Appendix D

BALLISTIC MISSILE DEFENSE COUNTERMEASURES

Chapter Five asserted that unsophisticated countermeasures could readily saturate terminal and midcourse missile defenses based in the continental United States. In discussing the urgency of boost-phase missile defenses, Chapter Three introduced the countermeasures. This appendix contains a thought-experiment to illustrate the possibility of an unconventional, unsophisticated countermeasure against terminal-area ballistic-missile defenses. The appendix also illustrates a possible unconventional, space-based deterrent weapon.

The straightforward approach to defeating midcourse and terminal missile defenses is to saturate them with multiple aim points. One way to saturate defenses during the midcourse portion of a missile's trajectory outside the atmosphere is to deploy relatively inexpensive, unsophisticated decoys (such as balloons or fragments of the booster) in large numbers and to alter the appearance of real targets to help confuse sensors trying to sort the real and false targets, for example, by deploying the real targets in what amounts to another decoy (APS, 1987; Lewis and Postol, 1997). By the time the decoys and a typical nuclear reentry vehicle reach the atmosphere, the lower ballistic coefficient of the decoys will cause them to fall behind and allow terminal-area defenses to concentrate on the reentry vehicles in the time remaining before the weapon detonates (Bethe, Boutwell, and Garwin, 1986, pp. 64–68; Flax, 1986, pp. 43–46; Garwin and Bethe, 1968). Because making a decoy's ballistic coefficient and other observable signatures match that of a reentry vehicle carrying a weapon is roughly equivalent to making another reentry vehicle, the conventional approach to defeating the remaining terminal-area defenses is normally not to saturate them with false targets but to try to

outmaneuver them. This technique originally involved faster reentry (higher ballistic coefficients) and, as the technology evolved, maneuverable reentry vehicles. Alternatively, the attacker can saturate the terminal defenses with real targets.

Either of these two approaches, maneuvering or multiple reentry vehicles, requires some degree of technical sophistication and more resources than we might associate with an unsophisticated opponent. However, an unsophisticated opponent may not follow the same development paths the United States or the Soviet Union took in developing their own strategic deterrent arsenals.

Launching a nuclear weapon in a reentry vehicle on a ballistic missile is not the only way to pose an unacceptable threat to the United States. Other possible weapons of terror or deterrence (depending on perspective and purpose) include chemical and biological weapons, and these may be more readily available to what might be called rogue states. Their proliferation is more difficult to detect or interdict than nuclear weapons. Their development signatures are identical to those of pharmaceutical research and production. Chemical weapons and agricultural chemicals need the same production infrastructure. The infrastructure for producing biological weapons is practically undetectable. Among these "poor man's nuclear weapons," the spores of anthrax bacteria have been described vividly in the open literature and in official information (DoD, 1998a; DoD, 1998b; OTA, 1993a; OTA, 1993b; Taylor, 1996). A few kilograms of the spores delivered in an inhalable form can cause extremely large numbers of fatalities in areas of high population density. Against that kind of a target area with that kind of lethality, precision delivery is not required, just widespread dispersal and rough timing relative to time of day and weather.

Defending against the means of delivering chemical and biological weapons for terrorist purposes (suitcases, shipping containers, car bombs, subway releases) is generally the realm of police, customs, coast guard, and intelligence agencies, rather than of the military. Some opponents of missile defenses are quick to point these means of delivery out as evidence of the futility of military missile defenses. However, if the weapons are intended as a military deterrent, their utility would be better served by more visible delivery means, such as aircraft or missiles. These delivery platforms still provide the op-

portunity for effective, unsophisticated counters to terminal-area missile defenses.

With shorter-range missiles, the acknowledged approach for saturating terminal defenses is to fractionate a unitary warhead into multiple submunitions and deploy them early in the trajectory (Lewis and Postol, 1997, p. 62). Some might think this approach applies only to short-range, theater missiles because the submunitions would not survive the heat of reentry associated with longer-range missiles unless their reentry vehicles were of the expense and complexity suitable for a nuclear weapon. However, that assumes an opponent would adopt a design philosophy that mirrors historical practice for nuclear reentry vehicles. It might instead be more effective to follow early practices in returning biological samples (cosmonauts, astronauts, and chimpanzees) to earth from orbital velocities. Small, low-tech submunitions for ICBMs of this type could deliver useful quantities of anthrax spores effectively against sprawling urban and suburban targets. The key insight comes from Appendix B's discussion of meteoroid reentry; all that is needed is a suitably low ballistic coefficient for the reentry vehicle.

Envision a submunition reentry vehicle design employing a spherical shape, thin-shell aluminum structure with a diameter of a few tens of centimeters, roughly the size of a basketball or globe. The spherical shape requires no attitude control in deployment and can be fabricated with the same spin-forming machines or presses that make pots and pans. It might use phenolic ablative material on the exterior made from the same materials used for insulating handles on pots and pans, brake pads, and the like (Tipco, 1998). To further insulate the few kilograms of biological payload from heat, the interior might be filled with mineral-fiber insulation (Rolan, 1999) and/or a vacuum flask dewar (which could simply be a Thermos™ bottle) in the center containing the anthrax spores. With a ballistic coefficient on the order of a few hundred pascals, such a container should lose most of its velocity above 30 to 40 km altitude and undergo a peak acceleration of about 100 g's, with manageable heating.

For fusing, the vehicle might sense its deceleration profile (see the characteristic shape in Figure B.2) using solid-state accelerometers, such as those used to deploy safety devices in automobiles, and perhaps timers to ignite detonation cord, open the package, and dis-

perse the spores near the desired altitude (Eagle Technology, 1999). The timing could be tailored for the atmospheric conditions in the desired target area at launch time, using current barometric pressure downloaded from the Internet (The Weather Channel, 1999). All the materials and knowledge required are readily available around the world without breaking the threshold of export controls on missile technology. In testing with more conventional reentry vehicles, these submunitions might look like decoys, and their intended purpose might not even be detected. A thin, midcourse, or terminal-area missile defense would not be much help against modest numbers of these weapons.

The alternative to midcourse and terminal area defenses for this kind of threat is a boost-phase defense.[1] Where it is possible (or economical) to station a ship, airplane, or land-based defensive platform with fast interceptors or directed-energy weapons close enough to the launch area, space-based defenses might not be needed. However, for such areas as the interior of Iran, China, or some states of the former Soviet Union, only space-based defenses could attempt a boost-phase defense.

---

[1]Aside from deterrence, which was ground-ruled out of the discussion by defining the threat as a rogue or undeterrable state and which may not be relevant to a small state trying to establish its own deterrent to U.S. operations it finds counter to its interests. If the state believes it can deter U.S. conventional forces with the credible threat of a limited use of its own weapon of mass destruction, it might believe the U.S. nuclear deterrent stalemated.