Militarization of Space:

Why not space weapons? Space-based missile defense?

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NPRI session on Weaponization of Space
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The Garwin Archive - 2000's

- "National Missile Defense: Prospects and Problems," by R.L. Garwin, presented at IEEE Aerospace Section Plenary, Big Sky, MT, March 6, 2005.
- "Space Weapons: Crossing the U.S. Rubicon," Bruce M. DeBlois, Richard L.Garwin, R. Scott Kemp and Jeremy C. Marwell, *International Security*, Vol. 29, Issue 2 - Fall 2004, pp. 50 - 84.
- "Space Weapons: Good for Us or Bad?" the 2004 Lynford Lecture by R.L. Garwin at Polytechnic University of Brooklyn, Novemberf 4, 2004.
- "Science and National Intelligence," by R.L. Garwin, presented at the 32nd Session of the International Seminars on Planetary Emergencies, Erice, Sicily, August 20, 2004.
- "Nonlethal Weapons and Capabilities," Report of an Independent Task Force Sponsored by the Council on Foreign Relations, R.L. Garwin, Project Director, G.T. Allison and P.X. Kelley, Co-Chairs, 2004.
- "A habit of distortion," Letter by R.L. Garwin regarding science advising, published in The Washington Times, April 3, 2004.
- March 15, 2004 Letter to Physics Today regarding the American Physical Society Study Group Report on Boost-Phase Intercept of July, 2003.
- "U.S. Nuclear Weapons and Nuclear Explosion Testing," by R.L. Garwin, Drell Lecture at Stanford University, March 9, 2004 (lecture and slides).
- "Nuclear arms control may reduce terrorism as well as avoid Hiroshimas, Garwin says," by D. Levy, published in in *Stanford Report*, March 18, 2004. A report on the Drell Lecture given by R.L. Garwin, March 9, 2004.
- "Bush Sets the Right Course in Control of Land Mines," Op-Ed by R.L. Garwin, in the Los Angeles Times, March 8, 2004.
- "New navigation system essential for pilots ," by R.L. Garwin and James Bergman, Letter to the Editor, Washington Times, February 6, 2004.

Background

- **Recent articles:**
  - **Fall *International Security*, "Space Weapons: crossing the US Rubicon"**
  - **November, 2004 *Scientific American*, "Ballistic Missile Defense"**
  - **March, 2005, *IEEE Spectrum*, "Star Crossed" (Space Weaponization)**
- **Garwin background:**
  - **Since 1950, nuclear weapon technology, testing at Los Alamos, Jason, etc.**
  - **Since 1953 , air and missile defense and offense (PSAC and its panels, DSB, etc)**

Garwin background (more)

- Since 1960, military and "national" space (NRO). In 2000, named one of ten "Founders of National Reconnaissance"
- In 1998 one of 9 members of Rumsfeld Commission
- Like Gen. Horner, testified Dec. 2004 to Canadian upper house on national MD

So much with which to agree in the comments by those who have spoken, but I wince at

-
  - "Network centric warfare is nonsense"

- **“Microbes would likely burn up on reentry”**
- **“If NK launched 10 ICBM and we shot down one, and it was aimed at my house...”**
- **“[Technological spin-off (e.g., deformable optics) makes the expenditures worthwhile]”**

On the other hand, I totally agree with

- **“terrorist delivery of [nuclear or BW] by long-range missile is the least likely mode”**
- **“Development of robust missile defense for mid- and short-range missiles makes sense”**
- **“Rods from God” and other force-projection weapons in space make no sense.**

- **“Supposing an effective (robust, survivable) missile-defense system could be built only in space,” I would build it if it fit with our other military priorities.**

The current mid-course NMD program must be cancelled if we are to achieve any significant defense against even a few ICBMs from NK. Reason, “Countermeasures”—bomblets for BW, warhead in a balloon and balloon decoys for a nuclear warhead: Countermeasures," A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System, (Executive Sumamry and full text) UCS-MIT Study, A.M. Sessler (Chair of the Study Group), J.M. Cornwall, R. Dietz, S.A. Fetter, S. Frankel, R.L. Garwin, K. Gottfried, L. Gronlund, G.N. Lewis, T.A. Postol, and D.C. Wright, April 2000.

Any valuable space object is vulnerable to destruction-on-demand via an accompanying "space mine"—a microsatellite within lethal range of its explosive charge.

Militarization of Space

Garwin believes and has often written:

- **Militarization of space is a fact and greatly benefits US and international security**
  - **DSP missile-launch detection satellites, 1970**
  - **Military (and now civil) weather sats**
  - **COMSATs, esp. military use of commercial**
  - **Imagery from space— 1960-1972 Corona film-return program. Now near-real-time electro-optical imagery.**

- **Global-positioning system (GPS) for navigating vehicles and homing bombs/missiles**

- **It would be a disaster for US military capability to lose our current military space resources**
- **We must take measures to protect US military space:**
  - **Reduce the perceived benefits of interfering with US military space resources, esp. by being able to field immediately "theater resources" with same or better capability—Horner's "20km-300km near-space capabilities"**
  - **Lay the military and political basis for responding to attacks on US MilSpace,**

includng declarations and "ASAT Treaty" banning use of ASAT or Space Weapons.

- **Prepare ASAT-Treaty-compliant means for countering MilSpace capabilities**

How about some of the most important facts in support of NMD?

- **Support by Congress, industry, and labor for contracts and jobs**
  - **Would be the same for a public-health system and deployment of technology and systems that would modernize US education and civil economy**

- **Former SDI (“Fletcher”) Commission co-chair Harold Agnew (former director of Los Alamos) regarding major programs taking resources better spent for technology development, “Don’t let the hogs trample the piglets on the way to the feeding trough”**

Stopping a Missile with a Missile

The Pentagon's midcourse intercept system is designed to destroy incoming warheads while they are above the earth's atmosphere.

1 LAUNCH/DETECTION
A Defense Support Program satellite in geosynchronous orbit detects the hot flame of an ICBM launched from North Korea. The satellite tracks the missile until the burnout of its rocket motor some 200 to 300 seconds after launch.

Defense Support Program satellite

Booster jettisoned

2 MISSILE TRACKING
After the missile jettisons its booster rockets and releases the threat cloud (the warhead and decoys) radar picks up the tracking. Currently the system relies on the Cobra Dane early-warning radar on Shemya Island, Alaska; a more advanced sea-based X-band radar is expected to be towed into position by the end of 2005.

Warhead and decoys

3 MIDCOURSE INTERCEPT
The radar data guide the kill vehicles, launched from Alaska and California, to the threat cloud. The vehicles' infrared sensors must pinpoint the warhead among the decoys and then put the craft on a collision course.

