How Strategic Anti-Missile Defense of the United States Could be Made to Work

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Extremely Important

US Missile Defense Policy is shaped mostly by US DOMESTIC POLITICS
Paul Krugman, Nobel Prize Winner in Economics and New York Times Columnist

Commenting on the US debate over economic priorities:

“what we have … is a political culture in which one side sneers at knowledge and exalts ignorance, while the other side hunkers down and pretends to halfway agree.”

The same observation applies to Missile Defense
Why Should the US Consider an Alternative to Its Current Missile Defense Program?

1. **Current Missile Defenses Will Never Be Reliable.**
   The sensor technologies used by current missile defenses will never be able to tell the difference between warheads and decoys.

2. **Paradoxically, Foreign Military Planners Will Assume Worst-Case US Capabilities and Will React As If US Missile Defenses Might Work.**
   US missile defenses will unleash powerful bureaucratic forces that foreign political leaders cannot always contend with.
   Even when foreign leaders are well informed about its limitations, they are subject to accusations of not being willing to defend their countries from this external threat.
   Perceived threats from US missile defenses also create powerful tools for bureaucracies aiming to increase their access to resources, power, and influence.
   Witness the vast expansion in the US nuclear arsenal in-part fueled by claims that the Moscow Anti-Missile Defense posed a major threat to US nuclear deterrence.
3. **Foreign Reactions to US Missile Defenses Might Result In:**
- China Expanding Its Currently Modest Long-Range Missile Forces
- Russia Refusing to Engage in Further Arms Reductions.
- Iran and North Korea Rendering US Ballistic Missile Defenses Useless by Developing Simple and Robust Countermeasures.
- India Continuing to Mimick the Mistakes of the United States by Expanding Its Missile Defense Program.
- Pakistan Further Reacting (It is Already Expanding Its Nuclear Materials Stockpiles) to Threats from India's Missile Defense Program.
Why Should the US Consider an Alternative to Its Current Missile Defense Program?

Hence,

Current US Missile Defense Programs Could Lead to the Worst of Two Worlds.

Defenses That Don't Work and Foreign Reactions to the Missile Defenses As If They do Work.

The End Result Would Then Be a Reduction in US Security
Why Should the US Consider an Alternative to Its Current Missile Defense Program?

The alternative missile defense to be described would work, unlike the current systems under development.

It would be highly intimidating against the adversaries it is aimed at.

It would pose no threat to the strategic nuclear forces of Russia and China.

However, it will not be built, because the argument that long-range ballistic missiles from rogue states threaten the security of the United States is derived from domestic political infighting, not from a true belief that there is a threat.

If the threat were perceived as truly real, we would be racing to build this alternative, which would be a highly workable defense.
How Current US Missile Defenses Are Supposed to Work
Basic Functional Architecture of a Baseline and Expanded National Missile Defense
Notional GMD Engagement of a Ballistic Missile Attack from North Korea

- Shemya Track Initiation (150+ Seconds)
- Shemya Acquisition
- Initial Clear Acquisition
- Interceptor Launched
- Intercept Point

Track Initiation (150+ Seconds)
The Rise of the “Phased Adaptive Approach” as a Replacement for the European Missile Defense System
The Phased Adaptive Approach Simply Replaces a Small Number of Heavy Ground-Based Interceptors with Numerous Light Sea-Mobile
Orbital Sciences Ground-Based Interceptor and Raytheon Exoatmospheric Kill Vehicle

### Estimated Dimensions and Weight of the National Missile Defense Launch Vehicle

<table>
<thead>
<tr>
<th>Rocket Components</th>
<th>Length (ft)</th>
<th>Diameter (ft)</th>
<th>Component Weight (lbs)</th>
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</thead>
<tbody>
<tr>
<td>Shroud</td>
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<td>4.17</td>
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<tr>
<td>Payload (Kill Vehicle)</td>
<td>–</td>
<td>–</td>
<td>155</td>
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<tr>
<td>Payload Adaptor</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>1st Stage (Orion 50XLG)</td>
<td>33.8</td>
<td>4.17</td>
<td>37,800</td>
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<tr>
<td>2nd Stage (Orion 50XL)</td>
<td>11.7</td>
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<td><strong>Total</strong></td>
<td><strong>51.4</strong></td>
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<td><strong>47,665</strong></td>
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### Estimated Performance Parameters of the National Missile Defense Launch Vehicle

<table>
<thead>
<tr>
<th>Rocket Components</th>
<th>Burn Time (sec)</th>
<th>Vacuum Specific Impulse (sec)</th>
<th>Vacuum Thrust (lbs)</th>
<th>Component Weight (lbs)</th>
<th>Propellant Weight (lbs)</th>
<th>Empty Weight (lbs)</th>
<th>Empty/Full Mass Fraction</th>
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<tr>
<td>Shroud</td>
<td>–</td>
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<td>–</td>
<td>200</td>
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<td>–</td>
<td>0.0000</td>
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<tr>
<td>Payload (Kill Vehicle)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>155</td>
<td>–</td>
<td>–</td>
<td>0.0000</td>
</tr>
<tr>
<td>Payload Adaptor</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.0000</td>
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<tr>
<td>1st Stage (Orion 50XLG)</td>
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<td>296</td>
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<td>37,800</td>
<td>36,480</td>
<td>2,320</td>
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<td>2nd Stage (Orion 50XL)</td>
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<td>289</td>
<td>36,000</td>
<td>9,500</td>
<td>8,880</td>
<td>820</td>
<td>0.0859</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>140</strong></td>
<td>–</td>
<td>–</td>
<td><strong>47,665</strong></td>
<td>–</td>
<td>–</td>
<td>0.0859</td>
</tr>
</tbody>
</table>
Navy Aegis Concept of Operation
Ship Radar Inadequate, Land Radar Marginal, and Interceptor Acceleration and Speed Low

1. Detection by Remote Sensor(s)
2. Surveillance and Track by Remote Sensors
3. Interceptor Launched Before Launch System Radar Detects Threat
4. Launch System Radar Acquires Threat Missile
5. Trajectory Refinement and Intercept by Launch System Radar
• Before Obama took office he expressed skepticism about whether existing science could produce workable missile defenses.

• Once he became President, he decided to “give his opponents what they want” by “pretending his administration had a better idea of how to build such defenses.” (The Phased Adaptive Approach)

• The Obama Administration now says that the better idea is the “Phased Adaptive Approach” to missile defense.

• In reality, the “Phased Adaptive Approach” has no technical merit.
What are the true and expected capabilities of the PAA?

The PAA uses no new technologies relative to the European Missile Defense System that was “put aside” on September 17, 2010 by the Obama Administration.

PAA interceptors home on targets using the same infrared technology that makes the unproven GMD interceptors vulnerable to simple infrared countermeasures.

The PAA radars do not have sufficient average power and aperture area to reliably acquire and track targets in combat.

The radars also provide very limited discrimination capability, as demonstrated by the catastrophic failure of the Sea-Based X-Band radar during the FTG-06 GMD test on January 31, 2010.

