When Will Mid-Course Missile Defense Work?

For the session titled
Ballistic Missile Defense: Timeline, Testing, and Cost Effectiveness

by
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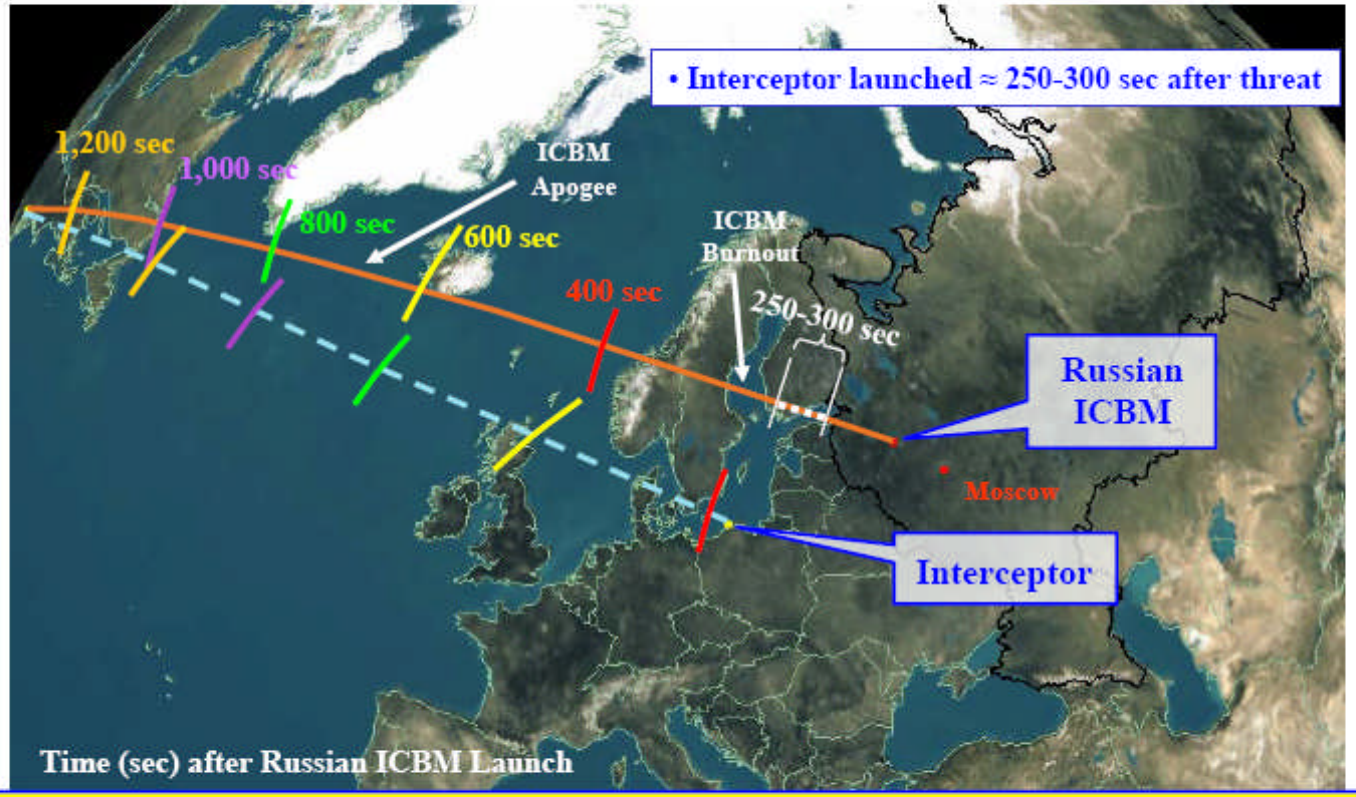
Outline of presentation

- **If countermeasures were taken seriously, what would a mid-course intercept system look like?**
- **MDA offers no protection against biological weapons in the form of bomblets.**
- **Boost-phase intercept—the partial solution to all these problems.**
- **Enter "ascent-phase" defense against ICBMs**
- **Three questions**

Interceptors Cannot Catch Russian Missiles



U.S. European Interceptor Site Cannot Affect Russian Strategic Capability

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This slide, from a June 2007 MDA presentation to European allies, is highly misleading. Interceptors could be launched 100 s after ICBM launch.