Kill vehicle

RUSSIA

ICBM

CHINA

ICBM Launch site

NORTH KOREA

JAPAN

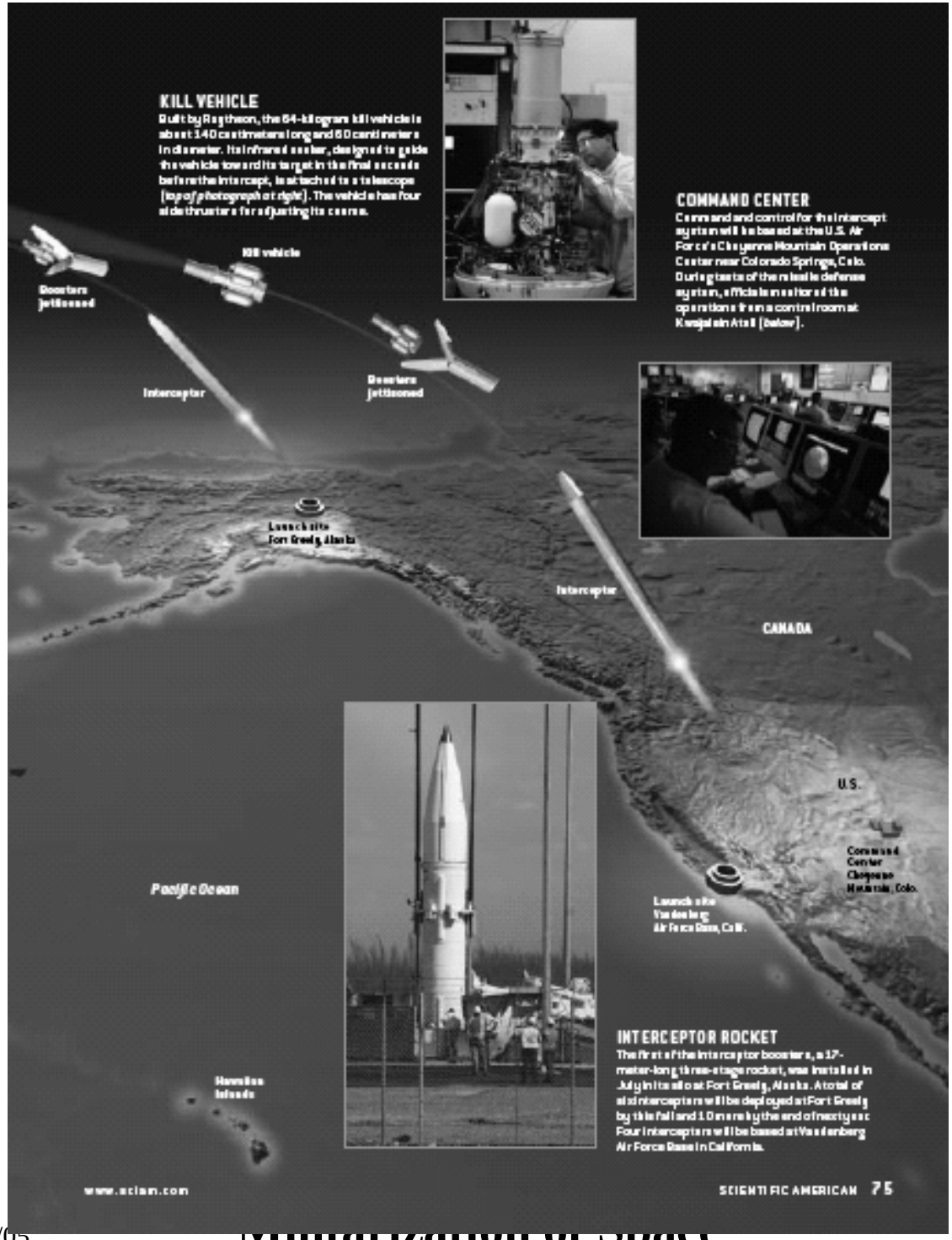
Pacific Ocean

Cobra Dane radar
Shemya Island, Alaska

X-band radar
Sea-based

X-BAND RADAR

Because the intercept system must precisely track the warheads and decoys, the X-band radar steers a narrow beam by shifting the phases of the signals transmitted from thousands of antenna elements. The radar can distinguish objects as close as 1.5 centimeters from one another, but if the warheads and decoys are enclosed in radar-reflecting aluminized balloons, the system may not be able to determine which is which. The floating platform for the radar will be roughly the size of two football fields; the radar's face (at right) will about 12 to 15 meters wide.


KILL VEHICLE
Built by Raytheon, the 64-kilogram kill vehicle is about 140 centimeters long and 60 centimeters in diameter. Its infrared seeker, designed to guide the vehicle toward its target in the final seconds before the intercept, is attached to a telescope (top of photograph at right). The vehicle has four side thrusters for adjusting its course.
Kill vehicle
Boosters jettisoned
Interceptor
Boosters jettisoned
COMMAND CENTER
Command and control for the intercept system will be based at the U.S. Air Force's Cheyenne Mountain Operations Center near Colorado Springs, Colo. During tests of the missile defense system, officials monitored the operations from a control room at Kwajalein Atoll (below).
Launch site Fort Greely, Alaska
Interceptor
CANADA
U.S.
Command Center Cheyenne Mountain, Colo.
Launch site Vandenberg Air Force Base, Calif.
Pacific Ocean
Hawaiian Islands
INTERCEPTOR ROCKET
The first of the interceptor boosters, a 17-meter-long three-stage rocket, was installed in July in its silo at Fort Greely, Alaska. A total of 16 interceptors will be deployed at Fort Greely by this fall and 10 more by the end of next year. Four interceptors will be based at Vandenberg Air Force Base in California.
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SCIENTIFIC AMERICAN 75

o By persuading states not to develop nuclear weapons.

o By persuading them not to develop missile-delivery capability.

o By destroying the industrial plants before they can produce nuclear weapons or missiles.

o Destroying the missiles at their launch sites before they can be launched.

o Destroying missiles in boost-phase, after they are launched, but before they reach a speed that will carry them to their target.

o Destroying the missiles and the warheads in mid-course as they fall through space or fly through the atmosphere.

o Destroying warheads in terminal phase, as they streak through the atmosphere toward their targets.

o Interfering with or preventing the detonation of the nuclear warhead itself, when it is within effective range of its target, which might be as little as 200 meters, for some hard targets.

For each of these phases there are different approaches to its accomplishment. For instance, boost-phase intercept might be based on the ground, on the sea surface, in the air, or in space. From space, one could use hit-to-kill interceptors (as from the other options for stationing) powerful lasers, or even a nuclear warhead.