All the X-Band radars being used by the PAA, like the FBX, depend on the same science and technology to achieve discrimination.
The SM-3 Block IA Has Only Been Tested on Short Range Trajectories

Yet the Department of Defense Claims that the System is “Proven and Effective” and Can Be Modernized to Deal With Much More Challenging Targets. Like the GMD, It Has Never Been Tested Against Credible Decoys or Other Simple Countermeasures.
PAA Tests Essentially Use Modified Two-Stage Surface-to-Air Missiles, Warheads and SM-3 Interceptors

- GMD Interceptor
- SM-3 Block IA/B
- Orion 50XL Rocket Stage
- SM-3 Block IIA/B
- SM-3 Block IA / IB
- Iranian Sejjil 2000km Range
- Minuteman/Trident/MX Warhead
- Navy Target Missiles for SM-3 Tests
- Launch Gross Weight with 1000 kg Warhead is 21,500 kg
- First Stage Solid Propellant
- Second Stage Solid Propellant
- Exoatmospheric Kill Vehicle

1.7m
1.7m
7.4m
18.21
3m
Current Testing of Missile Defense Systems
All the Interceptors in the GMD and PAA Systems Home on Targets Using Infrared Telescopes
All of the Missile Defense Kill Vehicles Use the Same Infrared Technology to Identify and Home on Targets

Ground-Based Kill Vehicle

≈8.5 in

55 in

Navy Large-Aperture High Divert-Speed SM-3 Block II Kill Vehicle

≈8.5 in
The Same Basic Physics Governs the Homing of All the Kill Vehicles

All the Kill Vehicles Use a Telescope and Infrared Sensors for Homing on Targets
What the US Defense Planner Expects the Kill Vehicle to See
What the Defense Planners Expect the Infrared Sensor on the Homing Interceptor to See
What the US Kill Vehicle Might Actually See
What the Infrared Sensor on the Homing Interceptor Might Actually See!
• The interceptor must know how the warhead looks relative to other objects in its field of view

• This information is essential for matching what it sees to what it expects to see.

• If the warhead appears different from what is expected, the interceptor will not be able to identify it relative to other objects.

• If the other objects match, or nearly match, the expected appearance of the warhead, then the interceptor will not be able to identify the warhead relative to the other objects.

• If all the objects look different from what is expected, and all the objects look different from each other, then the interceptor will not be able to identify the warhead relative to the other objects.

• HENCE, all an adversary needs to do to defeat the interceptor is to alter the appearance of the warhead and surround it with other unidentifiable objects.
False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT)
False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT)

Figure 8.4. The Signature of Fragmented Tanks experiment cut the Stage II of Titan II ICBM B-27 (62-008) into the numerous pieces shown above. The resulting debris cloud was used to test the ability of the Safeguard Anti-Ballistic Missile radar system to discriminate between debris from the upper stage and the reentry vehicle. From David K. Stumpf, “Titan II, A History of a Cold War Missile Program,” The University of Arkansas Press, Fayetteville, Copyright 2000, pages 200-201
**Figure 3:** The images below show how North Korea or Iran could defeat the SM-3 or GMD homing systems by simply using technology they already have demonstrated in flight tests. The technology used to separate rocket stages is exactly the same as that needed to cut a rocket or rocket stage into separate fragments. It would then not be possible for the sensor on the homing interceptor to tell which end of a fragment has the warhead, or which fragment has the warhead. The homing process could be yet further degraded by deploying balloons that would look like warheads to the distant Kill Vehicle. There is no publicly available information that indicates this last countermeasure technology has yet been demonstrated by North Korea or Iran.
Conclusion from US Navy Videos of “Successful Intercepts

Simple countermeasures that disguise the location of the warhead from the infrared homing sensors are very easy to implement and Will Drastically Reduce the Chances of Hitting a Target

These Could Be Used as Decoys
or to Surround Warheads Disguising Them as Balloons

Balloons that Have Been Flown in Space
The Kill Vehicle Must Determine Which of These Are Warheads and Which are Decoys from 50 (SM-3) to Several Hundred (GMD) Kilometers Range!

The IEO, an inflatable erectable decoy for Minuteman (L’Garde, Inc. Photo)

Mk 12A Minuteman III Reentry Vehicle
Why the SM-3 Missile Defense Could Appear to Be Threatening Even Though Its Capabilities are Obviously Limited
Basic Functional Architecture of a Baseline and Expanded National Missile Defense
Navy Aegis Concept of Operation
Ship Radar Inadequate, Land Radar Marginal, and Interceptor Acceleration and Speed Low

1. Detection by Remote Sensor(s)
2. Surveillance and Track by Remote Sensors
3. Interceptor Launched Before Launch System Radar Detects Threat
4. Launch System Radar Acquires Threat Missile
5. Trajectory Refinement and Intercept by Launch System Radar

Launch System (Land- or Sea-based)
Remote Sensor
Engagement Zone
Space Sensor
Locations of the Vertical Launch System Boxes on Two Different Variants of the DDG-51 Navy Destroyer
Basic Characteristics of the Vertical Launch System Components

SM-3 Block IIA
21” Diameter
4,000 – 5000 lb Interceptor
Basic Operational Characteristics of the Vertical Launch System Components
Basic Operational Characteristics of the Vertical Launch System Components

SM-3 Block IA/B Weight ~ 3300 lbs; Block IIA/B ~ 5100 lbs;
Mk 57 Max Encanistered ~ 9020 lbs
Variants of the Aegis SM-3 Interceptor and Kill Vehicles

<table>
<thead>
<tr>
<th>Burnout Speed</th>
<th>Block IA</th>
<th>Block IB</th>
<th>Block IIA</th>
<th>Block IIB</th>
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<tbody>
<tr>
<td>≈ 3 km/sec</td>
<td>Kill Warhead (KW)</td>
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<td></td>
<td>• 1-Color Seeker</td>
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<td></td>
<td>• Divert &amp; Attitude Control System (DACS)</td>
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<td></td>
<td>Stage 2 &amp; 3:</td>
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<tr>
<td></td>
<td>• 13.5” Propulsion</td>
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<td></td>
<td>Stage 1:</td>
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<tr>
<td></td>
<td>• MK 72 Booster</td>
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<tr>
<td></td>
<td>• MK 41 Vertical Launch System (VLS) Compatible</td>
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<tr>
<td>≈ 4.5 km/sec</td>
<td>KW</td>
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<tr>
<td></td>
<td>• 2-Color Seeker</td>
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<tr>
<td></td>
<td>• Improved Optics</td>
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<td></td>
<td>• Advanced Signal Processor</td>
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<td>• Improved DACS</td>
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<td>Stage 2 &amp; 3:</td>
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<td>Stage 1:</td>
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<tr>
<td></td>
<td>• MK 72 Booster</td>
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<td></td>
<td>• MK 41 VLS</td>
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<tr>
<td>≈ 5.5 – 6 km/sec</td>
<td>21” Nosecone</td>
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<tr>
<td></td>
<td>Large Diameter KW</td>
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<tr>
<td></td>
<td>• Advanced Discrimination Seeker</td>
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<td></td>
<td>• High Divert DACS</td>
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<td>Stage 2 &amp; 3:</td>
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<td>• 21” Propulsion</td>
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<td>Stage 1:</td>
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<td></td>
<td>• MK 72 Booster</td>
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<td>• MK 41 VLS</td>
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<td></td>
<td>Stage 2:</td>
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<td>• 21” Propulsion</td>
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<td>Stage 1: Existing MK 72 Booster</td>
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<td>High Performance Upper Stage</td>
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<tr>
<td></td>
<td>Improved KW</td>
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**AEGIS BMD SM-3 EVOLUTION.** The SM-3 is being fielded in “blocks” as technology advances, enabling improved defense through upgrades to the interceptor.
Aegis BMD SM-3 Evolution Plan

