuclear forces, reducing the launch readiness of the entire force will eliminate that possibility unless the United States is able to re-alert its force during a crisis. If, instead, the United States adopts a deterrence strategy that does not require a rapid response, launch readiness reduction will not affect its ability to meet its deterrence objectives—unless its force is vulnerable (not survivable) if Russia re-alerts its forces surreptitiously. This brings us to the second significant effect that reduced launch readiness could have: If cheating would make forces vulnerable, Option 8 could interfere with current U.S. strategies and targeting plans. If, however, the United States could verify Russian compliance with high confidence and in a timely manner, these concerns would go away.

In our view, U.S. forces would not be that vulnerable if cheating occurred, because most of them would be at sea—unless U.S. submarine vulnerability were increased by the monitoring system. Increased vulnerability is certainly possible, but it is also unlikely, because the United States would not agree to Option 8 or something like it unless it had high confidence that its submarines would remain undetectable. It is also an open question whether Russia would have the wherewithal to exploit a vulnerability if it did emerge.

Russia is more likely than the United States to be vulnerable to cheating, since it will have far fewer survivable forces. As a result, Russia may be less willing to adopt an approach as extensive as Option 8.
Effect on U.S.-Russian Political Relations. The effect of Option 8 on U.S.-Russian relations is likely to depend in large measure on the details of the option and the state of relations when it is implemented. If relations have improved to the point where standing down nuclear forces becomes an important symbol of progress, the effect is likely to be positive. If the deterrent strategy and mindset have not changed much from today, any significant step is likely to be viewed negatively. Before Option 8 can be implemented, the relationship will have to undergo significant improvement.

Effect on Other Major International Actors (China, Europe, etc.). Option 8’s overall effect on other major international actors is likely to be positive, as discussed above, for Option 7. However, unlike the case of Option 7, the United States and Russia will be unlikely to make across-the-board cuts in launch readiness unless relations with other nuclear powers are very good and nuclear weapons are not a central feature of their relations with one another.\footnote{29For a discussion of how other countries affect U.S. and Russian choices about their nuclear forces, see Roger Molander, David Mosher, and Lowell Schwartz, Nuclear Weapons and the Future of Strategic Warfare (Santa Monica, CA: RAND), MR-1420-OSD, 2002 (limited distribution; not for public release).}

Effect on Prospects for Achieving Nonproliferation and Counter-terrorism Goals. Option 8 will not affect U.S. nonproliferation goals, because it will not remove warheads (see discussion of Option 7).

Feasibility and Affordability. It will be very difficult to negotiate and implement Option 8’s complete stand down of all nuclear forces because of the complicated and central security issues involved. In addition, the technical details of the measure’s implementation are very complicated because of the differences in the two countries’ systems. And modifying the START inspection protocols to monitor compliance could also be challenging. However, Approach 2’s continuous monitoring system for all nuclear forces will be much more difficult to negotiate and implement, particularly because each country will want to ensure that it does not undermine the stealthiness of its survivable platforms—its submarines and mobile missiles. The continuous monitoring systems will also be fairly expensive, primarily because they require the continuous presence of inspectors, dedicated telephone lines, and monitoring hardware. The costs
will also be higher than those for the silo-based early-warning system because of the extra on-site inspections. Costs for this approach have to include those for hardware (modules, sensors, buoys, replacement tags), central collection centers, transmission lines (dedicated communications and Internet lines, including satellite access for mobile missiles and submarines), a monitoring center at the national command authority, on-site inspectors, and initial installation costs. Money will also be needed to develop some of the required hardware.

**Effect on Incentive to Strike First with Nuclear Weapons.** Whether an option to reduce launch readiness will affect the incentive to strike first depends fundamentally on the confidence each country has in the survivability of its forces and in the compliance of the other country. Option 8 can have a significant effect, either positive or negative. It will increase stability, provided that both countries feel confident that they can detect cheating before it becomes large enough to be significant or that their forces are survivable enough and their deterrence doctrine robust enough to make them relatively insensitive to cheating. Ideally, both conditions would hold.

The asymmetries in U.S. and Russian forces do not readily lend themselves to the ideal, however, particularly for Russia, whose forces are not very survivable today. The current mindset in both countries is such that the threat from cheating will be seen as significant, which means the monitoring system would bear the heavy burden of having to detect cheating quickly. For this reason, a continuous monitoring system such as the one outlined in Approach 2 is probably essential for success. The question is whether such a system can be devised that will provide enough confidence in compliance without reducing confidence in the survivability of submarines and mobile missiles. This question can be answered only by careful research and testing and cooperation between the two countries to develop such a system. Taking smaller steps initially, such as the ones proposed in Option 7, will also be helpful.