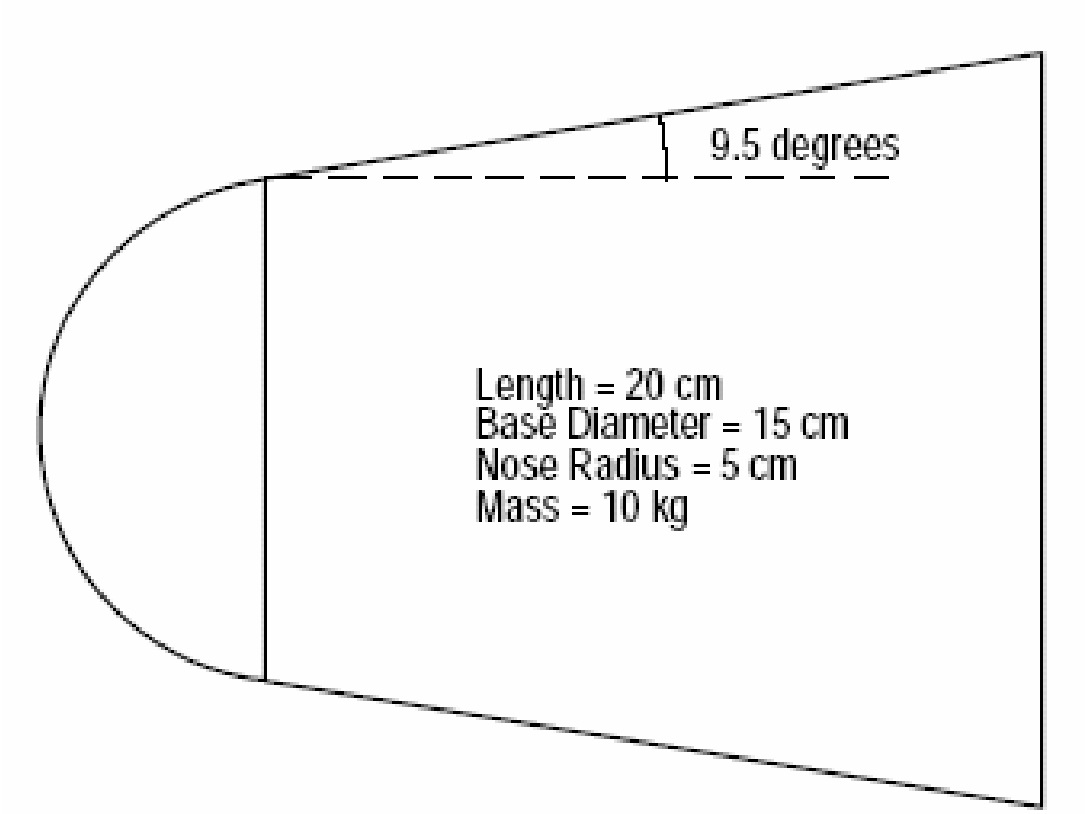


Figure 7-1. The configuration used for calculating the heating of a conical bomblet. *It has a nose radius of 5 cm, a base diameter of 15 cm, a length of 20 cm, a cone half-angle of 9.5 degrees, a mass of 10 kg, and a ballistic coefficient of 12,000 N/m² (250 lb/ft²).*

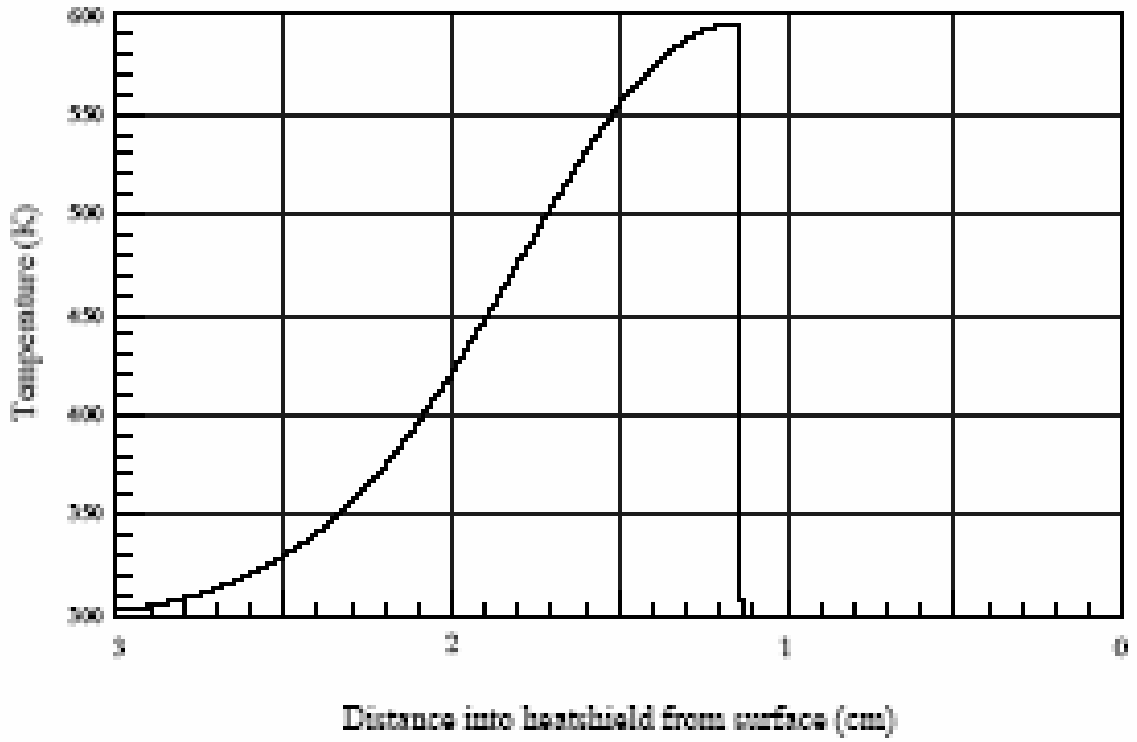


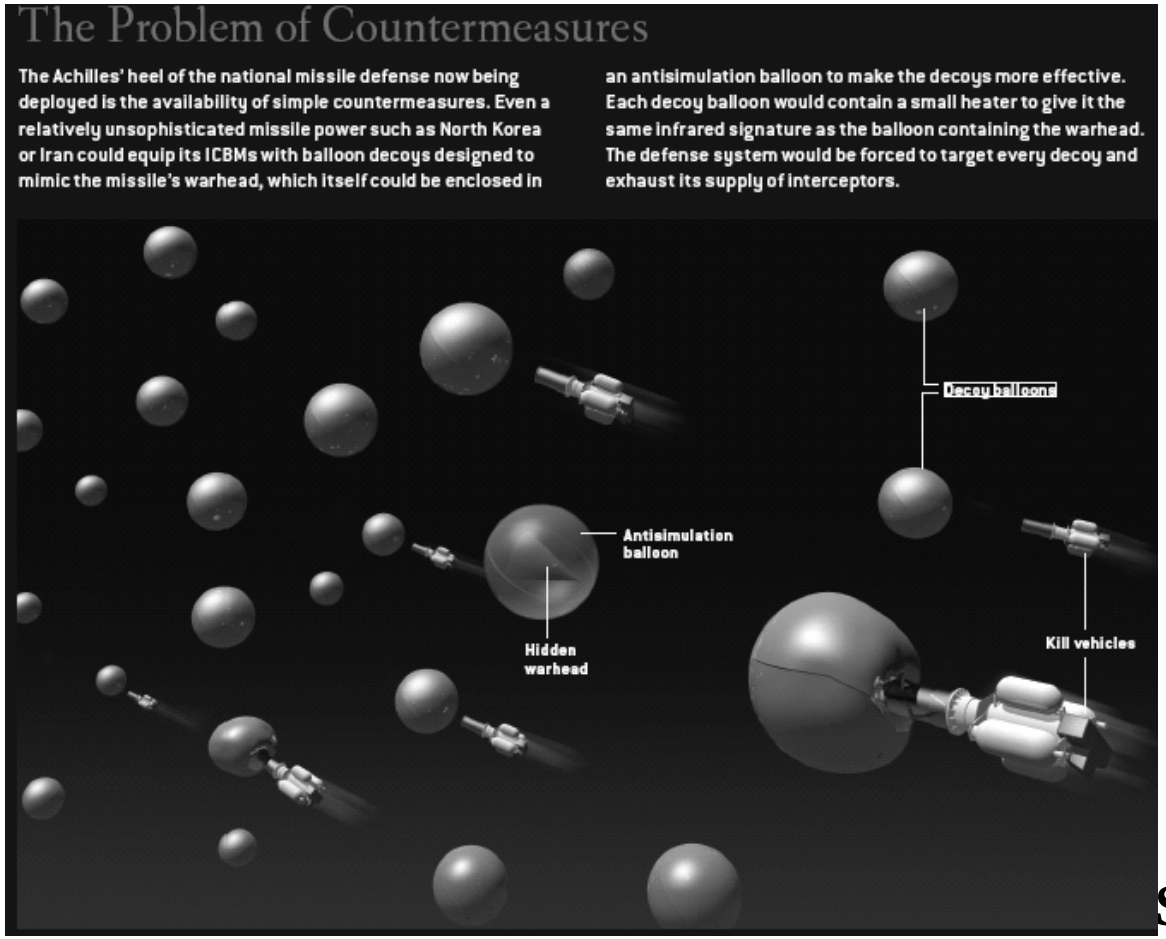
Figure F-13. Temperature profile in the heatshield at the nose of the conical bomblet when the bomblet hits the ground.

