Boost-Phase Intercept of North Korean Hwasong-15 Launched Against the United States

by

Richard L. Garwin
IBM Fellow Emeritus
IBM Thomas J. Watson Research Center
Yorktown Heights, NY 10598
RLG2@us.ibm.com

With planned commentary by two participants (Chatham House Rules)

Garwin Archive: https://rlg.fas.org
Search in Firefox with, e.g., site:rlg.fas.org "breeder reactor" AND Szilard [~4 results]

Nancy Forbes National Security Seminar

6:00 PM, Tuesday, October 25, 2022 (Via Zoom)

1. BMD in general – boost, mid-course, terminal phases.

2. Existing U.S. National Missile Defense System – ground-based interceptors (GBI) against warheads in midcourse. Ineffective because of countermeasures. Also limited numbers of expensive interceptors.

3. Limited role for boost-phase intercept – BPI. History of my involvement – PSAC Strategic Military Panel; national intelligence background; work with American Physical Society – APS – since 1999.

   Current potential in a nutshell – BPI could be configured against NK's liquid-fueled missiles directed against the U.S., such as the current Hwasong-15. Incidentally, happens also to be effective against IRBMs against Guam. (Many posts, papers, presentations on the Garwin Archive, including Rumsfeld Commission Report of 1998).

   Trajectory of the Hwasong-15; fly-out fan for typical interceptor; critical parameters:
   - Delay time to interceptor launch
   - Latest allowable intercept time (if one wants to keep potentially live payloads off all U.S. land)
   - Interceptor burn time

   All addressed here:

The North Korean Ballistic Missile Program and US Missile Defense

Theodore A. Postol
Professor Emeritus of Science, Technology, and National Security Policy
Massachusetts Institute of Technology
Voice: 617 543-7646; e-mail: postol@mit.edu