If none of the conditions—survivable forces, high confidence in compliance, a deterrence strategy that is not time sensitive—is met, even for one country, the standing down of all nuclear forces could sharply increase the incentive to strike first during a crisis. Uncertainty about compliance may actually increase the chance of nuclear
use in a crisis because one or both countries would not feel confident that the other has not secretly re-alerted its forces. If one country responded to the uncertainty by starting to re-alert its forces, that action might be perceived by the other as preparation for a first strike, at which point it might feel pressure to launch a first strike of its own. Under these conditions, reduced launch readiness would create a time dynamic for nuclear forces that could increase rather than lessen the risk during a crisis.

A number of U.S. critics of reduced launch readiness have raised such concerns, as have a number of Russian analysts. The Russian argument, which like the U.S. argument, focuses on the consequences of reduced launch readiness for Russia, goes like this: Russia is already vulnerable to a U.S. first strike. Its silos and command and control system are vulnerable to attack by U.S. ICBMs and Tridents. Moreover, Russia has few survivable forces, because all but a few of its submarines and mobile missiles are kept in port or garrison, where they can be easily destroyed. These forces are not only vulnerable, they can also be destroyed very quickly by Tridents close to Russian shores. Added to this bad situation are two other factors. The United States can also attack Russia’s hardened targets with its growing arsenal of nonnuclear precision-guided weapons. Moreover, NATO expansion has brought Russian targets within range of tactical aircraft that can carry nuclear and precision-guided weapons. Russia’s only solution is to be able to launch its forces quickly before they can be destroyed. So why would Russia accept reduced launch readiness and foreclose the only option it has?

And yet, Russians are not unanimous on these views. Indeed, several Russian analysts have advocated reduced launch readiness for at least some nuclear forces. But the concerns that Russian critics raise indicate that reduced launch readiness may be as tough to sell (at least in the near term) to Russia’s defense establishment as it could be in the United States. Again, the approach taken and the de-
tails of its implementation and monitoring will significantly affect how Russia perceives the value of launch readiness reduction.

**Ability to Monitor or Verify Implementation of the Option and Effect of Cheating.** Option 8 offers two different methods for monitoring: using modified START inspection protocols, and supplementing those inspections by using sensors for continuous monitoring. In general, using START procedures alone will only provide the ability to detect cheating within a month or so. Sensors can provide nearly instantaneous information about cheating, but they are more difficult to negotiate and implement.

**Approach 1: Modified START Provisions.** Under Approach 1, START monitoring provisions will be significantly modified to allow every silo, mobile missile, bomber and weapons storage facility for bombers, and submarine-based missile to be inspected during baseline inspections to verify that each platform has been disabled as required. Using tags and seals, inspectors will then conduct more annual inspections of each type of platform to confirm they all remain disabled.

Compared to the START provisions used in Option 7, those in this approach will provide a better method for detecting cheating. Cheating on a small scale will still be difficult to detect, but large-scale cheating can be detected within a month or so if inspections are timed and aimed strategically with information from national technical means. If the amount of time is not sufficient because of the far-reaching nature of this option, a continuous monitoring system can be used.

**Approach 2: Continuous Monitoring.** The continuous monitoring system offers two significant improvements. First, each country will have nearly continuous information about the launch-readiness status of many of the other country’s forces. That is, the time required to detect even small-scale cheating will be reduced to minutes, compared to weeks or months if only modified START monitoring is used. (Table 4.3, presented early in this chapter, compares the time to re-alert and detect cheating for Approaches 1 and 2.) These times are considerably shorter than what is needed to re-alert even small portions of the force. Second, this option provides a method for verifying the launch readiness status of at-sea submarines and
dispersed mobile missiles. Although it does not provide continuous information on these forces, it continuously monitors their status and releases a beacon to warn that missiles are being returned to alert.

Nevertheless, the addition of continuous monitoring does not increase the time it takes to re-alert forces: the methods for removing forces from alert remain the same and are less difficult to undo than removing warheads or entire guidance systems.

As for the risks of cheating in Option 8, they could be significant, particularly if one or both countries believes that being caught off guard would be a significant disadvantage.