For a BW payload, the countermeasure does not depend upon deceiving the defense; it simply provides far more equivalent threat aim points than there are interceptors.

For a decade or more I was on the White House Strategic Military Panel of the President's Science Advisory Committee (PSAC). In the mid-1960s we met for two days every month and continually reviewed the experimental data and programs for discrimination of decoys from real warheads. Lincoln Laboratory and other contractors did a marvelous job on designing, deploying, and operating radars to detect small differences between decoys and warheads-- differences not only in the body itself, but in the wake produced. Those who were designing the countermeasures in order to have credible decoys made advances of their own.

Our judgment, reflected in the SAFEGUARD system, was that discrimination was feasible in the low atmosphere, but was not feasible in the vacuum of space. At that time we discussed the powerful impact of antisimulation, rather than the "simulation" that was in vogue at the time. In the decoy field, "simulation" refers to the crafting of a decoy so that in every observable respect it resembles an RV. The simulation decoy for the Minuteman warhead has appeared on the contractor's website, together with a real-time video of its deployment and inflation in space. But such verisimilitude requires either advanced theory or complicated experimental verification on the large scale, and even in space; it is thus not suitable for a small fledgling nuclear power.

These problems can be avoided by antisimulation decoys that can be tested in a small vacuum chamber.(2) Accordingly, our 11-member group selected antisimulation in the form of spherical balloons for a non-spinning RV, such as the early U.S. Polaris warheads. Here are some of the figures and a discussion from our 2000 report:



Illustrator: Al Kamajian.

“Holes in the Missile Shield,” by R.L. Garwin, *Scientific American*, November 2004.

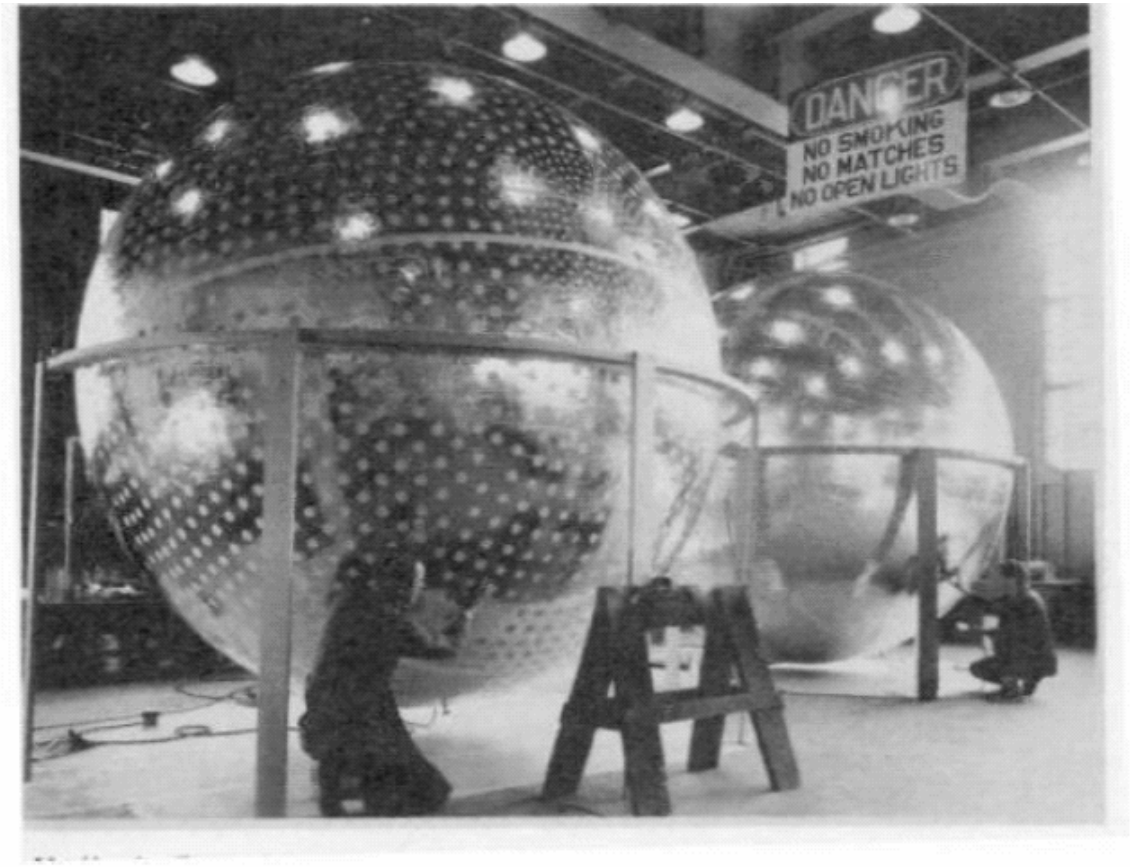


Figure 8-1. A photograph of one of the NASA Air Density Explorer inflatable balloon satellites.