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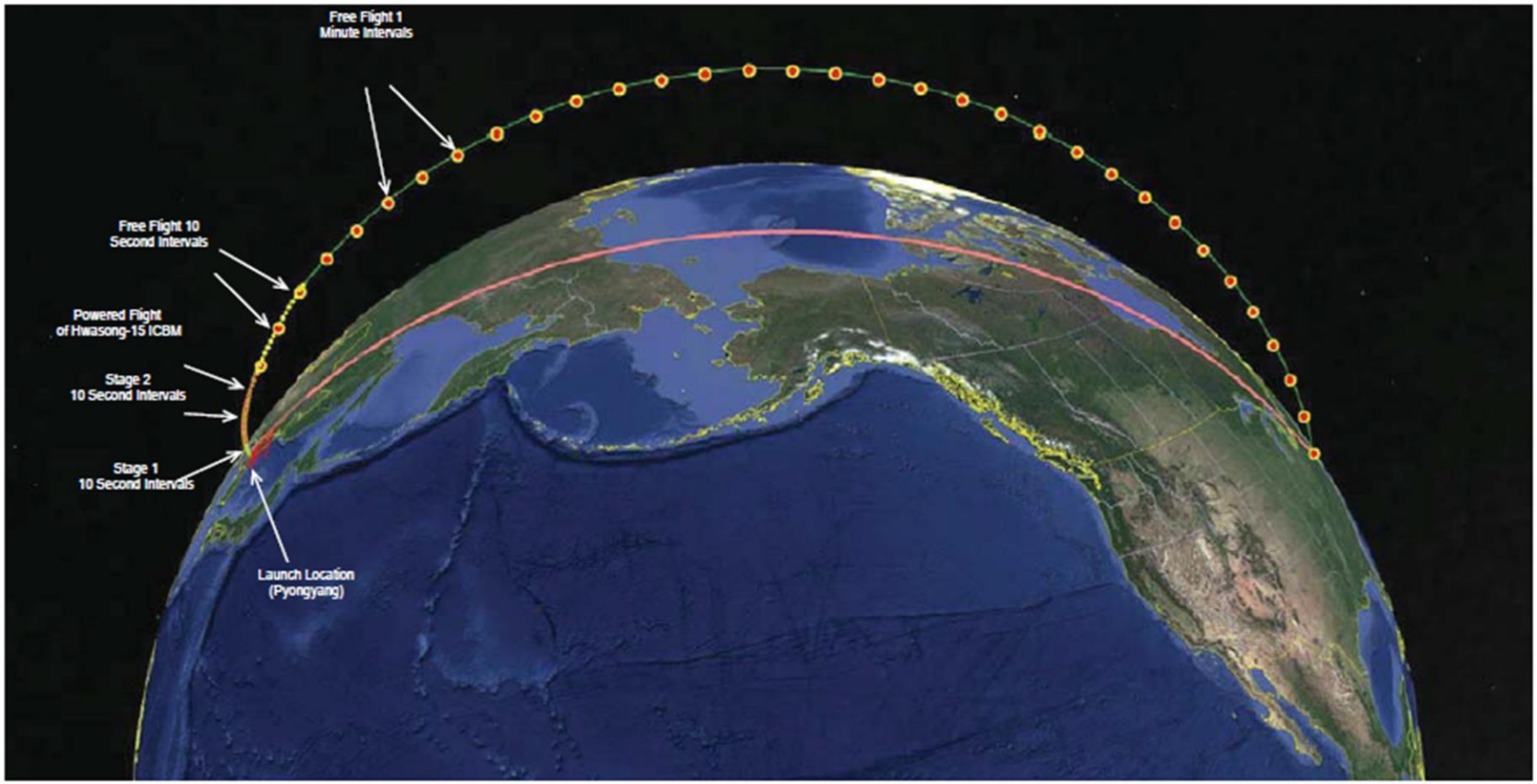
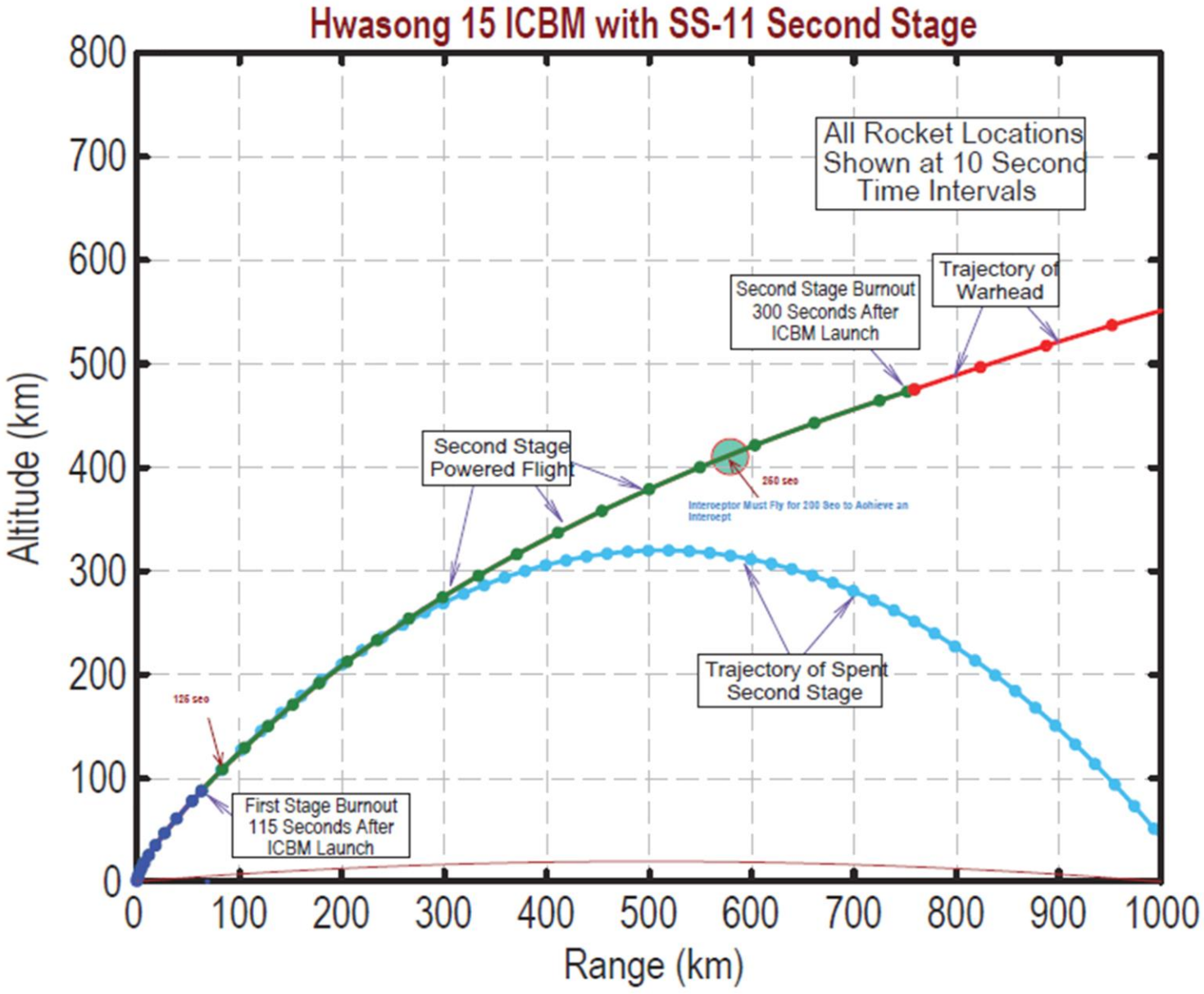
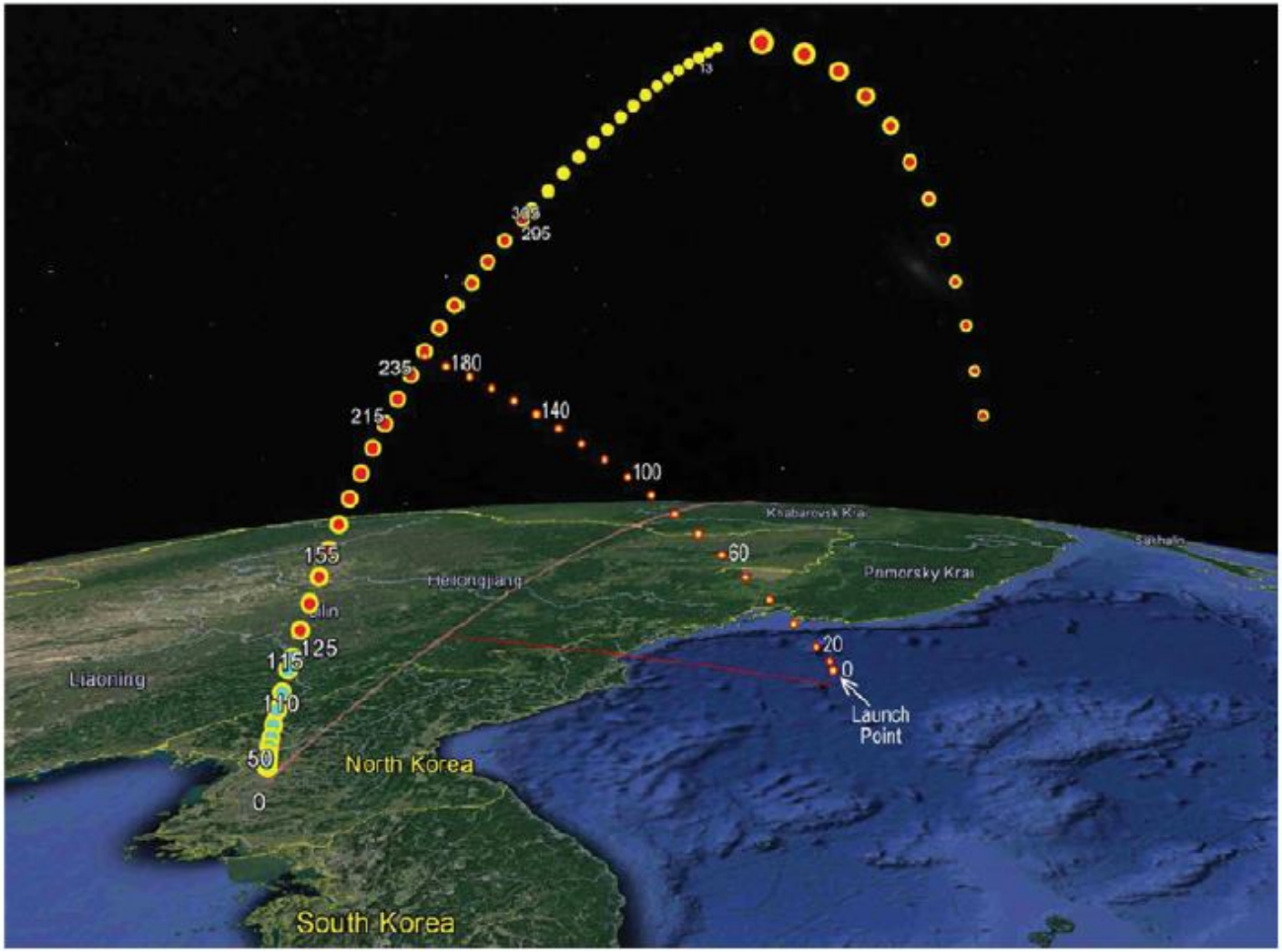
The Distances and Timelines for Intercepts of ICBMs Using Relatively Fast Interceptors Will Work Well Given the Specialized Geographic Situation of North Korea. However, It Is Important to Understand That Shorter Range Missiles End Powered Flight too Quickly for This Kind of Interceptor System to Be Effective against Them