The risks associated with cheating arise mostly in the context of a crisis. That is, in some situations, cheating may make a crisis situation less stable. If both countries agree to reduce the launch readiness of their forces, they have little reason to cheat during normal conditions, because they could get caught. But in a crisis, either country may feel compelled to cheat if it believes its survivable deterrent is inadequate. This brings us again to the point made earlier that the best force for launch readiness reduction is one that is very survivable because it is largely insensitive to cheating. The corollary is that a country with a highly survivable force is less likely to launch a counterattack based on erroneous information, because it can afford the time to make sure the attack is real before responding. In concrete terms, the United States, with most of its warheads deployed on submarines, may worry less about cheating than Russia, with its small survivable force, does.

**OPTION 9: INSTALL DESTRUCT-AFTER-LAUNCH (DAL) MECHANISMS ON BALLISTIC MISSILES**

Option 9 is a possible solution for four contributing factors:

- Nuclear forces kept at high day-to-day launch readiness
- Short warning times
- Inadequate security and control of nuclear forces and weapons
- Inadequate training precautions
Table 4.11 is a summary of our evaluation.

**Background**

Option 9 addresses the threat of unauthorized and accidental launches differently than the first eight options do. What distinguishes this option is that it seeks to minimize the consequences of a nuclear launch after it has occurred rather than to prevent the launch from occurring.\(^{33}\)

Option 9 installs a destruct-after-launch (DAL) system that allows each country to destroy its launched missiles in flight via a self-destruct mechanism it has installed. The main criticism of this DAL system is that a country’s nuclear deterrent could be rendered useless if a potential enemy were to intercept the codes and destroy the missiles in flight during a real nuclear crisis. The system’s advocates argue that this risk can be checked by including relatively simple measures, such as periodically changing the destruct codes or allowing the codes to be entered only during specified time intervals during flight.

**Table 4.11**

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Option: Install DAL mechanisms on ballistic missiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Very positive</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on U.S.- Russian political relations</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>N/A</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>Very positive</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Very negative</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>N/A</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>N/A</td>
</tr>
</tbody>
</table>

\(^{33}\)The same applies to Option 10, as well. See next section.
There is one historical case of a DAL system used on deployed missiles. The Soviet Union reportedly used a passive DAL system not only on test flights, but also on many of its deployed submarine-launched ballistic missiles and some of its deployed ICBMs. That is, the missile was programmed to self-destruct if it sensed that it was deviating significantly from its intended path; no external commands were required. This system was considered more reliable than the guidance systems or potentially irresponsible range safety officers.\(^3\)\(^4\) By contrast, the DAL system proposed in Option 9 requires an action by decisionmakers to rescind a decision to launch or to reverse an unauthorized or accidental launch.

**Specifics**

The DAL system discussed here is based on a DAL model proposed by Sherman Frankel,\(^3\)\(^5\) although other approaches have also been proposed.\(^3\)\(^6\) Implementing a DAL system involves creating an operational structure that would be added to current launch procedures.

The first step in activating the DAL system is detection of an accidental or unauthorized launch. Current early-warning systems that use satellites to detect near-infrared radiation from booster exhaust are adequate for use in a DAL system if they are positioned properly. Russia would need to either gain access to an adequate space-based system or develop an early-warning system that adequately surveys its home territory (see Options 1 and 2). The United States would have to make sure that its DSP or SBIRS-High system could observe U.S. as well as Russian launches.

The launch detection mechanisms are continuously monitored by a DAL control center (DALcc). Local DALccs are responsible for monitoring specific missile sites, and if a launch is detected, sending in-


\(^3\)\(^6\) Garwin, “Post-START: What Do We Want?”; and Garwin, “De-alerting of Nuclear Retaliatory Forces.”
formation about the launch to a national DALcc. The national DALcc then determines whether the launch was intended by proper authorities. If it appears to be accidental or unauthorized, the DALcc notifies personnel authorized to command a launch. Since destruction of a missile after launch reverses the decision to launch, only personnel with the proper authority to command a launch are allowed to make the reversal decision.

When the proper authorities are notified, they make the final determination about whether the launch was accidental or unauthorized. They also determine when it is appropriate to notify relevant countries of the launch. These authorities then have the option to command the DALcc to destroy the missile. If the decision is made to do so, the DALcc sends the appropriate self-destruct code to the missile. An appropriate system of geosynchronous communications satellites is needed to communicate the destruct signal.

Figure 4.3 shows a schematic of this process. Arrows indicate communication and/or transfer of responsibility. The numbers associated with the arrows indicate the sequential steps completed as time elapses.

A mislaunched missile can be destroyed in several ways. The first way is to deactivate the warhead, which involves making complicated alterations to the missile and, since the missile continues along its original trajectory, provides no way for the target country to de-
termine whether the warhead is, indeed, deactivated. Two other methods—destroying the missile in the boost phase and destroying or disabling the warhead in the midcourse phase—are better ways to build the target country’s confidence that the missile or warhead is no longer lethal.