In this prepared contribution, I limit myself to missile defense of the United States, and particularly to the mid-course intercept of intercontinental-range ballistic missiles—ICBMs. I have been involved in analyzing such programs for the U.S. government since the 1950s, and in contributing to such programs as well. This involvement began with my membership in the Strategic Military Panel of the President's Science Advisory Committee (PSAC) which met typically two days a month in the Old Executive Office Building. We faced an emerging missile threat from the Soviet Union to supplement and replace the threat of nuclear weapons delivered by Soviet bombers, with which I had been concerned since 1953, when I worked on Project LAMP LIGHT to extend the continental air defense to the sea lines of approach of Soviet bombers to the U.S. and Canada.

Our Strategic Military Panel tried its hardest to help make U.S. ICBMs and SLBMs effective and to give them the ability to penetrate potential Soviet missile defenses, whether armed with nuclear warheads or conventional. On the other hand, we tried our best to devise and to evaluate systems for defending the United States against nuclear-armed Soviet missiles. So we early-on analyzed such techniques and technologies as multiple independently-targeted reentry vehicles (MIRVs), various other countermeasures and tactics, such as attacking and blinding the defense, and antisimulation.

In the 1960s, the technology was not available to have homing intercept against warheads in space, so that the only feasible BMD systems used nuclear-armed interceptors. Even for the nuclear BMD, mid-course intercept is problematical because of the availability of countermeasures, together with the ability of the offense readily to stretch out the string of warheads and decoys for many hundreds of km along the trajectory even to a specific point target. Hans Bethe and I described many of these problems in a *Scientific American* publication[1].

[1] "Anti-Ballistic-Missile Systems," by H.A. Bethe and R.L. Garwin, *Scientific American*, 218, 3, pp. 21-31, March 1968. http://tinyurl.com/m6pxm9

Countermeasures become a lot simpler against the small kinetic-energy intercept (KEI) kill vehicles that form the core of current U.S. BMD efforts. The homing kill vehicle (HKV) either collides with the warhead or it doesn't. Decoys in the terminal region (within the atmosphere) are far more difficult than are effective decoys to mid-course intercept—a point that I and other technical colleagues have been trying to make to the army BMD folks and since then to the SDIO and the Missile Defense Agency. These discussions and publications have gone on in both classified and unclassified fora, for instance with the year-2000 publication of "Countermeasures".[2]

I note here a couple of what I believe are the most practical countermeasures from that document—the spherical inflated balloon of aluminized plastic as a decoy to an antisimulation warhead. The latter is a real nuclear warhead that is enclosed in a balloon essentially identical to the decoy balloons, which are the easiest type of decoy to make. "Antisimulation" simply means that rather than to go to the trouble to make tens of precise replica decoys per warhead, and to stabilize them so that they and the warhead look the same in the visual, infrared, and radar views, one chooses the cheapest decoy and dresses the warhead so that that decoy would be effective. In fact one prefers to use a sloppy range of decoys.

Other countermeasures to mid-course intercept include a large enclosing balloon, so that an individual HKV can surely strike the balloon, but it will with high probability miss the warhead that is enclosed.

[2] "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. http://www.ucsusa.org/assets/documents/nwgs/cm_all.pdf

And if one builds a warhead with very low radar cross section from one range of angles, the warhead can be roughly pointed toward the radar that is essential to conducting the intercept, in order to deny that radar the observation of the warhead.

A 1999 National Intelligence Estimate (NIE) <http://www.cia.gov/cia/publications/nie/nie99msl/html> judged that *"Many countries, such as North Korea, Iran, and Iraq probably would rely initially on readily available technology…to develop penetration aids and countermeasures. These countries could develop countermeasures based on these technologies by the time they flight test their missiles."*

It is often argued that a nation fielding an ICBM system with these mid-course countermeasures would need to test them in space, so that we would pretty soon have a good idea of the details and could therefore discriminate the real warhead from the decoys. This possibility puts a premium on countermeasures that can be effective without test in space, which also saves time and money. These include balloons that are rapidly inflatable, not so much because it is an operational necessity but so that they could be tested in a modest vacuum chamber, even under zero-g conditions. Similarly the inflation of the enclosing balloon around the warhead.