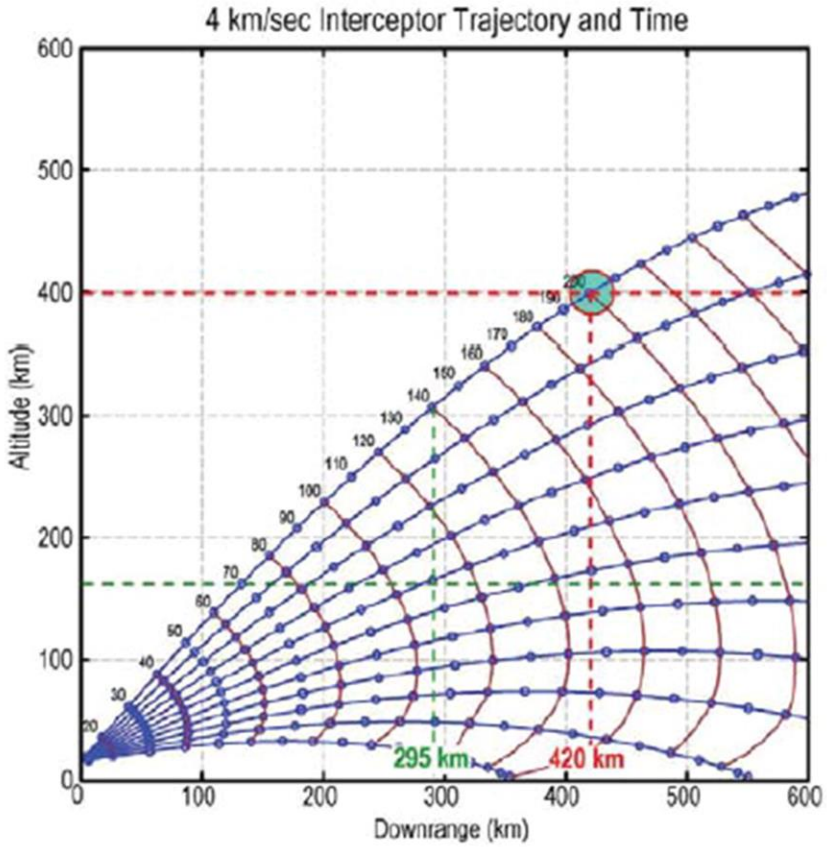
Rough Estimate of the Powered Flight of the Hwasong 15 ICBM