**Approach 1: Destroy the Missile in Boost Phase.** In Approach 1, the missile is destroyed in the boost phase using conventional explosives. Launch detection by the DALcc can be accomplished using a radar system, and satellites are not needed to communicate the destruct signal. This simplifies the DAL system structure. The technical capabilities needed to fulfill this approach already exist and are employed for test launches. In fact, every U.S. space launcher launched and every ballistic missile launched during a test is equipped with exactly this type of DAL mechanism for safety reasons.\(^{37}\)

With this approach, the missile is not detected by the target country’s radar system, and a crisis can be quickly defused. It allows approximately 3 minutes to communicate a self-destruct signal to an ICBM.\(^{38}\) This is a short window of opportunity for the DAL system to operate within.

An additional consequence of Approach 1 is that the warhead could land where it would cause considerable damage. Calculations could be performed to determine the ideal point at which to command destruct to minimize consequences, but it would be difficult to do such calculations in the narrow time frames available.

**Approach 2: Destroy or Disable Warhead in Midcourse Phase.** Approach 2 destroys the threat warhead in midcourse, the roughly 20-minute period when the warhead is coasting outside the atmosphere. This approach can be carried out in one of two ways: (1) using a high-explosive to destroy the reentry vehicle (a method that may not be destructive enough to render the warhead harmless), and (2) by triggering a low-yield nuclear explosion of the warhead itself at

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the apogee, using the x-rays emitted to confirm the missile’s de-
struction. In Approach 2, the DAL system has approximately 20
minutes to communicate a self-destruct signal to an ICBM.39

Both methods in Approach 2 require extensive changes to the reentry
vehicle or the warhead. The first method entails redesigning the
reentry vehicle; the second could entail redesigning the detonation
mechanism in the warhead. If a low-yield option is not available for
the warhead, it may have to be altered, in which case underground
testing of the modified nuclear weapons may be required.

To address the concern that an adversary could disable an authorized
launch, a digital code will be used to activate the destruct
mechanism. This code will be kept by authorities responsible for
commanding a launch and the destruction of a launch. If a decision
were made to abort a launch, the code would be given to the DALcc
and then communicated to a satellite transponder to destroy the
missile. Several precautionary steps could be taken to reduce the risk
of an adversary intercepting the code. First, the destruct codes could
be changed on a periodic basis, making it necessary for an adversary
to continuously intercept the code in order to retain the ability to de-
stroy an authorized launch. Second, several codes could be required,
and they could be stored at separate points along the chain of com-
mand. Lastly, a DAL disable code could be created that would deacti-
vate the DAL system on the missile. Leadership could use this code to
guarantee that no one could reverse the decision to launch a missile
by using the DAL system.

Another way to diminish the chances of an enemy intercepting the
destruct codes and negating a deterrence capability is for each mis-
sile to have its own set of codes. An adversary would then have to
intercept the destruct codes for every missile that is launched in
order to neutralize an entire nuclear arsenal.

Evaluation

Contribution to Reducing the Risk of Nuclear Use. Installing a DAL
system can significantly reduce the effects of unauthorized or acce-

39Ibid.
dental nuclear use. While a DAL system does not prevent the unauthorized or accidental launch of a nuclear weapon, it does provide a process whereby an errantly launched missile can be destroyed. Unlike a missile defense (see Option 10), however, a DAL system would not provide protection from missiles launched by a third country without such a system.

By making it possible to minimize the consequences of a mislaunch, the DAL system addresses to some degree the contributing factors of nuclear forces operating at high day-to-day readiness, inadequate security and control of nuclear forces, and inadequate training precautions. A DAL system also partially addresses the contributing factor of short decision times. It does so by allowing actors a chance to reverse actions that may have been executed in haste, providing 3 minutes for a boost-phase destruct capability and up to 20 minutes for a midcourse capability, although leaders would be unlikely to rely on this additional time.

**Effect on Current U.S. Strategies and Targeting Plans.** A DAL system has no effect on current U.S. strategies and targeting plans as long as it is secure against misuse. It does not affect a nuclear weapon’s ability to reach its target. Instead, it allows a decision to launch a nuclear weapon to be reversed. Given the concern about a DAL system’s vulnerability to misuse by an adversary and its potential effect on the U.S. or Russian deterrent, any method adopted must be carefully designed to ensure security.