Many of you will recall the Strategic Defense Initiative (SDI) launched by President Ronald Reagan in his televised address of March 13, 1983. This aimed to deploy a defensive system against Russian ICBMs that would confidently protect against every one of 6000 nuclear-armed RVs aimed at the United States. That lofty goal had many problems, among which were the vulnerability of the system and the unrealism of the goal. I recall debating many proponents, including President Reagan's Science Advisor, Jay Keyworth, and arguing that while SDI was not

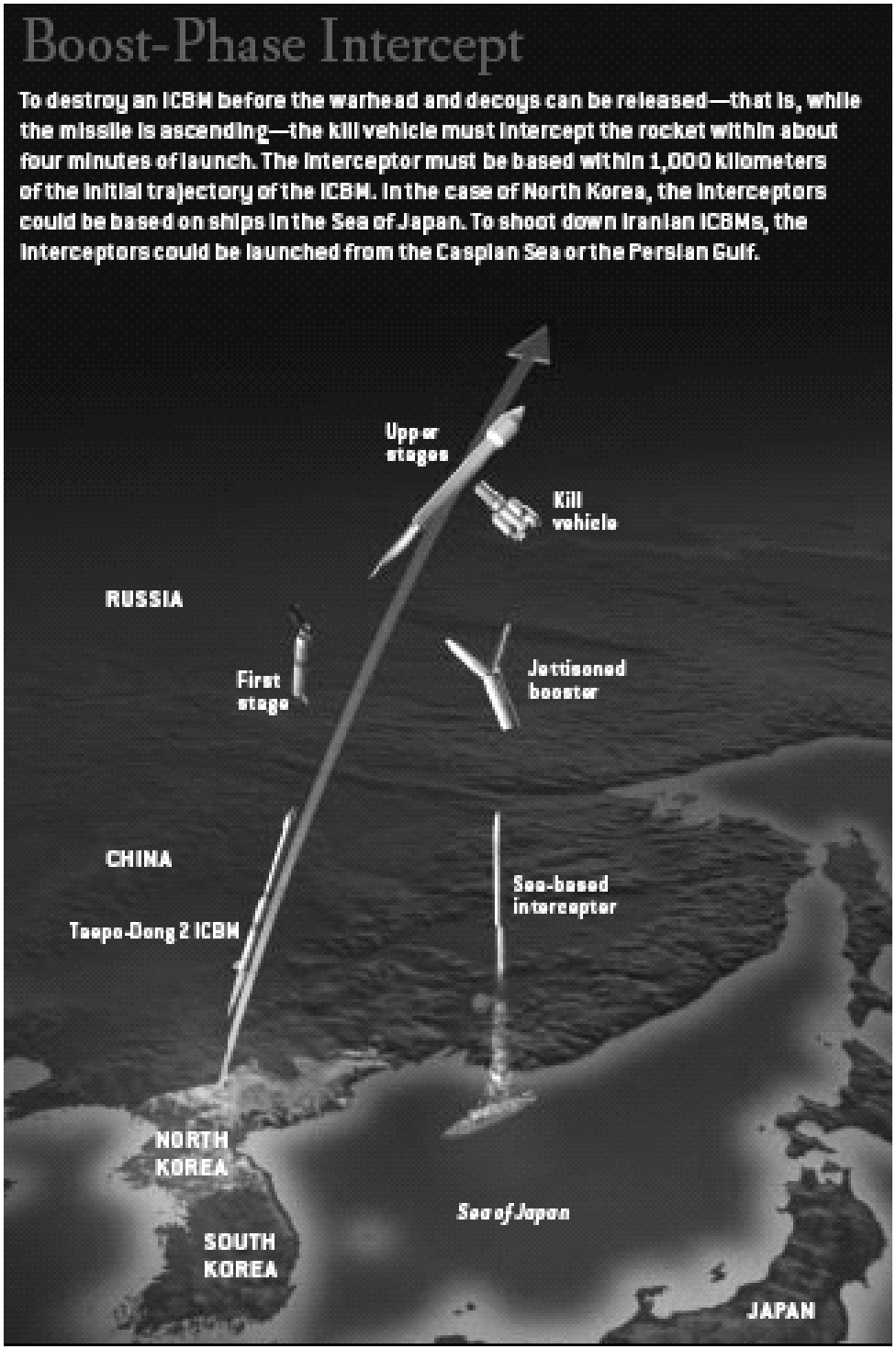
going to work, there were many other prospects for protection, including deterrence and pre-boost-phase intercept, known as "preemption."

Those are still the most important approaches to protecting the United States and its allies against ICBMs, BW, and nuclear weapons in the hands of other states.

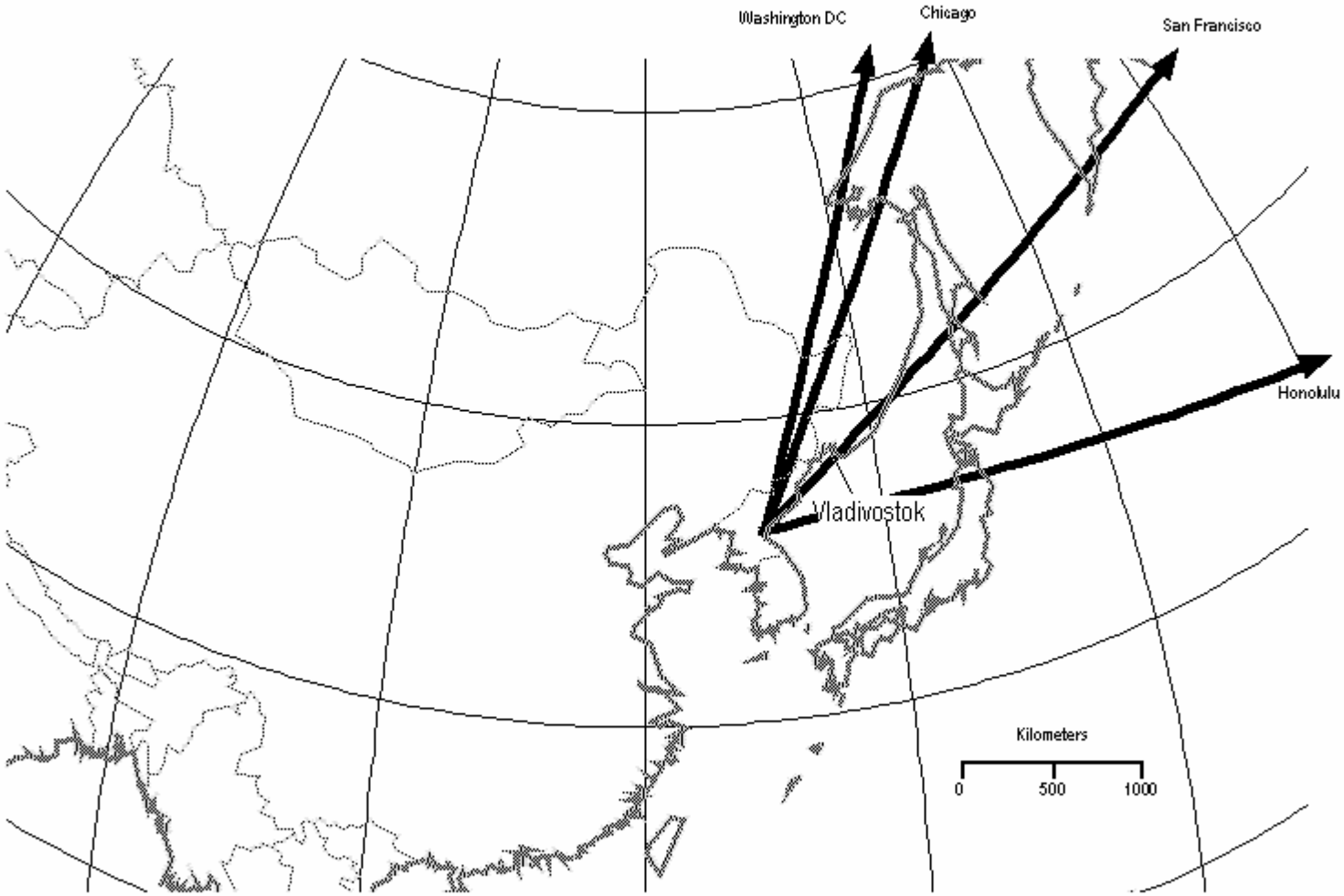
Given the propensity of U.S. Congress for high-tech muscular solutions, it seemed to me that something was needed that could work against the prospective North Korean ICBMs, in contrast to the mid-course system that was bound to fail in the face of countermeasures. So since 1999 I have publicly advocated boost-phase defense in these particular cases, as detailed in many of my articles.