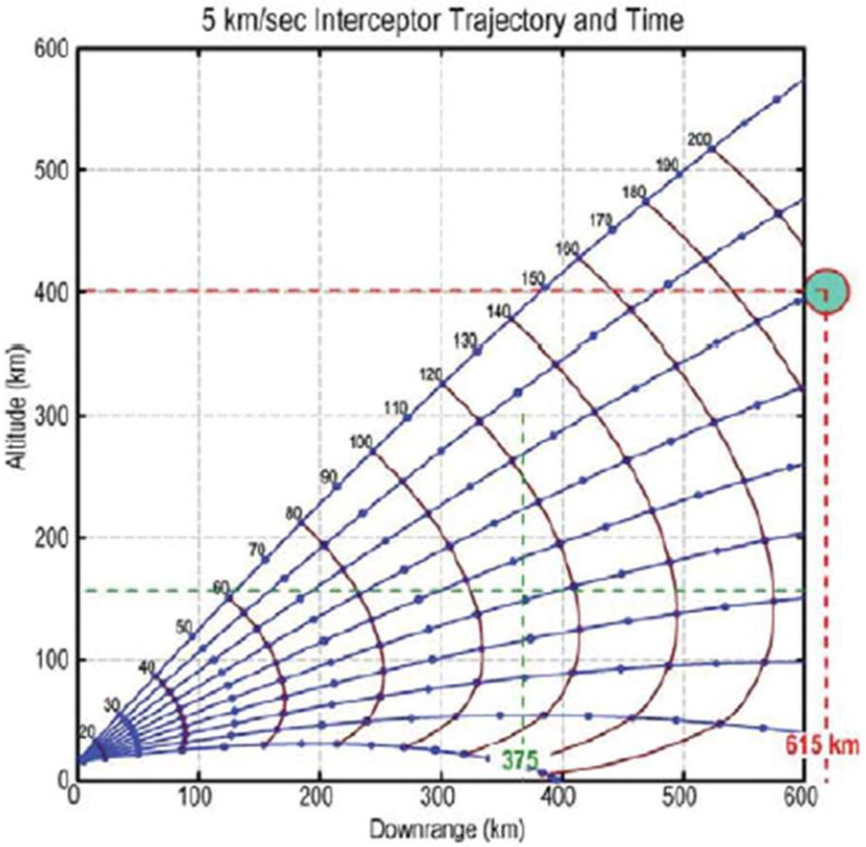


The Intercept Trajectory Shown below Shows the "Foot Race" between the ICBM and a 4 km/s Peak Velocity Interceptor. The ICBM Is on a Trajectory toward Washington DC on the East Coast of the United States. Simulations Show That Attack Trajectories Towards the East Coast of the United States Are the Most Demanding for the Defense – but Are within the Capabilities of an Interceptor with a4 km/s Peak Velocity



Our Analysis Assumes An Interceptor With A Peak Velocity of 4 Km/S And With Additional Divert Velocity of 2 km/s. An Interceptor with a 5 km/s Peak Velocity would have Considerably More Reach Relative to a 4 Kilometer Per Second Interceptor. This Is Due to the Extreme Gain In Range that Occurs After the Relatively Slow 25 Second Acceleration Time. The Faster Interceptor, of Course, Weighs More and Trade-Off Studies Need to be Done to Determine Which Combination of Speed And Interceptor Weight Works Best for the System's Overall Performance





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Defending the United States

Revisiting National Missile Defense against North Korea

Jaganath Sankaran and Steve Fetter

U.S. policymakers have long feared the emergence of a North Korean intercontinental ballistic missile (ICBM) threat. In 1998, the congressionally mandated bipartisan Commission to Assess the Ballistic Missile Threat to the United States, known as the Rumsfeld Commission, argued that North Korea was devoting an "extraordinary level of resources" to obtain ballistic missiles to threaten and coerce the United States, suggesting that North Korea could acquire ICBM capability within five years of deciding to do so.[1] North Korea made intermittent and limited progress in its nuclear and missile program since the Rumsfeld Commission, but these programs accelerated after Kim Jong Un came to power in 2011.[2] In 2016 and 2017, North Korea conducted three nuclear tests, the last of which had a yield that exceeded 100 kilotons.[3] In 2017,