<table>
<thead>
<tr>
<th>Block IA</th>
<th>Block IB</th>
<th>Block II</th>
<th>Block IIA</th>
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<tr>
<td>Block 2004</td>
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<tr>
<td>- 1-Color Seeker</td>
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<tr>
<td>- Pulsed DACS</td>
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<tr>
<td>Block 2004</td>
<td></td>
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<tr>
<td>- 2- Color Seeker</td>
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<td></td>
<td></td>
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<tr>
<td>- Increased IR Acquisition</td>
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<td>- Improved Discrimination</td>
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<td>- TDACS</td>
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<td></td>
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<tr>
<td>- Increased Divert</td>
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<td>- Lowers AUR Cost</td>
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<td>- All-Reflective Optics (ARO)</td>
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<td>High Velocity Variant</td>
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<td>- 2nd &amp; 3rd Stage</td>
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<tr>
<td>- Increased Missile Vbo = xx</td>
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<tr>
<td>- 21&quot; Nosecone</td>
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<tr>
<td>- MK 41 VLS Compatible</td>
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<tr>
<td>Block 2012 / 2014</td>
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<td>- Advanced Discrimination Seeker</td>
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<td>- 21&quot; Propulsion</td>
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<td>- 2nd &amp; 3rd Stage</td>
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<td>- 21&quot; Nosecone</td>
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<tr>
<td>- MK 41 VLS Compatible</td>
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Approved for Public Release
06-MDA-1922 (13 SEP 00)
Variants of the Aegis SM-3 Interceptor and Kill Vehicles

<table>
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<th>Model Interceptor Parameters</th>
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<td>Kill Vehicle</td>
</tr>
<tr>
<td>Weight≈1322 lbs</td>
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<tr>
<td>Third Stage Motor</td>
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<tr>
<td>$I_{sp}$≈289 sec</td>
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<td>Weight≈600 lbs</td>
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<td>Weight≈2000 lbs</td>
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<td>Fuel Load≈0.85</td>
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<tr>
<td>First Stage Motor</td>
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<tr>
<td>$I_{sp}$≈220 sec</td>
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<tr>
<td>Weight≈1200 lbs</td>
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<tr>
<td>Fuel Load≈0.75</td>
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Capabilities of the Future 4.5 km/sec and 5.5 km/sec Variants of the SM-3 Block IIA and Block IIB Interceptors to Engage ICBMs
Capabilities of the Future 4.5 km/sec and 5.5 km/sec Variants of the SM-3 Block IIA and Block IIB Interceptors to Engage ICBMs

Locations of All Missiles Shown at One Minute Intervals
Kinematic Capabilities of Future 4.0 km/sec and 4.5 km/sec Variants of the SM-3 Block II Interceptors to Engage ICBMs
Kinematic Capabilities of a 4.5 km/sec SM-3 Block IIA Interceptor

All ICBM Attack Corridors from Russia to the United States Could Be Covered by Suitably Placed SM-3 Aegis-Armed Destroyers

All ICBM and Interceptor trajectory locations marked at one minute intervals.
Kinematic Capabilities of a 4.5 km/sec SM-3 Block IIA Interceptor

All ICBM Attack Corridors from Russia to the United States Could Be Covered by Suitably Placed SM-3 Aegis-Armed Destroyers

All ICBM and Interceptor trajectory locations marked at one minute intervals.
Military planners have the responsibility of looking towards future threats.
  Increase in number and speed of the Interceptors
  Increase in the capabilities and numbers of radars
  Concerns about possible prior damage to nuclear forces from pre-emptive strikes.
  Interceptors with small nuclear weapons

**Result**

Military planners may recognize that the current US missile defense system has limited capabilities, but they will have to consider and plan for possible future expansions and upgrades of the system.

One way to deal with such circumstances would be for China to expand its nuclear forces and to also increase its emphasis on countermeasures.

Hence, the US preoccupation with missile defenses that have little capability could create the worst of two worlds for both China and the US, US defenses that are not reliable, and a Chinese reaction that would be expensive and dangerous to the security of both China and the US.

**An example from history.**

Vast expansion of US nuclear strike forces in response to the Russian Moscow missile defense
A National Defense Strategy Based on Provably False Assumptions

- Assumptions Used by the DoD for GMD Performance Cannot Possibly be Known
  Hence, Actual Performance of the GMD is Unknowable

- The Record of “Proven Reliability” of the Navy’s SM-3 Interceptor Actually Shows that the SM-3 Will Be Highly Unreliable in Actual Combat Conditions

Tony Auth Philadelphia Inquirer, Universal Uclick
If People Were Serious About the Ballistic Missile Threat to the United States – What Could Be Done Instead?
• The Only Long-Range Ballistic Missiles that Can Be Built by Iran and North Korea Would Use Liquid Propellant Rocket Technologies from the 1950s and 1960s.

• These Technologies Use Heavy Airframes, Low Energy Rocket Propellants, and Rocket Motors of that Have Relatively Low Exhaust Velocities (Specific Impulses)

• The Rockets Would Be Very Big – Weighing Between 90 to 120 Tons – and Would Have to be Assembled at Known Launch Sites.

• Hence, They Could Easily Be Targeted and Shot Down Shortly After They Are Launched.
What Are the Prospects for Building a Reliable, Robust, and Intimidating Boost-Phase Ballistic Missile Defense that Could Defend the Continental United States from Strategic Nuclear-Armed ICBM Attack?
Powered Flight Locations of a Titan II / SS-18 Class Liquid Propellant ICBM

- Powered Flight Profile of Large Liquid Propellant ICBM
- Range (km)
- Altitude (km)
- Missile and Debris Locations Shown at 5 Second Intervals

- 60 seconds
- 120 seconds
- 130 seconds
- 140 seconds
- 145 seconds
- 180 seconds
- 300 seconds
ICBM Attack Corridors from Iran to the United States

Washington, DC
Seattle, Washington
Hawaii
Hokkaido, Japan
Coverage Against Unha-2 – Like Large Liquid Propellant with 240 Second + Burn is Possible

5 km/sec Interceptor, ~500 km range in about 100 seconds, Unha-2 Ballistic Missile gets to about 400 km in about 240 seconds

500 km in About 100 Seconds

400 km in About 240 Seconds

Third Stage Burn begins at About 240 Seconds
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Coverage Against Unha-2 – Like Large Liquid Propellant with 240 Second + Burn is Possible
Stealthy Drone That Carries a Payload of 4500 pounds, Which Is More Than Enough to Accommodate Two 2000 pound Interceptors, or a Single Heavier Interceptor

Two Views Showing the Shape of the Northrop X-47B Stealthy Pilotless Drone

This particular drone can carry a payload of 4500 pounds, which is more than enough to accommodate two 2000 pound interceptors, or a single heavier interceptor. The heavier interceptor might be more desirable for situations where an interceptor burnout speed in excess of 5 km/s is desired. Smaller interceptors would probably have burnout speeds of perhaps 4 to 4 1/2 km/s. These lower burnout speeds may well be adequate.
Estimate of the Radar Cross Section of a 50 Meter Wing Span B-2 Like Aircraft

Radar cross-sections that are less than 0.01 m² are certainly achievable. Such small radar cross-sections require not only that the aircraft have a shape that does not strongly reflect radar signals, but it also requires that the aircraft be covered with radar absorbing material. A bare skinned version of this aircraft would have a small radar cross-section, but it would still be roughly 10 times larger relative to a similarly shaped aircraft constructed with radar absorbing materials.