Naturally, I have similarly advocated such systems to BMDO and its successor, the Missile Defense Agency (MDA), and with some success in that they now have an active program. However, it was clear to me that little progress would be made on boost-phase intercept (BPI) without national priority, and this would not be forthcoming while mid-course intercept was presented as a viable program.

Here are a few graphics detailing the BPI system that I advocate.


Boost-Phase Intercept
To destroy an ICBM before the warhead and decoys can be released—that is, while the missile is ascending—the kill vehicle must intercept the rocket within about four minutes of launch. The interceptor must be based within 1,000 kilometers of the initial trajectory of the ICBM. In the case of North Korea, the interceptors could be based on ships in the Sea of Japan. To shoot down Iranian ICBMs, the interceptors could be launched from the Caspian Sea or the Persian Gulf.
Upper stages
Kill vehicle
RUSSIA
First stage
Jettisoned booster
CHINA
Sea-based interceptor
Taepo-Dong 2 ICBM
NORTH KOREA
Sea of Japan
SOUTH KOREA
JAPAN

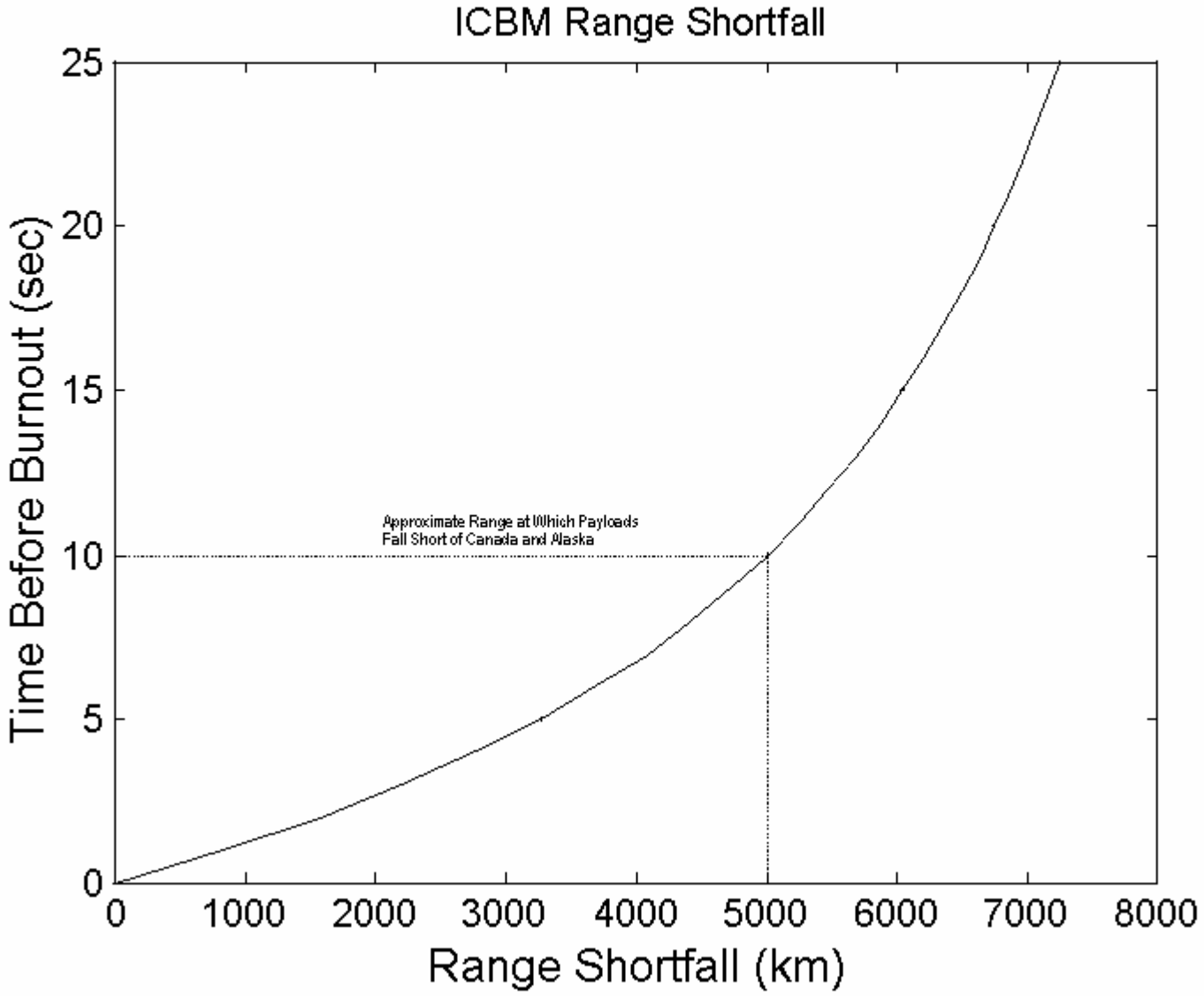
Ground-Trace of North Korean ICBM for Attacks on Washington, Chicago, San Francisco, and Honolulu