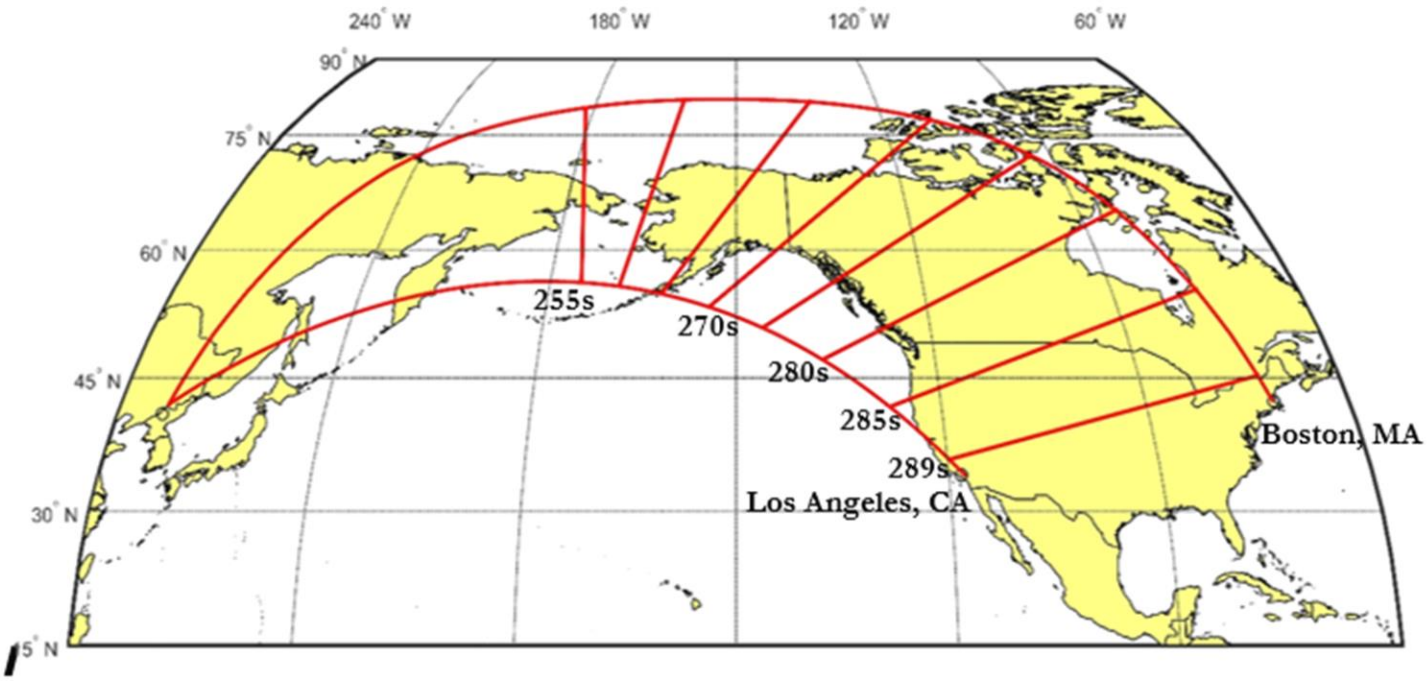


Figure A17: North Korean Hwasong-15 ICBM trajectories targeting United States (Northwestern launch site near Chunggangup). The time contours across the trajectories denote the impact point of the missile payload if interception occurs at that time in the missile's boost phase. The total boost-phase of the Hwasong-15 above is modeled as 290 seconds.

"The time contours across the trajectories denote the impact point of the missile payload if interception occurs at that time in the missile's boost phase." Intercept by 260 seconds would keep any of these trajectories from impact on Alaska, whereas on the trajectory to Boston, 285 s will keep the impact out of the United States. Calculating these curves is a technical question; assessing the necessity or value of this condtion is not.

Despite an excellent technical study by APS published[1] (2003 and) 2004, APS general conclusions were reported as negative. Disputed by RLG in presentations at the National War College and publications, and by Postol. In fact, here is the first of eight Conclusions of that report, with the small part highlighted that refers to our proposal at the time, for sea- or land-based interceptors at 8.5 km/s burnout speed.