Radar cross-section estimates from: Computer Simulation of Aerial Target Radar Scattering, Recognition, Detection and Tracking, Yakov D. Sherman, Editor, Artech House, 2002
• The system requires only a small number of drones, each carrying one, or perhaps two interceptors.
• A fleet of less than ten drones would be more than sufficient to keep four to five drones constantly on station.
• These drones could routinely operate outside of the national boundaries of the target state, and could not be regularly observed or tracked by air-defense radars.
• The system would have a very high intercept probability against long-range ballistic missile launches.
• It would only have to operate when a long-range ballistic missile has been set up for launch.
• The system could be diverted towards Russian or Chinese strategic missile forces, but it would have to operate within Russian and Chinese airspace and only a very small number of the total number of drones could be kept on-station.
• Because the number of drones that could be kept on station would be very small, and each drone carries only one or two interceptors, the system could never have more than a negligible shoot-down capability against Russian or Chinese long-range ballistic missile forces.
• The system does not address the threats from shorter range ballistic missiles; those must be addressed by other means.
Radar Search, Acquisition and Tracking Capabilities in the Phased Adaptive Approach is Very Weak
Aegis Cruiser and Destroyer Radar System

Radar Characteristics
Average Power per Radar Face = 58 KW
Face Area = 12 M²
3.3 GHz Frequency (S-Band)
Assumed System Losses = 10
Known System Temperature = 500°K

Estimated Performance per Dwell
Range Against 1M² Target ≈ 900 – 1000 km
(Single 0.1 Second Dwell)
Coherent S/N = 56, Incoherent S/N ≈ 20 -25
Range Against 0.01M² Target ≈ 250 – 300 km
(Single 0.1 Second Dwell)
Coherent S/N = 56, Incoherent S/N ≈ 15 -20
Beam Width:
1.5° × 1.5° ≈ 2 Square Degrees per Dwell
Comparison of the Relative Sizes and Average Power of the Fylingsdale UEWR, the GLOBUS II Radar at Vardo, Norway, and the Forward-Based X-Band (FBX) Radar

**UEWR**

- **PAVE PAWS**
  - 31 meter Diameter
  - ~ 755 m² Antenna Area
  - 150 KW
  - Average Power
    - \( PA = 113 \times 10^6 \text{ W} \cdot \text{m}^2 \)
    - \( PA \sigma = 65 \times 10^6 \text{ W} \cdot \text{m}^4 \)
    - \( \sigma = 0.5 \text{ m}^2 \)

**FBX**

- 9.2 m² Antenna Area
- 30 – 70 KW
- Average Power
  - \( PA = 0.7 \times 10^6 \text{ W} \cdot \text{m}^2 \)
  - \( PA \sigma = 0.007 \times 10^6 \text{ W} \cdot \text{m}^4 \)
  - \( \sigma = 0.01 \text{ m}^2 \)

**GLOBUS II**

- 27 meter Diameter
- ~ 570 m² Antenna Area
- 150 KW
- Average Power

**Aegis Radar**

- Average Power per Radar Face = 58 KW
- Face Area = 12 m²
- 3.3 GHz Frequency (S-Band)
Radar Cross Section of Large Round-Nose Warhead

Nose-On View 0 Degrees
Back-On View 180 Degrees
Side-On View 180 Degrees

UHF Radar Cross versus Look Angle
400 to 500 MHz (UEWR)

X-Band Radar Cross versus Look Angle
10,000 MHz (10 GHz)
The operating frequency of Russia’s Early Warning Radars was chosen so that the radar reflectivity of warheads approaching Russia would be as large as possible, thereby making it easier for the radars to detect the approaching warheads at very long range. However, a serious drawback associated with radars operating at these frequencies is that they highly vulnerable to blackout effects from high-altitude nuclear explosions.
The Forward-Based X-Band Radar (FMX) Has Limited Acquisition Abilities Against 0.01 m² Cone-Shaped Warheads at Ranges Greater Than 600 to 700 km and Against 0.001 m² Targets at Ranges Greater Than 300 to 400 km
FBX Range \(\approx 1300\) km against Targets with RCS 0.1 m\(^2\) to 0.2 m\(^2\) Targets
FBX Range ≈1300 km Against Targets with RCS 0.1 m² to 0.2 m² Targets
PAA Missile Defense Targets and Interceptors

- GMD Interceptor
- SM-3 Block IA/B
- Orion 50XL Rocket Stage
- Orion 50XLG Rocket Stage
- Exoatmospheric Kill Vehicle

SM-3 Block IIA/B

Iranian Sejjil 2000km Range

Launch Gross Weight with 1000 kg Warhead is 21,500 kg

First Stage Solid Propellant
Second Stage Solid Propellant

Minuteman/Trident/MX Warhead

Navy Target Missiles for SM-3 Tests

SM-3 Block IA / IB

Launch Gross Weight with 1000 kg Warhead is 21,500 kg

First Stage Solid Propellant
Second Stage Solid Propellant

Minuteman/Trident/MX Warhead

Navy Target Missiles for SM-3 Tests

SM-3 Block IA / IB

Launch Gross Weight with 1000 kg Warhead is 21,500 kg

First Stage Solid Propellant
Second Stage Solid Propellant

Minuteman/Trident/MX Warhead

Navy Target Missiles for SM-3 Tests

SM-3 Block IA / IB
### Other Possible Targets for the PAA Missile Defense

<table>
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<tr>
<th>Range (km)</th>
<th>Missile</th>
<th>Length (m)</th>
<th>Propellant (kg)</th>
<th>Density (kg/m³)</th>
<th>Oxidizer to Fuel Volume</th>
<th>Oxidizer to Fuel Weight</th>
<th>Actual Density (kg/m³)</th>
<th>Launch Gross Weight (kg)</th>
<th>Warhead (kg)</th>
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<td>3.4</td>
<td>1326.6</td>
<td>36,220</td>
<td>1,000</td>
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- **SCUD-C**
  - Length: 15.5 m
  - Propellant: 4,300 kg
  - Density: 1252.5 kg/m³
  - Oxidizer to Fuel Volume: 1.83
  - Oxidizer to Fuel Weight: 3.4
  - Actual Density: 1326.6 kg/m³
  - 0.944 of Fuel Tank Volume Filled

- **Nodong**
  - Length: 18.21 m
  - Propellant: 7,400 kg
  - Density: 1252.5 kg/m³
  - Oxidizer to Fuel Volume: 1.83
  - Oxidizer to Fuel Weight: 3.4
  - Actual Density: 1326.6 kg/m³

- **Shahab-2**
  - Length: 10.9 m
  - Propellant: 12,400 kg
  - Density: 1252.5 kg/m³
  - Oxidizer to Fuel Volume: 1.83
  - Oxidizer to Fuel Weight: 3.4
  - Actual Density: 1326.6 kg/m³

- **Shahab-3**
  - Length: 15.5 m
  - Propellant: 4,300 kg
  - Density: 1252.5 kg/m³
  - Oxidizer to Fuel Volume: 1.83
  - Oxidizer to Fuel Weight: 3.4
  - Actual Density: 1326.6 kg/m³
Notional Intercept Trajectory of Standard Missile 3 Block IA/B (SM-3 Block IA/B) Against 2000 km Range Iranian Ballistic Missile

Obama Missile Defense Plan (Announced on Thursday, September 17, 2009)

Trajectories Show Missile Locations at One-Minute Intervals

SM-3 Block IA/B Interceptor Launched from Mediterranean

2000 km Range Ballistic Missile Launched from Iran
Notional Intercept Trajectory of Standard Missile 3 Block IA/B (SM-3 Block IA/B) Against 2000 km Range Iranian Ballistic Missile

Trajectories Show Missile Locations at One-Minute Intervals

SM-3 Block IA/B Interceptor Launched from Mediterranean

Location of Ballistic Missile When SM-3 Interceptor is Launched

2000 km Range Ballistic Missile Launched from Iran

Egypt
Sudan
Ethiopia
Somalia
Saudi Arabia
Arabian Sea
Afghanistan
Pakistan

Iran
Notional Intercept Trajectory of Standard Missile 3 Block IA/B (SM-3 Block IA/B) Against 2000 km Range Iranian Ballistic Missile

Trajectories Show Missile Locations at One-Minute Intervals

2000 km Range Ballistic Missile Launched from Iran

Location of Ballistic Missile When SM-3 Interceptor is Launched

SM-3 Block IA/B Interceptor Launched from Mediterranean

Mediterranean

Italy

Sicily

Greece

Turkey

Israel

Egypt

Libya
Testing Issues Directly Relevant to GMD and PAA Performance in Real Combat Conditions
EXTREMELY IMPORTANT INFORMATION NEEDED BY THE INTERCEPTOR TO IDENTIFY WHICH OBJECT IS THE WARHEAD

• The interceptor must know how the warhead looks relative to other objects in its field of view

• This information is essential for matching what it sees to what it expects to see.