A chamber not much bigger than a warhead would serve for either of these, and the system should be designed to be insensitive to gravity. For the most part, this could be tested with the system right-side-up in normal gravity, and also upside-down. Any remaining uncertainty could be removed by enclosing the warhead or the mechanism in a steel chamber able to withstand the pressure of the atmosphere, and dropping it down a vertical mineshaft while the deployment takes place, observed by a video camera. It does not need to be a deep mine or a mine at all; if the

deployment can be done in a second, which is a reasonable expectation, a mere 10 meters of drop suffices, plus another 5 m or so for arresting the test chamber.

My point has always been *not* that these countermeasures can defeat any conceivable BMD system, but that they will defeat a system that does not take them into account, and there is a history of decades of ignoring or wishing away such countermeasures.

If countermeasures were taken seriously, what would a mid-course intercept system look like?

In "Countermeasures" we provide the details of balloons that cannot be distinguished from the anti-simulation warhead. But this assumes only passive observation. Obviously, if one could push on a balloon and move it gently a few meters, there would be a big difference between the empty balloons and the balloon containing the warhead that weighs at least hundreds of kg.

It is entirely feasible to provide such a gentle push on the warhead and its accompanying decoy balloons, for instance by having the set of decoys (and warhead) collide with a stationary cloud of 10 kg of gas spread over a cubic km. This assumes that the whole "cloud" of countermeasures is spread over 1 sq km or less. Nor need the gas cloud be stationary; it could be deployed by a homing interceptor to collide with the "threat cloud". Thus, a KV that has relaxed accuracy requirement and carries a 10-kg charge of gas-producing high explosive at an assumed "closing speed" of 10 km/s could provide a total momentum of 10 billion dyne-s/sq cm over a sq km. Incident on an empty 1-mil-thick aluminized plastic decoy balloon of 2m diameter (0.3 kg mass) this would induce a recoil of about 1 m/s.

Of course, this would not be detectable until a fraction of a second later, so that a following HKV would need to be at a distance such that it could divert to the real warhead, if indeed it could be distinguished by such active means. An HKV with a 5-g divert acceleration and perfect homing would need 4.5 s for a 500-m divert; at a closing speed of 10 km/s it would have to trail the discrimination burst by 45 km.

But unless MDA and those in the administration and in Congress who provide its direction and funds recognize that the system they have built for mid-course intercept will, from day one, be defeated by an ICBM threat from North Korea or Iran carrying such countermeasures, there will be no chance that we would be able to develop, deploy, and test such active means of discrimination.

Naturally, the offense is not without a response to such a defense that uses active means to detect empty decoy balloons. A simple response would be to put into some of the decoys a 10-kg central mass, which would reduce the decoy's recoil by a factor 33, which reduced recoil speed might be difficult to distinguish quickly from that of a real warhead.

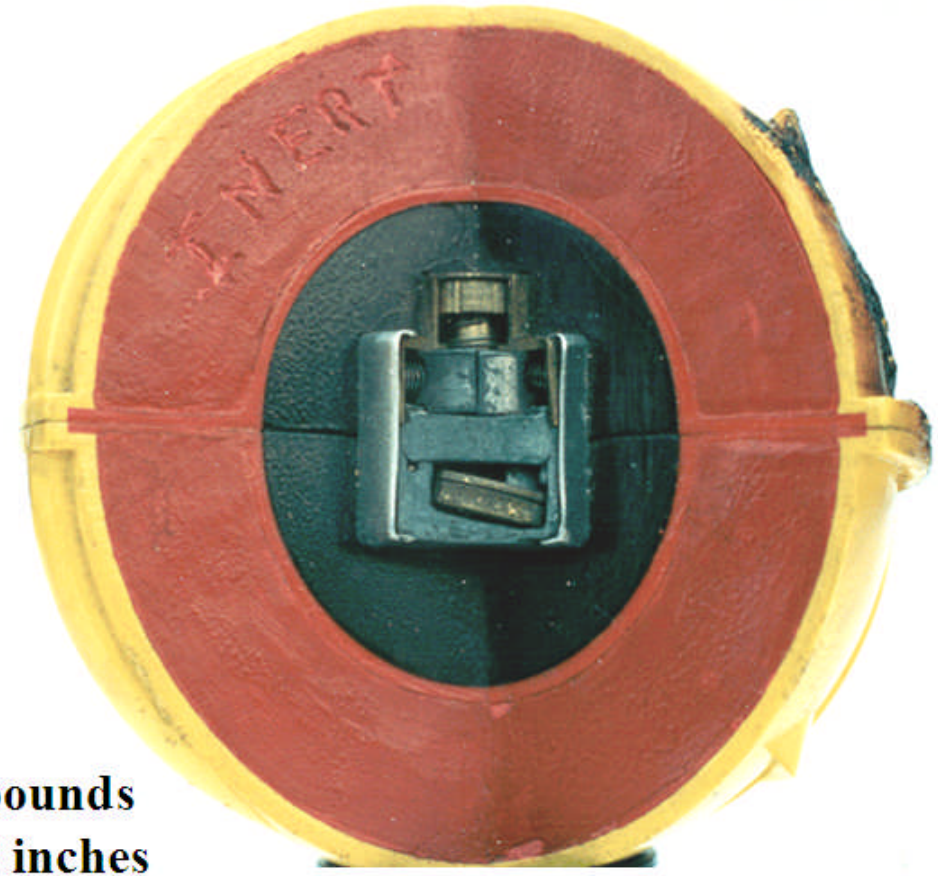
MDA offers no protection against biological weapons in the form of bomblets.