**Effect on U.S.-Russian Political Relations.** A DAL system can have a moderately positive effect on U.S.-Russian relations as long as both countries view it as reliable and secure against misuse. It could encourage confidence between the United States and Russia because it diminishes the likelihood of either country suffering the consequences of an accidental or unauthorized launch. In addition, if a joint program were established to develop the communications satellites for such a system, it could foster a positive relationship. A possible drawback may be that a DAL system will not diminish the importance of nuclear weapons in U.S.-Russian relations, instead diminishing the consequences of continued reliance on such weapons.
This option also fulfills the requirement set forth in the 1971 Accidents Agreement. Article 2 of this agreement states that in the event of an accidental or unauthorized launch, “the Party whose nuclear weapon is involved will immediately make every effort to take necessary measures to render harmless or destroy such weapon without its causing damage.” Meeting the requirements of this agreement could reenergize the commitment to guard against accidental or unauthorized launches.

Effect on Other Major International Actors (China, Europe, etc.). Option 9 has no significant effect on other major international actors as long as the DAL system is secure against misuse. The only likely effect is a slight reduction in the concern that an accidental or unauthorized U.S. or Russian missile launch could target another major international actor. In the best-case scenario, implementation of a DAL system will have a minutely positive effect. In the worst-case, some international actors, such as Europe and Canada, might be apprehensive about the potential shortfall of the warhead and debris.

Effect on Prospects for Achieving Nonproliferation and Counterterrorism Goals. Counterterrorism goals will be enhanced by a DAL system. September 11, 2001, fundamentally changed the post–Cold War security landscape, verifying that terrorist groups will strive to inflict enormous destruction and will pursue strategic attacks designed to produce high casualties. Access to nuclear weapons will help them achieve these goals. A DAL system will minimize the probability that an unauthorized launch by terrorists will achieve its purpose.

Feasibility and Affordability. The technical capabilities needed to create the DAL system proposed by Approach 1 already exist. It is standard practice to put DAL systems in NASA space launches and DoD missile test launches. Approach 1 is a relatively inexpensive option and can be used as a stepping stone to achieve a more robust system, such as the one outlined in Approach 2. This sequential im-

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plementation of the two approaches may allow the time needed for control centers and procedures to mature.

One challenge in applying such a technology to nuclear arsenals is ensuring an adequate system for both countries. Satellites to monitor home territories will have to be launched, or sensors will have to be deployed on U.S. silos to fill current gaps in Russia’s early-warning system. In addition, Approach 2 requires that satellites communicate the destruct signals to the missiles. These could be existing satellites or new ones designed and launched expressly for this purpose. The cost of new satellites could be defrayed to some degree by joint launches of satellites. U.S. and Russian electronic components could be secured and launched on the same satellites.

The key challenge for Approach 2 is implementing the destruct mechanism on reentry vehicles or, if necessary, modifying warheads to trigger a low-yield explosion. For example, can a DAL destroy or damage a reentry vehicle such that the warhead is reliably disabled? Can this destruction be confirmed by either country? By contrast, a low-yield nuclear explosion will reduce or eliminate fatalities on the ground from the launch in a way that can be observed by both countries. But it can also cause extensive damage to satellites operating in low-earth orbits and may be viewed as a precursor attack by the other country.

Effect on Incentive to Strike First with Nuclear Weapons. A DAL system can be seen as encouraging launch on warning, but it is important to remember that the decision to destroy a launched nuclear weapon is not consequence free. Shortfall and debris can cause severe damage. Countries with a DAL system are not more likely to launch a nuclear strike solely because they have the ability to prevent the missiles from reaching their intended targets. Installing a DAL system thus should have no effect on the incentive to strike first.

Ability to Monitor or Verify Implementation of the Option and Effect of Cheating. There is no need to monitor or verify the implementation of a DAL system. The purpose of the system is to provide a way to reverse an accidental or unauthorized launch. Neither country has an incentive to cheat—i.e., to make the other country think it has such an asset when it in fact does not. There is value,
however, in demonstrating to the other country that the system is in place.

**OPTION 10: DEPLOY LIMITED U.S. MISSILE DEFENSES**

Option 10 is a possible solution for three contributing factors:

- Nuclear forces kept at high day-to-day launch readiness
- Inadequate security and control of nuclear forces
- Inadequate training precautions

Table 4.12 summarizes our evaluation of Option 10.

**Background**

One possible way to reduce the risk of accidental Russian launches is for the United States to deploy missile defenses to protect its territory. Option 10 deploys a limited, ground-based defense aimed at improving nuclear safety.