• If the warhead appears different from what is expected, the interceptor will not be able to identify it relative to other objects.

• If the other objects match, or nearly match, the expected appearance of the warhead, then the interceptor will not be able to identify the warhead relative to the other objects.

• If all the objects look different from what is expected, and all the objects look different from each other, then the interceptor will not be able to identify the warhead relative to the other objects.

• HENCE, all an adversary needs to do to defeat the interceptor is to alter the appearance of the warhead and surround it with other unidentifiable objects.
Current Testing of Missile Defense Systems

Last Five SM-3 Tests are Exact Replicas of the Same Experiment

Even Though The Tests Were Exact Replicas of the same Simplified Experiment, the DoD Advised the President that the Tests Prove that the SM-3 Would be Effective Against Varied Missile Targets

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**Exact Replicas of the Same Experiment**

- Targets exactly the same length
- Warheads located in the same position
- Tail fins large and located in same position
- Targets always perpendicular to the line-of-sight of the closing interceptor
- Tall fins allow identification of front from back ends
- Targets not tumbling perpendicular to interceptor line-of-sight
- Targets not tumbling in direction of interceptor line-of-sight
- Targets not broken into multiple pieces
- Warhead locations and appearances not distorted by inflated balloons
- Gulf War of 1991 – Targets Tumbled at High Altitudes, Targets Broke Into Pieces During Interceptor Homing

Last Five Experiments
Exact Replicas of the Same Experiment
Current Testing of Missile Defense Systems

Time to Impact

Less than 0.1 seconds to Impact
- Full Video Frame
- Full Video Frame
- Full Video Frame

Roughly 0.5 seconds to Impact
- Full Video Frame
- Magnified Image
- Magnified Image

Roughly 1.0 seconds to Impact
- Full Video Frame
- Magnified Image
- Magnified Image
False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT)

Booster Fragmentation
False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT)

Figure 8.4. The Signature of Fragmented Tanks experiment cut the Stage II of Titan II ICBM B-27 (62-008) into the numerous pieces shown above. The resulting debris cloud was used to test the ability of the Safeguard Anti-Ballistic Missile radar system to discriminate between debris from the upper stage and the reentry vehicle. From David K. Stumpf, "Titan II, A History of a Cold War Missile Program," The University of Arkansas Press, Fayetteville, Copyright 2000, pages 200-201

6 Ft Man and Minuteman Warhead

Booster Fragmentation
False Targets Cloud Created by a “Simple” One-Stage Ballistic Missile

Figure 3: The images below show how North Korea or Iran could defeat the SM-3 or GMD homing systems by simply using technology they already have demonstrated in flight tests. The technology used to separate rocket stages is exactly the same as that needed to cut a rocket or rocket stage into separate fragments. It would then not be possible for the sensor on the homing interceptor to tell which end of a fragment has the warhead, or which fragment has the warhead. The homing process could be yet further degraded by deploying balloons that would look like warheads to the distant Kill Vehicle. There is no publicly available information that indicates this last countermeasure technology has yet been demonstrated by North Korea or Iran.
Current Testing of Missile Defense Systems
Current Testing of Missile Defense Systems

Rotation Rate
2.5 Revolutions per Minute

Rotation Rate
5 Revolutions per Minute

Rotation Rate
7.5 Revolutions per Minute

Warhead Locations After One Second
Conclusion from US Navy Videos of “Successful Intercepts

Simple countermeasures that disguise the location of the warhead from the infrared homing sensors are very easy to implement and will drastically reduce the chances of hitting a target.

These could be used as decoys
or to surround warheads disguising them as balloons.

Balloons that have been flown in space.
The Kill Vehicle Must Determine Which of These Are Warheads and Which are Decoys from 50 (SM-3) to Several Hundred (GMD) Kilometers Range!

The IEO, an inflatable erectable decoy for Minuteman (L'Garde, Inc. Photo)

Mk 12A Minuteman III Reentry Vehicle
What the Failure of the January 31, 2010 FTG-06 Missile Defense Test Shows About the Vulnerability of the X-Band Radars Abilities to Identify Warheads Relative to Decoys
NOTE:

All of the US Missile Defense Systems (GMD and SM-3) Depend on X-Band Radars to Identify Warheads Relative to Decoys
• The solid propellant upper rocket stage, which deployed the warhead, and possibly other objects, exhibited an unexpected phenomenon known as “chuffing.”

• When a solid rocket motor burns out, sections of the remaining fuel in the spent rocket stage can spontaneously combust, causing tens or hundreds of mini-explosions per second in the shut down motor.

• This phenomenon can cause chunks of unburned fuel, insulator material, and the like to be expelled from the shut down rocket.

• The chunks of expelled rocket motor pieces have dimensions of less than one inch to 6 to 8 inches or more.

• From the point of view of the motor’s mission, to accelerate a payload to a given velocity and altitude, this is an inconsequential phenomenon.
Potential Sources of TBM Natural/Countermeasure Debris

I. Non-Separated Payloads

(a) Liquid Fuel (Little or No Debris)
(b) Chuffing
(c) Reentry Breakup

II. Separated Payloads

(a) RV, Tank with Deployment Debris
(b) Solid Fuel

III. Intentional Exo Tank Breakup

(a) Fragment Cloud
(b) Fragmentation/Detonation

IV. Intercept

(b) Segmentation

MIT Lincoln Laboratory
Why Did the FTG-06 Missile Defense Test Fail?

- In the FTG-06, the chuffing rocket motor expelled chunks of material that created numerous radar signals comparable in magnitude to the radar signal from a warhead.
- The radar signal therefore contained numerous unexpected targets.
- This “scene data” was passed to computers that were programmed to look for a scene that was expected.
- Since the scene was totally unexpected, the computer analysis failed catastrophically, resulting in a failure to identify the warhead, and possibly even a failure to properly track the entire complex of targets.
Why Did the FTG-06 Missile Defense Test Fail?

Conclusion that follows from the FTG-06 Failure

- This failure reveals the fundamental vulnerability to catastrophic failure of the GMD, SM-3 and all similar such systems.
- An adversary can inadvertently, or by design, change the scene and target appearance using simple measures, like cutting the upper stage into pieces.
- The adversary can also change the appearance of the warhead by covering it with radar absorbing materials, or surrounding it with a balloon, or by yet other methods, with totally devastating consequences for the defense.
Missile Defense Agency’s Claimed Solution to the Problem

- Measure the “length” of the different targets observed by the X-Band radar.
- Pieces of rocket fuel will have lengths of centimeters and warheads will have lengths of meters.
- All of the short objects can be immediately rejected as not being a warhead.
- In radar terminology, this process is called “Bulk Filtering”
Radar Discrimination Capabilities

**Narrowband**

Mean Unresolved RCS vs Scintillation Frequency

**Wideband**

Mean Unresolved RCS vs Length

---

MIT Lincoln Laboratory

EDE-GR32-114
12/9/99
How the Missile Defense Agency’s Claimed Solution Can Be Readily Defeated

Make it *impossible* to measure the “length” of the warhead!
Examples of Radar Signals from Warheads

C-Band (5GHz) Radar Signal Against 1.5 Meter Long Warhead

X-Band (10GHz) Radar Signal Against 1.5 Meter Long Warhead
X-Band (10GHz) Radar Can Measure the Length of the Warhead
Some Aspects of Radar Measurement Capabilities

X-Band (10GHz) Radar Cannot Measure the Length of the Warhead
Briefing on Theater Missile Defense Technology Provided to Military Officers Visiting the MIT Security Studies Program in 1999 for Command School Training

MISSILE DEFENSE TECHNOLOGY
(Can BMD Systems Work?)