Our main conclusions are the following:

1. **Boost-phase defense against intercontinental ballistic missiles (ICBMs) hinges on the burn time of the attacking missile and the speed of the defending interceptor rocket. Defense of the entire United States against liquid-propellant ICBMs, such as those deployed early by the Soviet Union and the People's Republic of China (China), launched from countries such as the Democratic People's Republic of Korea (North Korea) and Iran, may be technically feasible using terrestrial (land-, sea-, or air-based) interceptors. However, the interceptor rockets would have to be substantially faster (and therefore necessarily larger) than those usually proposed in order to reach the ICBMs in time from international waters or neighboring countries willing to host the interceptors. The system would also require the capability to cope with at least the simplest of countermeasures.**

In particular *"Defense of the entire United States against liquid-propellant ICBMs .... launched from countries such as ... North Korea ... may be technically feasible using terrestrial (land-, sea-, or airbased) interceptors. However, the interceptor rockets would have to be substantially faster (and therefore necessarily larger) than those usually proposed in order to reach the ICBMs in time from international waters or neighboring countries willing to host the intereptors."*

[1] "Report of the American Physical Society Study Group on Boost-Phase Intercept Systems for National Missile Defense: Scientific and Technical Issues," D. K. Barton et al., Rev. Mod. Phys. 76, S1 (2004)

Have a look at my 1999 presentation,

- "Missile Defense Policy and Arms Control Issues," by R.L. Garwin, presented at Second Annual U.S. Army Space & Missile Defense Conference, Huntsville, AL, August 26, 1999.

"We should start over. That doesn't mean we should lose time. In fact we will gain time if we start over on the NMD. We should start over with hit-to-kill on the ICBM booster. We can launch these interceptors from 1000 kilometers east, west, or north of North Korea from military cargo ships. Not from Aegis cruisers. Not because those aren't good ships. But it'll save money to take a special ship, take it out of the rusting inventory and equip it with interceptors, no radar, launch on DSP indication. Or there is the opportunity for a U.S.-Russian joint test range south of Vladivostok. There is a strip of land, as you'll see, that abuts North Korea. We should launch and vector on DSP data; home on the booster flame plus the hard body lead-ahead so we don't kill the flame. And the hit-to-kill interceptor should have 8 kilometers per second more or less burn out speed with a 10-g average acceleration, something which is really easy to do compared with 100-g and 400-g interceptors we had in the 1960s. (Slide 10, please)"

And to this, the 2003 APS study replies, " .. "*would have to be substantially faster (and therefore necessarily larger) than those usually proposed."*

With all due respect to my friends and colleagues, have these people even read our proposal? Our 40,000-lb interceptor was indeed "larger than those usually proposed." And my 1951 design of the MIKE shot (~11 megaton yield) was big, too.

Life is short, and there were other opportunities to attempt to help our well-being and national security.

Fast forward to the 2022 Report by APS Panel on Public Affairs – POPA BMD Study – not only negative about the 2017-2018 Garwin-Postol proposal for *Airborne Patrol,* but has evident important errors accounting for its negative conclusions. Going in, we had identified problems with BPI, but they are not the ones published in the 2022 POPA BMD report.

Our *Airborne Patrol* proposal uses fast interceptor missiles carried by high-altitude drone aircraft built by GA Aeronautical Systems, used by the USA for 20 years in Iraq, Afghanistan, and elsewhere in the world. The concept is to have the drones patrol over international waters near North Korea, with the IR (infrared)-satellite national system to detect NK ICBM launches and determine the trajectory in 20-40 seconds, to enable the launch of an interceptor against the ICBM while the propulsion

motors are still burning and the missile is highly visible to the satellites in GEO. The thrusting booster soon becomes visible also to radar on the ground and to IR sensors on the same drones or on smaller ones, also in international waters.

We proposed *Airborne Patrol* only against North Korea, because of NK's small size and proximity to international waters and to South Korea.

Naturally, unless done right, the system has no chance of working, and whether by intent or inadvertence, the POPA Panel presented results which they claimed to be for a 5 km/s interceptor speed that was actually from interceptors capable only of less than 4 km/s. Here is the difference, as Ted Postol and I have presented it to some congressional staff and at least one member of Congress on May 27, 2022.

The reach-versus-time challenge for BPI

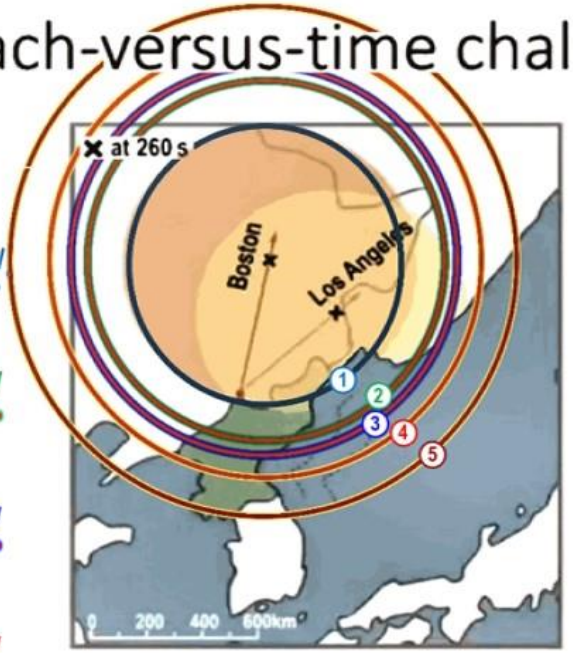
Sankaran/Fetter/APS Interceptor
65 Sec Interceptor Launch Delay Time ①
195 Seconds of Interceptor Flight, 500 kg, 60kg KV