It should be noted that MDA in its early stages promised protection against not only nuclear warheads but also against those containing biological agents, that, despite being banned by international treaty, are nonetheless potentially devastating weapons. MDA has given up this claim, which was never credible, because the defense would certainly have been defeated by a warhead configuration that is not so much a countermeasure but a design for military effectiveness of these weapons.

The most effective ballistic missile attack on a city using BW would come not from a single warhead that would need to disseminate its payload during flight or after it landed, but from the repackaging of the chemical or biological agent into “bomblets” weighing a few kg or less, each equipped with its own heat shield, that would explode on impact with the ground and thus disseminate infectious BW agent essentially at nose level. The United States perfected and stockpiled such bomblets for delivery by aircraft or artillery shell in its programs in the 1960s, as did the Soviet Union. Here is a picture of such an actual bomblet and its packaging in the form of an ICBM-delivered bomblet—one of hundreds that could be fit quite flexibly into an ICBM payload.

M-143 BIOLOGICAL BOMBLET

ca 1965



FILL: 212 ml
WEIGHT: 0.76 pounds
DIAMETER: 3.3 inches
DISSEMINATION: Explosive

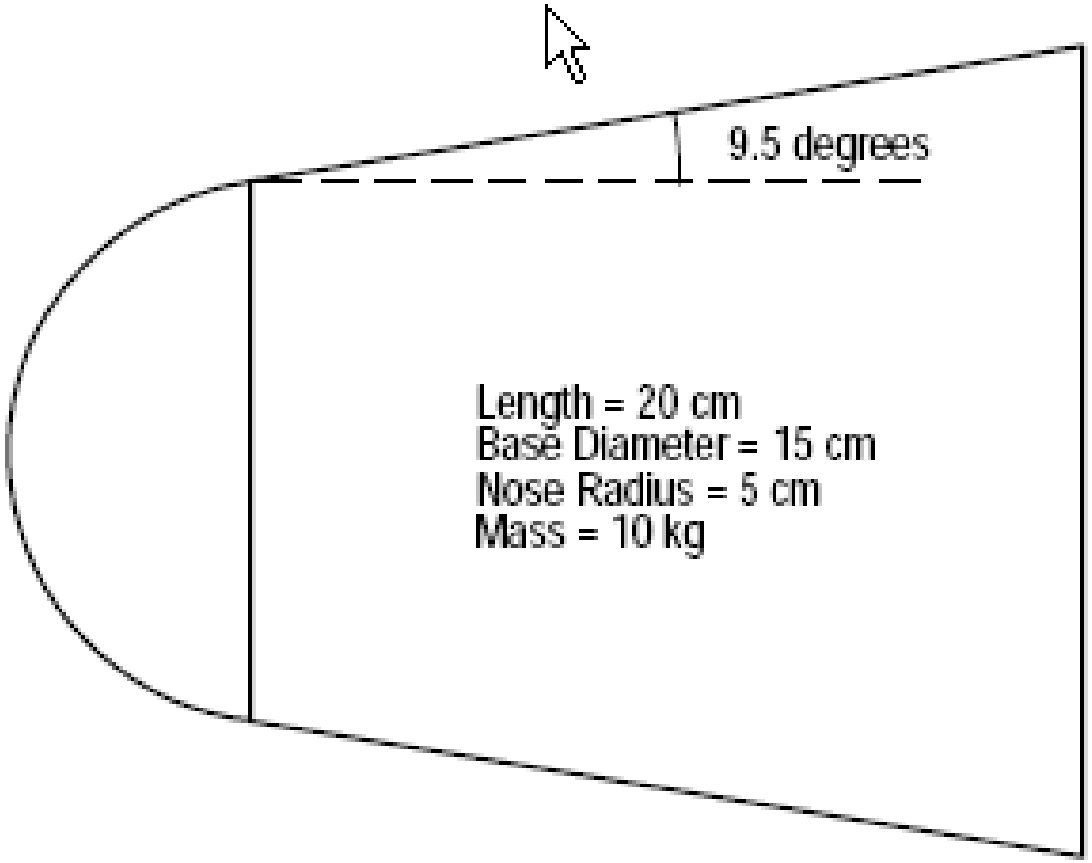


Figure 7-1. The configuration used for calculating the heating of a conical bomblet. *It has a nose radius of 5 cm, a base diameter of 15 cm, a length of 20 cm, a cone half-angle of 9.5 degrees, a mass of 10 kg, and a ballistic coefficient of 12,000 N/m² (250 lb/ft²).*

Boost-phase intercept—the partial solution to all these problems.

Having made these arguments for years, in 1999 I presented a paper at Huntsville and also had discussions with MDA (then BMDO) advocating that mid-course strategic defense be terminated in favor of boost-phase intercept against the most urgent threat, thought then to be North Korea. It was clear that BPI could work ONLY against North Korea and, with more difficulty, against Iraq, at that time also regarded as a threat.

I opposed the airborne laser because to have it permanently on station would require many large aircraft, and to handle the supposedly urgent North Korean ICBM threat I wanted to have both a sea-based fast-burn high-speed interceptor against liquid-fueled ICBMs, and also a cooperative program with Russia, with similar interceptors based on the little strip of Russian territory abutting North Korea.