Eric D. Evans
MIT Lincoln Laboratory

Mini DTS Course

10 December 1999
What the Failure of the July 8, 2000 IFT-05 Missile Defense Test Shows About the Vulnerability of the GMD and SM-3 Systems to Infrared Countermeasures
IFT-6 Target Complex as Seen By Distant Approaching EKV

Range of Observed Target Complex ~ 230 – 250 km for FOV 1 – 1.5°

- 2.2 Meter Diameter Balloon (Roughly Ten Times Brighter than the Mock Warhead)
- Mock Warhead
- Rocket Stage that Deployed the Mock Warhead and Balloon

The Inflated Balloon is Heated by the Sun and is 7 to 10 Times Brighter Than the Warhead at Infrared Wavelengths.

The Kill Vehicle Has Been Programmed In Advance to Select the Least Bright Object It Is Supposed to See. As Long As Nothing Is Done to Cause Another Object to Be the Least Bright Object, the Kill Vehicle Will Correctly Select the Warhead.
"So the decoy is not going to look exactly like what we expected. It presents a problem for the system that we didn't expect,"

Statement of
Lieutenant General Ronald Kadish,
Director of the Ballistic Missile Defense Organization, while being filmed by 60 Minutes II after learning that the 2.2 meter balloon misdeployed (did not inflate properly) during the IFT-5 experiment
IFT-6 Target Complex as Seen By Distant Approaching EKV

Range of Observed Target Complex ~ 230 – 250 km for FOV 1 – 1.5°

In The IFT-5, The Balloon Failed to Inflate, So Only the Canister, Instead of the Hot Inflated Balloon, Would Have Been Observed By the Kill Vehicle.
Since the Cannister Has a very Small Signal in the Infrared, It Is Now the Least Bright Object Observed by the Kill Vehicle
Hence, The Kill Vehicle Would Now Select the Cannister as the Warhead

2.2 Meter Diameter Balloon
(Roughly Ten Times Brighter than the Mock Warhead)

Mock Warhead

Rocket Stage that Deployed the Mock Warhead and Balloon

~3 km

~3.5 km
Sequence of Events During Deployment of a Space-Balloon Decoy (1 of 3)
Sequence of Events During Deployment of a Space-Balloon Decoy (2 of 3)

1. Deployed Balloon Decoy
2. Piece of Balloon Packaging
3. Balloon Unfolding from Canister
4. Canister Being Deployed from Mission Service Launch System
5. Spherical Section Formed by the Injection of Gas from the Deployment Canister
6. Balloon Deployment Canister in the Shadow of the Mission Service Launch System
7. Section of Balloon that is in the Sun-Shadow of Mission Service Launch System
8. Section of Balloon that is Not Yet Inflated
9. Unfused Balloon Section that is Not Yet Inflated
10. Spherical Section Formed by the Injection of Gas from the Deployment Canister
11. Balloon Deployment Canister in the Shadow of the Mission Service Launch System
12. Sun-Shadow from Mission Service Launch System Continues to Diminish As Balloon Moves Away into Full Sunlight
13. Note Reflecting Rough Surface of the Balloon
14. Note Stripes on the Balloon
15. Fully Inflated Balloon
16. Note Reflecting Rough Surface of the Balloon
17. Balloon Deployment Canister Fully Illuminated by the Sun
Balloon As It Continues to Move Away from the Mission Service Launch System
Sequence of Events During Deployment of a Space-Balloon Decoy (2A of 3)

1. Deployed Balloon Decoy
2. Spherical Section Formed by the Injection of Gas from the Deployment Canister
3. Balloon Deployment Canister in the Shadow of the Mission Service Launch System
4. Spherical Section Formed by the Injection of Gas from the Deployment Canister
5. Section of Balloon that is in the Sun-Shadow of Mission Service Launch System
6. Section of the Balloon Illuminated by Sunlight
7. Sun-Shadow from Mission Service Launch System Continues to Diminish As Balloon Moves Away into Full Sunlight
8. Note Reflecting Rough Surface of the Balloon

1. Piece of Balloon Packaging
2. Balloon Unfolding from Canister
3. Canister Being Deployed from Mission Service Launch System
4. Section of Balloon that is Not Yet Inflated
5. Unfolded Balloon Section that is Not Yet Inflated
6. Fully Inflated Balloon
7. Note Stripes on the Balloon

1. Balanced Ballon
2. Piece of Balloon Packaging
3. Balloon Unfolding from Canister
4. Canister Being Deployed from Mission Service Launch System
5. Section of Balloon that is in the Sun-Shadow of Mission Service Launch System
6. Section of the Balloon Illuminated by Sunlight
7. Note Reflecting Rough Surface of the Balloon

1. Sun-Shadow from Mission Service Launch System Continues to Diminish As Balloon Moves Away into Full Sunlight
2. Note Reflecting Rough Surface of the Balloon
3. Note Stripes on the Balloon

TMD Countermeasure Concepts

- Tumbling target
  - Missile or RV

- Multiple objects
  - Frag/Segmentation, CSOs

- Orientation control
  - RV pointing or spin-up

- Anti-cueing tactics
  - Depl. stage disposal

- Maneuvers
  - Evasive corkscrew, etc.

- Submunitions
  - Early Release, CW, BW

- Signature control
  - Low RCS, IR coatings

- Enveloping structure(s)
  - Extended targets...

- Masking
  - Chaff, Flares, Corner Cubes

- Decoys
  - Radar, IR

- Jammers
  - Escort, barrage, repeaters

- Other
  - Suites, ARMs, EMP...
IR Seeker Discrimination Capabilities

One - Color IR Seeker
Metrics: Mean IR Signature Scintillation Rate

Two - Color IR Seeker
Metrics: Emissivity - Area Temperature
What the Failure of the June 1997 and January 1998 IFT-1A and IFT-2 Missile Defense Tests Show About the Vulnerability of the GMD and SM-3 Systems to Infrared Countermeasures
Fraudulent Testing of Missile Defense Systems


Source: Theodore A. Postol, M.I.T.
New York Times Reports Major Fraud in Missile Testing in Front Page Story

Critics Maintain Pentagon Has Been Rigging Antimissile Tests to Hide a Crucial Flaw

Bar Reported Rigged For Missile Defense Tests

The Department of Defense of the United States has been accused of rigging antimissile tests to hide a crucial flaw. The New York Times reported that the Department of Defense has been using deceptive testing methods to ensure that their antimissile systems are effective, even though they may not be. The report has caused a major controversy, with many calling for an investigation into the testing methods used by the Department of Defense.

Julia 3003 Test: Decoy Replaced

All new decoy are modeled to be featureless so they have no effect on the test size, remaining in the radar detector and causing it to look undetected.

KEEPING TRACK

Bar Report

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Julia 3003 Test: Decoy Replaced

All new decoy are modeled to be featureless so they have no effect on the test size, remaining in the radar detector and causing it to look undetected.
Purpose of the Baseline Algorithm (BLA)

• Identify Known Objects by matching *Expected* Appearance to *Observed* Appearance.