Garwin/Postol Interceptor
65 Sec Interceptor Launch Delay Time ②
195 Seconds of Interceptor Flight, 300kg, 25kg KV

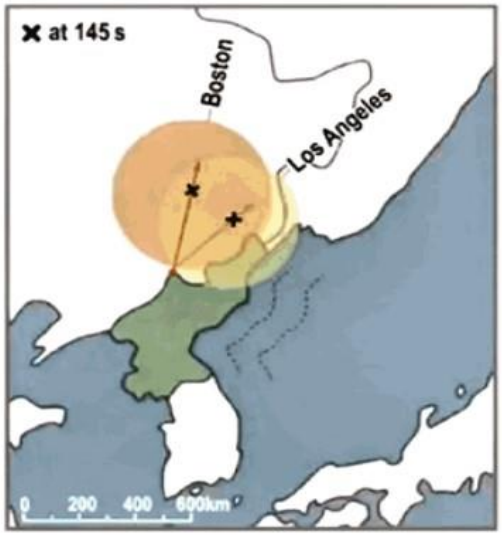
Garwin/Postol Interceptor
50 Sec Interceptor Launch Delay Time ③
210 Seconds of Interceptor Flight, 300kg, 25kg KV

Garwin/Postol Interceptor
40 Sec Interceptor Launch Delay Time ④
220 Seconds of Interceptor Flight, 300kg, 25kg KV

MODIFIED Sankaran/Fetter/APS Interceptor
40 Sec Interceptor Launch Delay Time ⑤
220 Seconds of Interceptor Flight, 500kg, 25kg KV



Hwasong-15: 290 s burn time



Solid-propellant: 170 s burn time

- Left: A BPI system could theoretically defend at most only part of the US against liquid-propellant ICBMs launched from North Korea against the US
- Right: Using a BPI system to defend the US against solid-propellant ICBMs launched from North Korea against the US would not be feasible

APS

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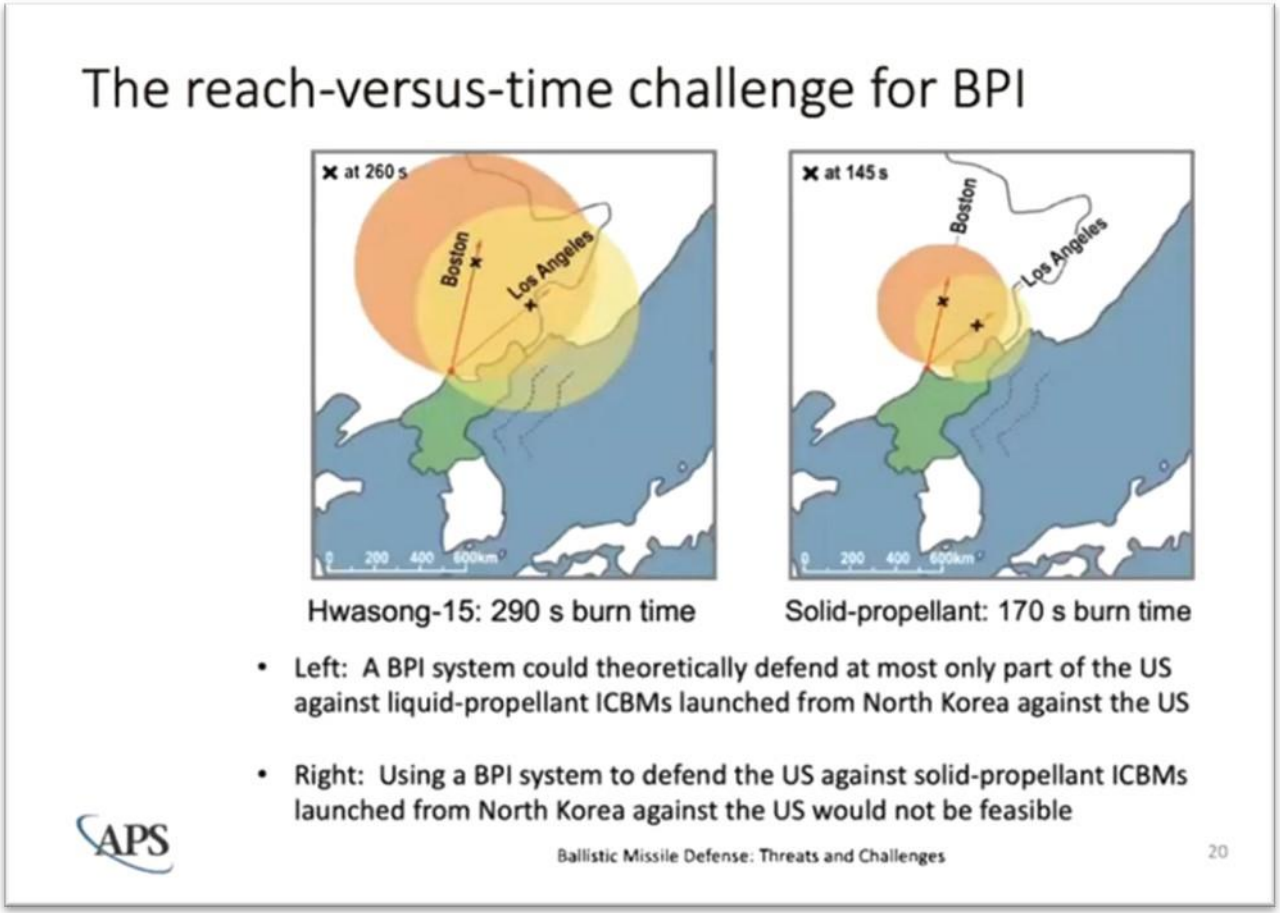
The original graphic from the February, 2022, BMD Panel is this one:



Aside from the controversy with the APS, there is the reality of BPI. In April, 2000, Ted and I, with others, published "Countermeasures" a 175-page analysis of countermeasures to missile defenses that are detailed, practical, and effective[2]. Of

[2] "Countermeasures," A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System, (Executive Summary 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. Now at https://www.ucsusa.org/resources/countermeasures

course, there are counter-countermeasures – CCM, and C-CCM, and so on. But we have deployed the National Missile Defense System now which is fully vulnerable to some of those countermeasures.

BPI comes with its own problems, which we list in our proposal since 1999. One of them is the fast-burn ICBM, which I emphasized in the 1980s the USSR could use at modest cost to counter a U.S. submarine-based system of pop-up nuclear-explosion-powered X-ray lasers proposed by Edward Teller and colleagues at LLNL in support of President Reagan's Star Wars system – Strategic Defense Initiative. The 2004 APS study judged that within 15 years NK could have solid-fuel missiles that would render BPI impossible. In the year 2022 – 19 years after the 2003 publication, NK has not tested a solid-fuel ICBM and continues to deploy the Hwasong-15, with adequately long burn time for BPI.

[These blocks of indented text will be suppressed or not read]

Rarely does the deployed and refined system have details in common with the demonstration system that perforce, in my approach, uses existing technology. That is to say, the GA Predator-derived MQ-9 Reaper would work for BPI against North Korea, but a new version would be, of course, better and more affordable if scores were being built rather than one or two, for which the development and test cost could not be spread over many. I had the same experience in developing a really nice touchscreen for the IBM classroom lectern in 1983. We replicated some hundreds of copies of our laser-scanned touchscreen for the IBM internal education lecterns, but to make a production unit that would be much less costly, one needed to project hundreds of thousands of sales.

That said, we -- particularly Ted Postol -- have contributed details to what could actually be built for BPI against the North Korean Hwasong-15 or, now, against nuclear-armed IRBMs launched from NK against Guam. However, the endgame – the actual collision of the Powered Kill Vehicle – PKV – against the large thrusting booster needs more attention than we were able to give it. The very capable APS 2004 Report does not discuss the end game in detail, but particularly with a version of the PKV that has only a single steerable motor rather than six thrusters, has not been modeled to include sensor accuracy and delays in response to commands. One can fall back on the conventional PKV, which would make the system heavier; a development program should define the PKV – perhaps using both a steerable axial thruster and side thrusers, and with liquid propellant for the PKV, not for higher I_{sp} but for flexibility.

Our beef with the APS group is that the alleged deficiencies in our approach that they identified simply don't exist. We would make the same objections to the POPA BMD report if others had proposed the *Airborne Patrol* system.

In fact, returning to my original proposal to the Army's Space and Missile Command in 1999, a large, extremely fast (8.5 km/s) interceptor based either on converted merchant ships in international waters or in South Korea (and in the good old days of cooperation with Russia, on Russian territory northeast of North Korea) would still be effective, and require considerably less development than the *Airborne Patrol.* This was, unfortunately, never analyzed as a point design by the APS group's 2004 report. We specified a speed for this surface-based interceptor of 8.5 km/s – a higher speed than an ICBM, that with a PKV of that era led to a gross launch weight of some 40,000 lbs. The APS Panel convinced itself that NK could readily develop solid-fuel boosters that would render such BPI ineffective; Ted Postol and I, of course, not only recognized that as a problem but had put it in our paper. However, rapid deployment of an evolving BPI system would likely have delayed the NK deployed ICBM by several years or more.

In general, the Missile Defense Agency – MDA – is not going to solve the countermeasures-driven ineffectiveness of its mid-course system unless it acknowledges the efficacy of the countermeasures. In the year-2000 era I met several times for good technical discussions at MDA in the Pentagon with the commanding general of the program. I have also prescribed active means for countering some of these mid-course countermeasures – "Puff, the Magic Dragon" for sensing whether a balloon mid-course countermeasure contains a warhead. And I have provided a counter-countermeasure for that as well. All that has nothing to do with our proposals for BPI – boost-phase intercept of the Hwasong-15, only with U.S. security.