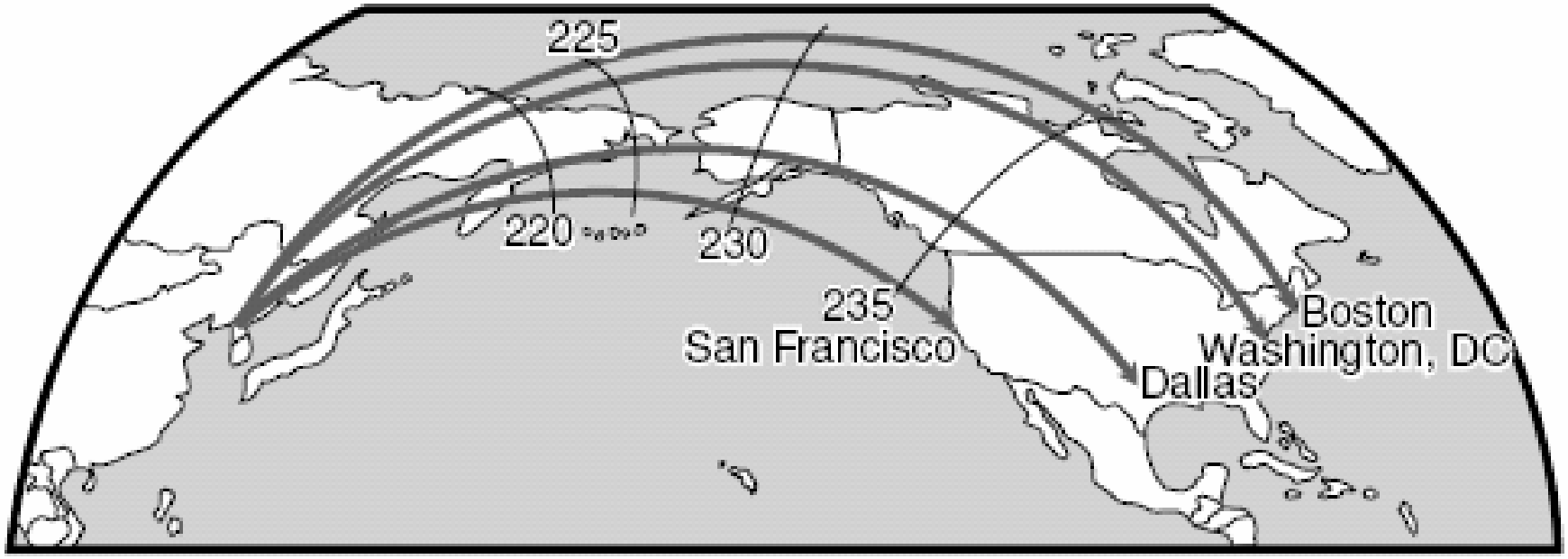


North Korean Launch Site to
Chicago=5244.69nmi, 10,524.02km
Minimum Energy Loft Angle = 21.37 degrees
Velocity at Ground = 7.28 km/sec
Range Angle=94.52 degrees
Time of Flight = 33.22 minutes

North Korea Launch Site: 39.6N, 127.3E
Chicago: 41.85N, 87.65W
San Francisco: 37.75N, 122.45W
Washington, DC: 38.9N, 77.0W
Honolulu, 21.3N, 157.9W

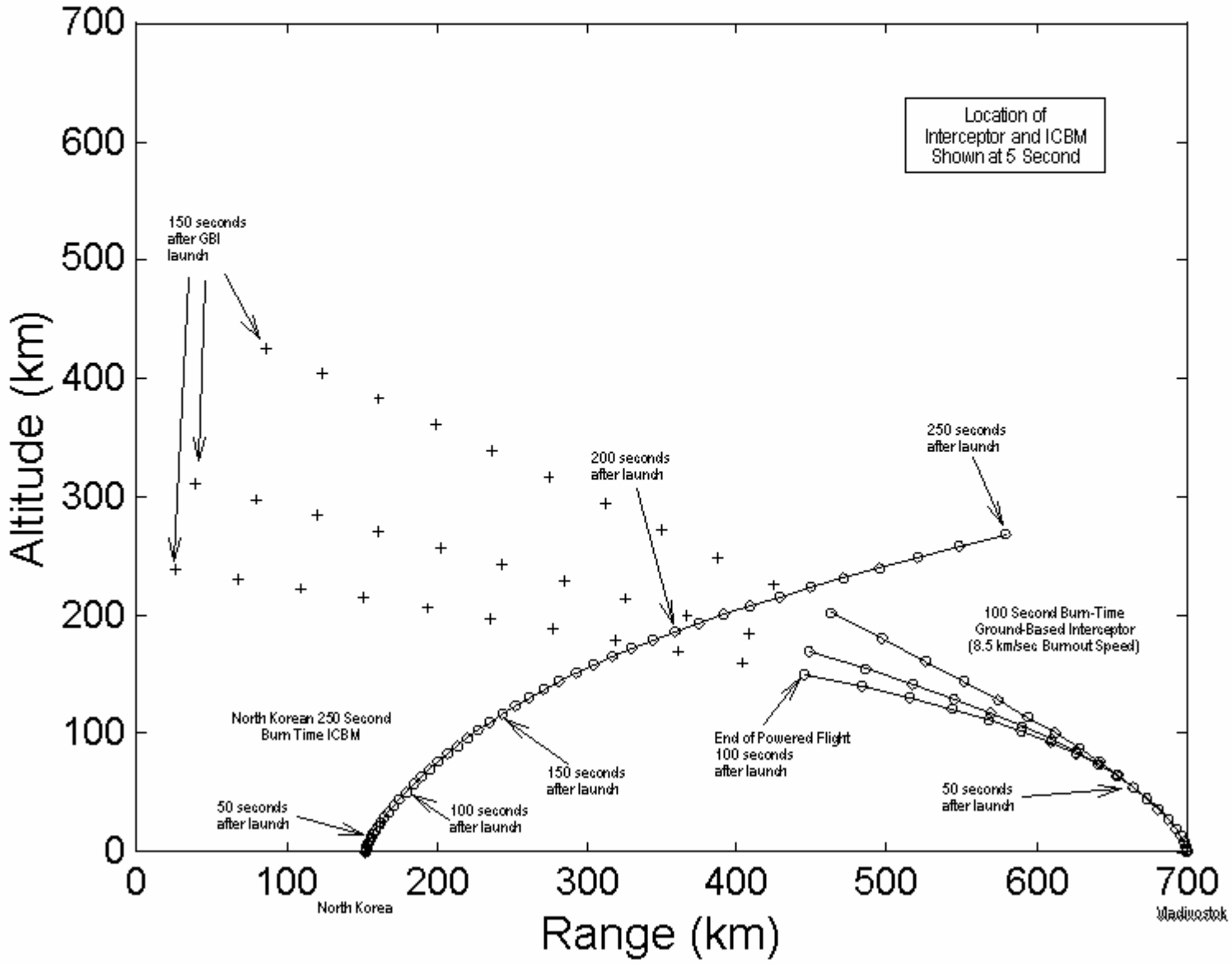
Range Shortfall of Intercepted North Korean ICBM for Various Intercept Times Prior to Burnout





APS Study Group

Powered Flight Profiles of North Korean 250 Second Burn-Time ICBM and Russian-US 100 Second Burn-Time Ground-Based Interceptor