• Similar to Visually Identifying Suitcases at an Airport
# Objects Flown in the IFT-1A and IFT-2 NMD Tests

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>LARGEBAL</td>
<td>Large Balloon (2.2 Meter Diameter Balloon)</td>
</tr>
<tr>
<td>SCLR</td>
<td>Small Canisterized Light Replica (Balloon)</td>
</tr>
<tr>
<td>MEDBALA</td>
<td>Medium Balloon A (0.6 Meter Diameter Balloon)</td>
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<tr>
<td>MEDBALB</td>
<td>Medium Balloon B (0.6 Meter Diameter Balloon)</td>
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<td>MEDRLR1</td>
<td>Medium Rigid Light Replica 1 (2 Meters Long &amp; 0.6 Meter Base)</td>
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<tr>
<td>MEDRLR2</td>
<td>Medium Rigid Light Replica 2 (2 Meters Long &amp; 0.6 Meter Base)</td>
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<tr>
<td>MSLS</td>
<td>Mission Service Launch System (Rocket Upper Stage)</td>
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<tr>
<td>SCTBA</td>
<td>Small Cannisterized Traffic Balloon A (Small Balloon)</td>
</tr>
<tr>
<td>SCTBB</td>
<td>Small Cannisterized Traffic Balloon B (Small Balloon)</td>
</tr>
<tr>
<td>MRV</td>
<td>Medium Reentry Vehicle (2 Meters Long &amp; 0.6 Meter Base)</td>
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</table>
Non-Gaussian Behavior of the Data from the IFT-1A Experiment

Expected Values (One-σ Ellipse) for the Composite Intensity and Fluctuation in Composite Intensity for IFT-1A Target Set

Target's Infrared Intensity (J)

Fluctuation in the Target's Infrared Intensity (ΔJ / J)

Reference:
Transparent Overlay of Figures 4 and 5 from the POET Report 1998-5
UNCLASSIFIED

TSRD TARGET REQUIREMENTS SUMMARY (IFT-1 – 1FT-4) (U)

IFT 1&2
SENSOR FLIGHT TESTS
AUG 96 / NOV 96

1 MED RV (I)
2 MED RIGID LIGHT REPLICA (MRLR) (I)
2 MED BALLOONS (MB) (U)
1 CANISTERIZED LIGHT REPLICA (CLR) (I)
2 CANISTERIZED TRAFFIC BALLOONS (CTB) (I)
1 LG BALLOON (LB) (U)

IFT 3&4
EKV FLIGHT TESTS
OCT 97 / JAN 98

1 MED RV (I)
2 MED RIGID LIGHT REPLICA (MRLR) (I)
3 MED BALLOONS (MB) (U)
1 CANISTERIZED LIGHT REPLICA (CLR) (I)
2 CANISTERIZED TRAFFIC BALLOONS (CTB) (I)
1 LG BALLOON (LB) (U)

9 OBJECTS IN 1 CLUSTER

10 OBJECTS IN 3 CLUSTERS
After First Test Failed, All Subsequent Tests Rigged to Avoid the Further Failures
After First Test Failed, All Subsequent Tests Rigged to Avoid the Further Failures

**IFT TARGETS SELECTIONS AS OF 05/05/00 (U)**

| Date mmmyy | IFT # | MRV | LB | CSB-1 | CSB-2 | MB | MRLR | SCLR | LSB | SSB-A | SSB-B | MTRV | IRB-1 | IRB-2 | IRB-3 | IRB-4 | IRB-5 | RB-1 | RB-2 | GROW | MLRV |
|------------|-------|-----|----|-------|-------|----|------|------|-----|-------|-------|------|-------|-------|-------|-------|-------|------|------|------|------|------|
| 06/97      | 1A    | 1   | 1  | 1     | 1     | 2  | 2    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 01/98      | 2     | 1   | 1  | 1     | 1     | 2  | 2    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 10/99      | 3     | 1   | 1  | 1     | 1     | 1  | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 01/00      | 4     | 1   | 1  | 1     | 1     | 1  | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 06/00      | 5     | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 09/00      | 6     | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 01/01      | 7     | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 05/01      | 8     | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 08/01      | 9     | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 11/01      | 10    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 03/02      | 11    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 06/02      | 12    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 11/02      | 13    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 03/03      | 14    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 06/03      | 15    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 11/03      | 16    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 02/04      | 17    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 06/04      | 18    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 11/04      | 19    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 03/05      | 20    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |
| 05/05      | 21    | 1   | 1  | 1     | 1     |   | 1    | 1    | 1   |       |       |      |       |       |       |       |      |      |      |      |      |      |

**Notes:**
- Scintillating Targets Removed from Test Program
- Scintillating Stripes Removed
- Strongly Scintillating Tumbling Warhead
- OTA Tests

Configuration controlled by NMD JPO – Do not alter this document
Opening Statement By Lieutenant General Lester L. Lyles, USAF
Director, Ballistic Missile Defense Organization
before the Subcommittee on Defense Committee on Appropriations (April 22, 1998)
"During the past year, Mr. Chairman, we conducted two very successful NMD exoatmospheric kill vehicle - or EKV - flight tests. Two different industry teams supported those efforts and are competing against each other. We demonstrated in those initial tests that we can use an EKV sensor to identify and track objects in space - including threat representative targets and decoys - and allow us to discriminate and determine what is an actual target and what is not."

Statement of
Lieutenant General Ronald T. Kadish, USAF
Director, Ballistic Missile Defense Organization
Before the
House Armed Services Committee
Subcommittee on Military Research & Development
Thursday, June 22, 2000

This significant countermeasures package [in the IFT-1A and IFT-2 experiments] contained more objects than the countermeasures packages we employed during IFT-3 and IFT-4 because we wanted to see how well the EKVs could discriminate within the target complex and identify the warhead. We gathered an immense amount of data that increased our confidence in our ability to meet the discrimination challenge. IFT-1A and 2 demonstrated a robustness in discrimination capability that went beyond the baseline threat for purposes of designing the Expanded C-1 system.

This phase began with IFT-3, a partially integrated intercept test, when we successfully demonstrated our ability to do on-board discrimination and target selection as well as hit-to-kill.
EKV prototypes discriminate 'spectacularly well,' Boeing NMD chief says

Inside Missile Defense, September 30, 1998 -

"[The] particular target complex that these seekers were launched against was a quite sophisticated target complex, far more than we have to handle for an initial deployment," Peller noted. "Without going into details let me say that each seeker, using its own discrimination algorithms, positively nailed the reentry vehicle identified in the set of all those objects. . . . It picked it all up -- objects of all types," he said.

"We went from the case of not having any demonstrated optical discrimination to all of a sudden having an abundance of it."

BMDO BEGINS 'ORDERLY PHASEOUT' OF BOEING BACKUP NMD KILL VEHICLE

Inside Missile Defense, May 19, 2000 -

"We found that in both cases we were able to pick the reentry vehicle out of the target complex. There was just some minor adjustments done after that based on what they learned, but with the data that they had, they were able to pick it out in both cases."

Data from those tests will benefit the NMD program over the next 10 years, Englander noted.
All the Interceptors in the GMD and PAA Systems Home on Targets Using Infrared Telescopes
The Same Basic Physics Governs the Homing of All the Kill Vehicles

All the Kill Vehicles Use a Telescope and Infrared Sensors for Homing on Targets
What the US Defense Planner Expects the Kill Vehicle to See
What the Defense Planners Expect the Infrared Sensor on the Homing Interceptor to See
What the US Kill Vehicle Might Actually See
What the Infrared Sensor on the Homing Interceptor Might Actually See!
The interceptor must know how the warhead looks relative to other objects in its field of view.

This information is essential for matching what it sees to what it expects to see.

If the warhead appears different from what is expected, the interceptor will not be able to identify it relative to other objects.

If the other objects match, or nearly match, the expected appearance of the warhead, then the interceptor will not be able to identify the warhead relative to the other objects.

If all the objects look different from what is expected, and all the objects look different from each other, then the interceptor will not be able to identify the warhead relative to the other objects.