I have the greatest admiration for Secretary of Defense Robert M. Gates, and support his recent decisions on bringing missile defense into closer contact with reality. Certainly eliminating ABL as a boost-phase defense is the right thing to do. In regard to the cancellation of the KEI ("kinetic energy interceptor"—a confusing name in view of the fact that the MDA mid-course and ascent-phase interceptors are all based on collision with the target warhead-- this KEI is distinguished by faster burn and higher speed in order to complete its intercept while the ICBMs rocket engines are still firing), Gates testified to the House Appropriations Defense Subcommittee on May 20, 2009,

"But a big part of the problem with this program is that it needs to be close to the launch site to be able to be effective. And so it has -- the only potential country where it could have a role with some confidence would be North Korea. It has poor capability against Iran and virtually no capability against either Russia or Chinese launch facilities. And so you have a very limited capability here at considerable cost.

"The other problem that we have is we don't know what to put it on. The missile's 38 or 39-feet long. It weighs 12 tons. There's no extant ship that we can put it on. We would have to design a new ship to put it on. And as I say, it would have to operate in close proximity to the territorial waters of these countries."

I do agree with Gates's comments that the KEI would have no capability against launch of ICBMs from China or from Russia, but if North Korea is the threat that was assumed by the Clinton Administration and the George W. Bush Administration, it would be perfectly reasonable to deploy a defense that would work only against North Korean ICBMs, and even only against early generation NK ICBMs. I do share Secretary Gates's dismay, *"First of all, this was to have been a five-year development program and it now looks like it's about a 16-year development program."*

But if one starts with a merchant ship of typical 20 kt maximum speed, one has great flexibility in mounting such a KEI missile, or a Standard Missile SM-3 Block IIa. I suggest a re-look at a North-Korea only KEI for boost-phase intercept based both on Russian territory and on ships, as proposed in my 1999 paper.