Two successive U.S. administrations and several Congresses have been committed to deploying national missile defenses, although they have been motivated largely by the desire not to improve nu-

### Table 4.12

<table>
<thead>
<tr>
<th>Nuclear Safety Criterion</th>
<th>Option: Deploy limited U.S. missile defenses</th>
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</thead>
<tbody>
<tr>
<td>Contribution to reducing the risk of nuclear use</td>
<td>Positive?</td>
</tr>
<tr>
<td>Effect on current U.S. strategies and targeting plans</td>
<td>Positive</td>
</tr>
<tr>
<td>Effect on U.S.- Russian political relations</td>
<td>?</td>
</tr>
<tr>
<td>Effect on other major international actors</td>
<td>Negative</td>
</tr>
<tr>
<td>Effect on prospects for achieving nonproliferation and counterterrorism goals</td>
<td>Positive?</td>
</tr>
<tr>
<td>Feasibility and affordability</td>
<td>Negative?</td>
</tr>
<tr>
<td>Effect on incentive to strike first with nuclear weapons</td>
<td>?</td>
</tr>
<tr>
<td>Ability to monitor or verify implementation of the option and effect of cheating</td>
<td>Positive</td>
</tr>
</tbody>
</table>
clear safety, but to counter the threat of deliberate attack by emerging missile states. For some advocates, though, protection against accidental or unauthorized launch has been a primary motivation.41

In 1988, Senator Sam Nunn delivered a speech to the Arms Control Association calling for a reorientation of President Ronald Reagan’s missile defense system known as the Strategic Defense Initiative (SDI). Nunn called for the new SDI program to focus first on developing a “limited system for protecting against accidental and unauthorized missile launches.”42 In 1989, the first Bush administration did reorient the missile defense toward this goal and began developing the Global Protection Against Limited Strikes (GPALS) system, which included ground- and space-based interceptors to protect against accidental or unauthorized launch from the Soviet Union. During the Clinton administration, the possibility of an accidental or unauthorized launch from Russia was regarded as an important rationale for a national missile defense, although it had become secondary to the goal of defending against a limited ICBM threat from rogue nations. For example, the stated goal of the National Missile Defense program in 2000 was “to protect all 50 states from a limited number of long range ballistic missiles launched from a rogue nation or as a result of an accidental or unauthorized launch from a current nuclear power.”43

Concerns about an accidental launch have continued into the second Bush administration. Representative Curt Weldon, one of Congress’s chief advocates for missile defense, said in a May 2, 2001, speech on the House floor: “Today, Madame Speaker, America is totally vulnerable. If an accidental launch occurred of one missile from Russia, from North Korea, which we know now has the long range capability, or from China, we have no capability to respond . . . so the

41See, for example, Senator Sam Nunn’s amendment to the FY97 Defense Authorization Act, “Amendment No. 4180 to the FY97 Defense Authorization Act,” Section 1303, National Missile Defense Policy. (b) System Design, “The antiballistic missile system developed under subsection (a) shall—(1) be designed to protect the United States against limited ballistic missile threats, including accidental or unauthorized launches or attacks by Third World countries.”


first reason we need a missile defense is to protect us against an accidental or deliberate launch.” 44

In determining what type of defense would be most useful against an accidental or unauthorized launch, it is important to decide first what the size and characteristics of such an attack might be. For example, a terrorist or rogue commander who was able to take over one Russian Delta IV submarine and launch its missiles could deliver 16 missiles, each with four independently targetable warheads, for a total of 64 warheads. And these warheads are likely to have sophisticated countermeasures, because they were modernized against a potential U.S. missile defense system in 1988, and Russia may continue to improve their countermeasures to neutralize any defenses the United States might deploy.45 Another possible threat whose size and characteristics need to be considered is a rogue commander or terrorist taking over one ICBM missile division in Russia. This threat would vary from roughly 20 to 50 missiles that also may carry sophisticated countermeasures.

A national missile defense system could be sized against a smaller threat, perhaps a single missile or a handful of missiles launched accidentally, each carrying one to three warheads. At the moment, the United States has no ability to defend against even a very limited accidental or unauthorized launch, so a missile defense with such limited capabilities (say, 5 to 20 warheads) would be an improvement, as long as the likely threat was very small.

Finally, it is possible that the United States would want a very large national missile defense system to defend it against a large retaliatory strike that might be launched if Russian commanders erroneously believed the United States was attacking.