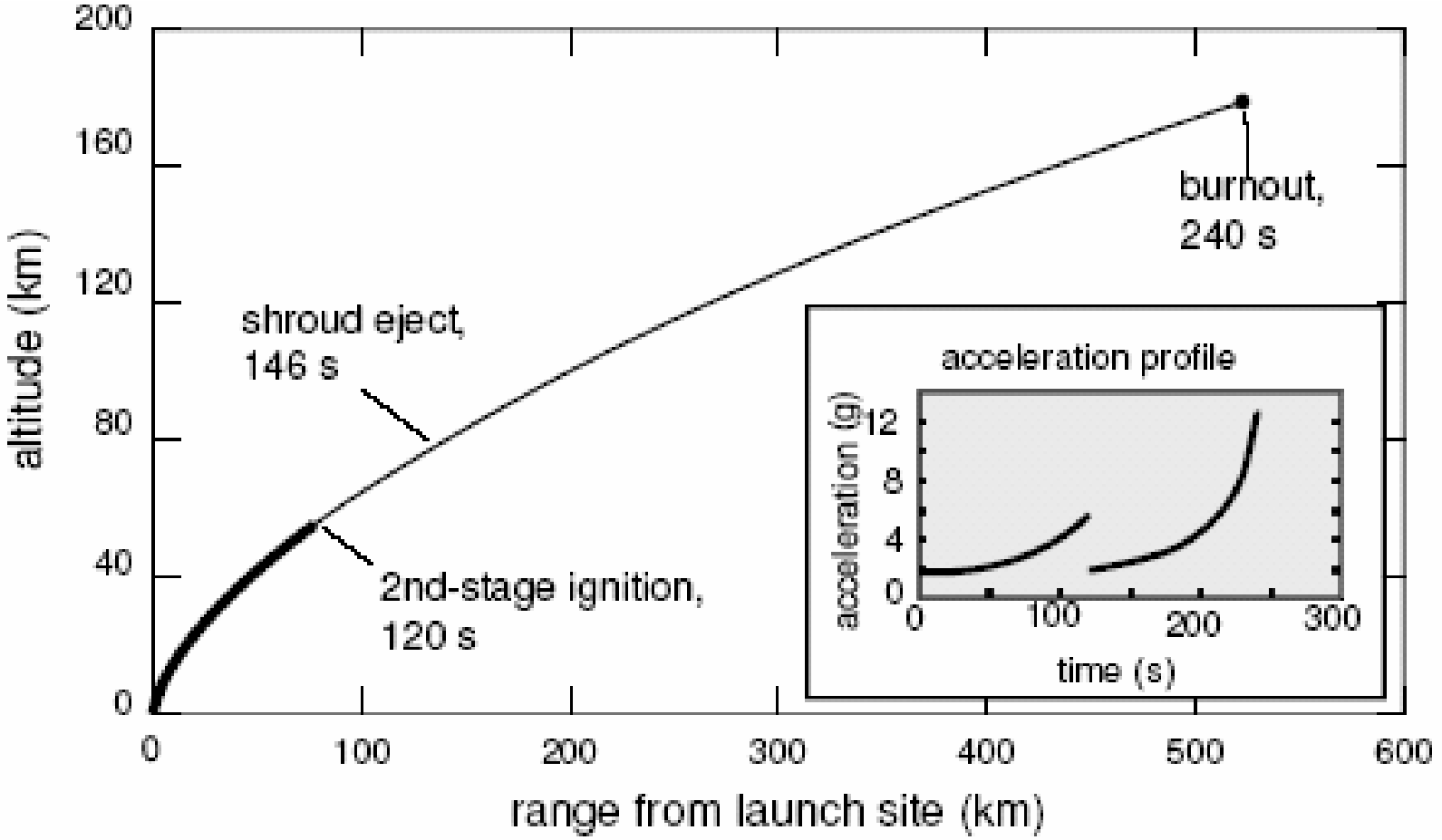


Figure 4.1. Liquid-propellant ICBM model L maximum-range boost-phase trajectory in the altitude-range plane. The first- and second-stage boost-phase trajectories are shown respectively by the heavy and light lines. Inset: Acceleration profiles of the two stages. The acceleration of the second stage reaches 12 g before it burns out.

(APS Study Group)

In 2003 the American Physical Society Study Group on Boost-Phase Intercept published its highly substantive study.(4) This confirmed that no land or sea-based BPI was feasible against China and Russia, given their vast land areas available for deployment, but, to my mind it reinforced its feasibility against North Korea and even against Iran. It did spell out the analysis that

showed that with current interceptor kill-vehicle technology, the interceptor itself would have to be in the range of the 14-ton rocket that I advocated in my 1999 presentation, and not in the 1.4-ton range that is adapted to the vertical launch system on existing Navy ships. The APS Group detailed the countermeasures that might be used against BPI—primarily maneuvering of the ICBM booster—and scoped the •V required of the kill vehicle, leading to the large mass ratio that demands the 14-ton interceptor launch mass. Another critical parameter is the time required for a decision to launch the interceptor(s) after DSP detects the booster in flight—typically some 30 seconds after launch.

I still believe that the U.S. mid-course intercept program should be terminated, and the effort placed on rapid acquisition of a BPI system that would not only have some prospect of working against North Korean ICBMs before they had a chance to bring a payload of BW bomblets up to speed that would carry them to the United States, but by its nature would also deter the acquisition of such capabilities by North Korea and Iran.

Still, the problems remain-- of performance of the defense against ICBMs and, worse, the greater threat of delivery against U.S. coastal cities by short-range missiles. It is not worthwhile to defend against the ICBM threat (barricade the back door) when the simpler and more effective option is available to an adversary state, of short-range missile attack (an open front door).

In any case, we will need to depend on deterrence and preemption for our security against armed states. A greater threat, outside the scope of this talk, is terrorist delivery of nuclear or biological weapon, about which I have written for a long time. Here deterrence does not work, and defense against smuggling is difficult. The first line of defense against terrorist nuclear explosions in the United States lies in securing the world's nuclear weapons and weapon-usable materials-- plutonium and highly enriched uranium-- and in mounting a public health defense against terrorist induced disease-- especially smallpox. But that is another talk.

I would be delighted to entertain questions or comments on this presentation.

RLG:jah:5045NMDP:021405NMDP

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1 "Countermeasures, A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System," UCS-MIT Study, A.M. Sessler (Chair of the Study Group), J.M. Cornwall, R. Dietz, S.A. Fetter, S. Frankel, R.L. Garwin, K. Gottfried, L. Gronlund, G.N. Lewis, T.A. Postol, and D.C. Wright, April 2000. Available online at *http://www.ucsusa.org/publications/report.cfm?publicationID=308*

2 "Midgetman Needs Anti-Simulation Decoys," paper by E. Teller on p. 44 of Armed Forces Journal International, March 1987.

3 "Cooperative Ballistic Missile Defense," by Richard L. Garwin November 17, 1999 Available online at *www.fas.org/RLG*.

4 "Report of the APS Study Group on Boost-Phase Intercept Systems for National Missile Defense," published 15 July 2003. Available online at *http://www.aps.org/public_affairs/popa/reports/nmd03.cfm.*

Please remember

- **Don’t be misled by those who deny the existence or relevance of science *so that* they can make it a matter of preference or ardor**
- **That editors believe readers, viewers, or listeners can’t tolerate a number or a fact does not relieve us of the responsibility to understand these numbers or facts**
- **Marvelous tools serve the media as well as terrorists or foreign technologists, e.g., search engines such as Google**
- **For those of you more traditionally oriented, see my own papers and talks at www.fas.org/RLG/**