In his testimony of May 14, 2009 to the Senate Armed Services Committee, Gates observed,

"On the Multiple Kill Vehicle, the policy of the Bush administration and the policy of this administration has been to develop a missile defense against rogue nations, not against China and Russia. And the Multiple Kill Vehicle, in addition to schedule and cost and technology issues, was a -- was designed against a far more capable enemy than either North Korea or Iran are going to be in -- for the next 10 to 15 years."

To the extent that the MKV was to handle the decoy threat from North Korea or Iran, as envisaged by the 1999 NIE, this statement appears to be ill-founded. In fact, I don't see how the multiple-balloon decoy tactic, coupled with a balloon-enclosed RV, could be defeated by a modest force of interceptor, even if armed with Multiple Kill Vehicles.

"There are also classified programs that are aimed at giving us the boost-phase capability. So I'm a strong defender and proponent of missile defense, but I want to spend the dollars on missile defense -- both on R&D and operationally -- where they will do us the most good."

I hope that the "classified programs" for BPI have been subject to the same light of reason that Gates has used in rationalizing the open programs. I, too, am a strong proponent of missile defense programs that work.

So to return to the topic of this session, "Timeline, Testing, and Cost Effectiveness," as regards mid-course intercept I don't see progress that will be effective against elementary ICBMs that include feasible countermeasures such as multiple small bomblets for biological weapon payloads and balloon decoys with a matching antisimulation warhead.

Enter “ascent-phase” defense against ICBMs

The advantage of boost-phase intercept is that the missile is to be struck while the large rocket engine is still firing, with the resulting ease of detection and initial homing. It is difficult to hide the flame or to provide effective simulation (decoys) of the large hot plume. And the rocket is much larger and more fragile than the warhead, once separated. Furthermore, a warhead containing BW bomblets, atop an intercepted rocket, will not fall on the target city. Even if the bomblets separate, they will fall short, probably in an area with population density 100-fold smaller than in the target city.

None of these advantages hold in “ascent phase” after the warhead is in free fall. Yes, it is “falling” up, like a batted baseball, but in space decoys can just as well be deployed in ascent phase as in descent. They should in any case be deployed as soon as possible. Indeed, they will not be so far from the real warhead as will later be the case, but if they need to be targeted individually by homing kill vehicles, that makes little difference. If MDA now accepts that it cannot do effective mid-course intercept because of countermeasures, it is time to take seriously countermeasures during ascent phase. I don’t want to go into detail here how a typical, motivated missile engineer would devise or choose effective ascent-phase countermeasures but would be pleased to have these discussions elsewhere.

My current judgment is that BW bomblets will defeat the ascent-phase intercept and can still be targeted all against the same city.

Our best defense against states that might fire ICBMs against the United States is still the commitment to a massively destructive retaliatory strike against the military of that country. We

should not weaken that deterrence in our enthusiasm to replace it with a system to destroy the warhead in flight.

I am troubled by ambiguities in the MDA program and the widespread support for it, so I ask three questions:

Three questions

- As the 1998 Rumsfeld Commission report emphasized, all potential threat countries could sooner and more accurately deliver a nuclear or biological warhead from short-range missiles based on ships. Where is the program to defend United States coastal regions against such a capability?
- In his cancellation of the KEI program, Secretary Gates noted that it had "*virtually no capability against either Russia or Chinese launch facilities.*" But I thought we were developing a BMD system against rogue nation threats. Which brings me to
- MDA's purpose: "*Maintain a ground-based midcourse capability to defeat a limited, long-range, rogue-state attack or accidental launch against the United States."* [3] If our purpose is to reduce the likelihood of destruction of US or allied cities by accidental launch of missiles targeted against us by non-rogue states, whom are we talking about? Russia or China, I suppose. Are we doing all we can to help those states maintain best control of their weapons and to guard against accidental launch, which they surely want to avoid.

My advice continues to be to prize the uncomfortable but effective tool of deterrence of attack by other states, by the capability and commitment to retaliate, while we work to nullify the potential North Korean threat by boost-phase intercept and the evidently difficult effort to eliminate the nuclear threat itself

[3] David Altwegg, Executive Director of MDA, in Defense Department briefing with David Altwegg and Rick Lehner, Missile Defense Agency at 3:31 p.m. EDT, May 7, 2009.