**Specifics**

Option 10 deploys a limited, land-based system capable of intercepting a few tens of warheads and whose objective is to improve nuclear

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45 Podvig, *Russian Strategic Nuclear Forces*, p. 337.
safety. It would be a midcourse system, which is the most technically feasible approach over the next 10 years or more. Although larger attacks are a possibility, particularly if Russian commanders were to launch a deliberate attack based on erroneous information, we chose this system for two reasons. First, this report repeatedly emphasizes the need for the United States to build a more cooperative relationship with Russia. The Russians could regard a large national missile defense system (such as a space-based boost-phase system) as a threat to their strategic deterrent and thus feel compelled to take steps more apt to lead to an accidental or unauthorized launch. The small missile defense in Option 10 could easily be overcome by even a reduced Russian force.

Second, while the United States has made progress on missile defense technology, particularly hit-to-kill technology, there are still important technical limitations to the kind of system it could build over the next decade or two. Some advocates of a large missile defense want to move immediately to space-based systems. However, an operational hit-to-kill system based in space is at least 15 to 20 years away, and the space-based laser will not be operational until after 2020. We judge these to be too far off to deal with the immediate problems of accidental and unauthorized launch.

The missile defense architecture for Option 10 is based on what was known as Capability 3 under the national missile defense plan that DoD proposed in the late 1990s. There would be a total of 250 ground-based interceptors deployed at two sites, as well as enough radars to track any accidental or unauthorized missile launch that might come from Russia. The interceptors would be based in Alaska and New England, where they would be better situated than a single-site system to protect the United States from Russian ICBM launches over the pole and submarine-launched missiles from the northern Atlantic or Pacific. As many as nine X-band radars would be deployed around the United States and Europe, including in Alaska, Britain, Greenland, North Dakota, and Canada. This system, advertised as capable of intercepting with high probability roughly 20 warheads accompanied by relatively sophisticated countermeasures, might be deployed within a decade or so.

In the past, to deploy a missile defense for accidental launch protection would have required a completely new system, since no system
Beyond the Nuclear Shadow

was deployed or under development. Today, with a consensus for deploying a national missile defense, the Bush administration has made deployment of a missile defense with multiple layers one of its highest priorities. It plans to start deploying the first elements of a defense before 2006 and to then continually add to the system every two years as part of a so-called spiral development approach. Therefore, the question for Option 10 becomes, “What changes, if any, would be required to the administration’s current plans in order to provide adequate protection against accidental or unauthorized launch from Russia?” Unfortunately, this question is difficult to answer with certainty at this time because the administration has not articulated what final set of systems it plans to deploy. However, this option attempts an answer based on the information that is available today.

Despite the uncertainty surrounding the Bush administration’s plans for a missile defense, it is clear that all components of the system proposed under Option 10 would already be under development. For example, the administration is forging ahead with plans to develop the kill vehicle and booster rocket for a ground-based interceptor even if it deploys only a few of them in Alaska and California, as current plans now suggest. In addition, development of the X-band radars, tracking satellites, and command and control systems are proceeding. However, the administration has not articulated plans to deploy more ground-based interceptors than the 10 planned for each of the two test-beds in Alaska. Nor has it indicated plans to deploy any land-based X-band radars. Therefore, in our estimation, Option 10 will require the purchase and deployment of 250 interceptors and as many as nine X-band radars above what is in the administration’s current plans. Of course, if the administration’s final plans include some of the items listed above, fewer of them would have to be purchased under this option.

Evaluation

Contribution to Reducing the Risk of Nuclear Use. Like Option 9 (installing a DAL system), Option 10 does not prevent the launch of nuclear weapons. Instead, it provides a mechanism to destroy a missile-delivered warhead before it detonates. Its goal is to avert the
consequences of an accidental or unauthorized launch after the launch has occurred.

Also like Option 9, Option 10 can address the contributing factors of nuclear forces at high day-to-day readiness and inadequate security and control of nuclear forces by providing a chance to reverse the consequences of an accidental or unauthorized launch. However, because Option 10’s missile defense system is limited, it could intercept only a small number of missiles and warheads and could be rendered useless if Russia deploys countermeasures on its missiles that can penetrate the defense.

Therefore, Option 10’s effectiveness depends both on the size of any launch and on what steps, if any, Russia takes to deploy countermeasures.

**Effect on Current U.S. Strategies and Targeting Plans.** The proposed missile defense system will have only a limited effect on current U.S. strategy and targeting plans against Russia. Advocates of missile defense argue that an effective system will enhance the U.S. deterrence posture against emerging missile states, such as North Korea and Iraq, but the U.S. ability to annihilate a rogue state with its massive nuclear arsenal may already be an effective deterrent.

**Effect on U.S.-Russian Political Relations.** As long as both the United States and Russia view the missile defense presented in this option as limited in size and capabilities, their relations are likely to remain cooperative. The United States may even provide missile defense technology to Russia, thereby allowing it to build its own limited missile defense. However, there could be a negative effect on relations if Russia believes the system is intended to undermine its deterrent. In that case, Russia could become less cooperative on many issues, including those related to nuclear safety.

**Effect on Other Major International Actors (China, Europe, etc.).** Option 10 could have a major negative effect on international actors, particularly China. At the moment, China has only about 20 single-warhead ICBMs that can reach the United States. Even the relatively small missile defense envisioned in Option 10—with 125 interceptors on each coast—could negate China’s deterrent. How China would react to this option is difficult to ascertain. China might have only a mild reaction and merely continue down its established path, build-
ing a slightly larger and more modern nuclear force. However, China could also see the system as a U.S. attempt to gain greater flexibility in a U.S.-Chinese regional conflict over Taiwan. In this case, China might substantially increase the size and readiness of its nuclear arsenal, which could lead to a U.S.-Chinese nuclear relationship reminiscent of that between the United States and Russia during their nuclear buildup in the 1960s and early 1970s. The result could be a serious degradation of global nuclear safety.

**Effect on Prospects for Achieving Nonproliferation and Counterterrorism Goals.** The missile defense system presented in this option might be an effective tool for meeting nonproliferation and counterterrorism goals. Its most important contribution would be to limit the probability of success of an unauthorized launch against the United States. However, if U.S.-Russian or U.S.-Chinese relations deteriorate because of missile defense, U.S. nonproliferation and counterterrorism could be undermined. Russia has been developing technologies to defeat missile defenses since the late 1960s and would likely continue its research in the face of U.S. deployments. China would also be likely to continue its own research efforts. Although these technologies are not likely to spread, one cannot rule out their transfer to states such as Iran and North Korea if relations with the United States were to get bad enough.

**Feasibility and Affordability.** There are two potential problems with the effectiveness of the midcourse system proposed in this option. First, it may be vulnerable to countermeasures that would undermine its effectiveness even against small numbers of warheads. Second, it could easily be overwhelmed by a large number of missiles, which could not be ruled out in an accidental or unauthorized launch.

There is strong disagreement in the technical community about the feasibility of a midcourse missile defense. Critics of a midcourse system claim it will be susceptible to simple countermeasures. The most complete documentation of this problem is contained in a report by the Union of Concerned Scientists, a report detailing a number of

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simple countermeasures that rogue nations could use to confuse the sensors of the national missile defense system, thereby preventing the system from distinguishing between decoys and the warhead. Although there is much speculation about what emerging missile states might be able to do to penetrate the defense, there is no question that Russia’s well-developed missile program and 40-year history of developing and deploying countermeasures would enable it to deploy countermeasures that have a good chance of overcoming the defense. Therefore, the midcourse defense posited in this option could be ineffective against even a small accidental or unauthorized launch if Russia routinely deployed countermeasures on its missiles. However, if Russia views the accidental launch protection system as too small to be a threat to its deterrent, it may not deploy countermeasures, and the defense would then have some value in reducing nuclear risk.

Effect on Incentive to Strike First with Nuclear Weapons. The limited midcourse system in this option—with around 250 interceptors (125 at each site)—might be small enough to have a positive effect on first-strike or crisis stability with respect to Russia, as long as it is

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not perceived as a threat to Russia’s retaliatory deterrent. If a very small accidental or unauthorized launch occurred, a limited national missile defense system would give the President more flexibility in dealing with the crisis, assuming he had confidence in the system’s ability to handle any Russian countermeasures.

However, first-strike stability may decrease if Russia perceives the defense as large enough to counter its survivable, second-strike nuclear forces. This could compel Russia to keep an even greater number of its weapons on high alert so that they could be launched on warning to avoid being destroyed by a U.S. first strike. Whether the defense in Option 10 would be large enough to make Russia feel insecure about its retaliatory deterrent depends on how effective Russia perceives the system to be and how small it believes its survivable deterrent is. The state of U.S.-Russian relations will likely color these perceptions.

**Ability to Monitor or Verify Implementation of the Option and Effect of Cheating.** Generally, advocates of missile defense do not believe verification is necessary. However, the United States and Russia could, if they chose to, set up an inspection regime to verify the rough capabilities of the missile defense. Because the proposed mid-course system would be based on land, either satellites or on-site inspections could be used to verify how many interceptors the United States or Russia had deployed. This would serve as an upper bound on the system’s capabilities, since the system cannot shoot down more warheads than it has interceptors. In fact, the current plans for national missile defense call for several interceptors to engage each incoming warhead in order to give the United States several different opportunities to attack the missile.