HENCE, all an adversary needs to do to defeat the interceptor is to alter the appearance of the warhead and surround it with other unidentifiable objects.
False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT)

Booster Fragmentation
False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT)

Figure 8.4. The Signature of Fragmented Tanks experiment cut the Stage II of Titan II ICBM B-27 (62-008) into the numerous pieces shown above. The resulting debris cloud was used to test the ability of the Safeguard Anti-Ballistic Missile radar system to discriminate between debris from the upper stage and the reentry vehicle. From David K. Stumpf, "Titan II, A History of a Cold War Missile Program," The University of Arkansas Press, Fayetteville, Copyright 2000, pages 200-201
False Targets Cloud Created by a “Simple” One-Stage Ballistic Missile

Figure 3: The images below show how North Korea or Iran could defeat the SM-3 or GMD homing systems by simply using technology they already have demonstrated in flight tests. The technology used to separate rocket stages is exactly the same as that needed to cut a rocket or rocket stage into separate fragments. It would then not be possible for the sensor on the homing interceptor to tell which end of a fragment has the warhead, or which fragment has the warhead. The homing process could be yet further degraded by deploying balloons that would look like warheads to the distant Kill Vehicle. There is no publicly available information that indicates this last countermeasure technology has yet been demonstrated by North Korea or Iran.
Current Testing of Missile Defense Systems
Balloons that Could Be Used to Make the Warhead Look Different from What is Expected

These Could Be Used as Decoys or to Surround Warheads Disguising Them as Balloons

Balloons that Have Been Flown in Space
The Kill Vehicle Must Determine Which of These Are Warheads and Which are Decoys from 50 (SM-3) to Several Hundred (GMD) Kilometers Range!

The IEO, an inflatable erectable decoy for Minuteman (L’Garde, Inc. Photo)

Mk 12A Minuteman III Reentry Vehicle
Most Recent MDA Misrepresentation

The SM-3 is a “Ballistic Missile Defense System [that] has *demonstrated 20 hit-to-kill intercepts* [italics added] out of 24 at sea firing attempts.” **

** MDA Fact Sheet, November 24, 2009 09-MDA-5060
Other Problems with the Homing Process
The Kill Vehicle Must Hit the Warhead to Destroy It

Bullet Passes Through an Empty Container

Bullet Creates A Shock as It Passes Through the Material in a Filled Container
Predictions Made by the Missile Defense Agency for a Hit on US Satellite 193 that Misses and Hits a Full Hydrazine Tank in the Satellite

**Predicted Infrared Image for a Kill Vehicle Hit that Misses the Satellite’s Hydrazine Tank**

**Predicted Infrared Image for a Kill Vehicle Hit that Strikes the Satellite’s Hydrazine Tank**
Actual Infrared Image of the Kill Vehicle Hit on US Satellite 193

Actual Infrared Image for the Kill Vehicle Hit that Struck the Satellite’s Hydrazine Tank
Real World Event
Satellite Intercept – 20 FEB 08

- **Objective**
  - Protect against potential loss of life due to uncontrolled reentry of ~ 5,400 lb (2,450 kg) satellite
  - Destroy ~ 1,000 lbs (450 kg) hydrazine fuel tank

- **Preparation**
  - 3 Standard Missiles-3 (SM-3), radars and system software extensively modified to enable intercept

- **Engagement**
  - 1 SM-3 launched by USS Lake Erie northwest of Hawaii
  - Successful intercept occurred ~153 miles (250 km) above the earth verified by 3 different phenomenologies

- **Post Intercept**
  - Analysis (as of 25 FEB 08) shows vast majority of intercept debris has already burned up upon reentering the Earth’s atmosphere, or will do so shortly – there have been no reports of debris landing on earth
  - The 3 Aegis ships have already been reconfigured to support BMD mission
Results of U.S. Standard Missile 3 Flight Tests

A. MISS  January 25, 2002  FM-2
B. MISS  June 13, 2002  FM-3
C. MISS  November 21, 2002  FM-4
D. DIRECT HIT  December 11, 2003  FM-6
E. POTENTIAL HIT  February 24, 2005  FM-7
F. MISS  April 26, 2007  FTM-11
G. MISS  November 6, 2007  Target 1, FTM-13
H. MISS  November 6, 2007  Target 2, FTM-13
I. MISS  November 1, 2008  Pacific Blitz
J. MISS  July 30, 2009  FTM-17

These images show the estimated hit points in 10 SM-3 flight tests that the Pentagon’s Missile Defense Agency (MDA) reported as successful hits. In eight to nine of these successful flight tests, the warhead, which must be struck directly by the kill vehicle to guarantee its destruction, was not hit. The warhead is the cone-shaped section on the front end of the rocket. (The images are from MDA video; the authors of this article added the red crosses indicating the estimated hit points and the text characterizing the test as a “miss,” “potential hit,” or “direct hit.”)
Most Recent Concrete Example

Misrepresenting the SM-3 system test results to the press, and almost certainly to the President and the Secretary of Defense.

"There were subsequent views not publicly released to preclude potential adversaries from seeing exactly where the target was struck, so the authors were basing their assessment on incomplete information," Rick Lehner, a spokesman for the agency, told AOL News.

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HIT ON WARHEAD IN THE FM-6 TEST ON DECEMBER 11, 2003 — ABSOLUTELY NO EVIDENCE OF SIGNIFICANT LATERAL ACCELERATION DURING HOMING
"There were subsequent views not publicly released to preclude potential adversaries from seeing exactly where the target was struck, so the authors were basing their assessment on incomplete information," Rick Lehner, a spokesman for the agency, told AOL News.

HIT ON WARHEAD IN THE FM-6 TEST ON DECEMBER 11, 2003—ABSOLUTELY NO EVIDENCE OF SIGNIFICANT LATERAL ACCELERATION DURING HOMING
"There were subsequent views not publicly released to preclude potential adversaries from seeing exactly where the target was struck, so the authors were basing their assessment on incomplete information," Rick Lehner, a spokesman for the agency, told AOL News.

WARHEAD MISS IN THE FTM-11 TEST ON DECEMBER 7, 2006 — ABSOLUTELY NO EVIDENCE OF SIGNIFICANT LATERAL ACCELERATION DURING HOMING
"There were subsequent views not publicly released to preclude potential adversaries from seeing exactly where the target was struck, so the authors were basing their assessment on incomplete information," Rick Lehner, a spokesman for the agency, told AOL News.

WARHEAD MISS IN THE FTM-11 TEST ON DECEMBER 7, 2006 – ABSOLUTELY NO EVIDENCE OF SIGNIFICANT LATERAL ACCELERATION DURING HOMING
"There were subsequent views not publicly released to preclude potential adversaries from seeing exactly where the target was struck, so the authors were basing their assessment on incomplete information," Rick Lehner, a spokesman for the agency.

Lateral Accelerations Required to Shift the Impact Point 1 Meter Within 1/30th of a Second

\[
\text{Distance} = \frac{\text{acceleration} \times \text{time}^2}{2} = \frac{a t^2}{2}
\]

\[
\text{acceleration} = \frac{2D}{t^2} = \frac{2 \times 1}{0.033^2} = 1800 \text{ m/sec}^2
\]

\[
\text{Acceleration in Gs} = \frac{a}{g} = \frac{1800 \text{ m/sec}^2}{9.8 \text{ m/sec}^2} = 184 G
\]

\[
\text{Required Rocket Thrust (Tonnes)} = \frac{1800 \text{ m/sec}^2 \times 25 \text{ kg}}{1000 \text{ kg/Tonne}} = 45 \text{ Tonnes} \approx 3 \text{ Times the Thrust of a SCUD-B Rocket Motor}
\]
Video Animation Images Used by Missile Defense Agency to Describe the Instrumentation Used in the FM-6 Flight Test to Determine If Warhead Was Hit

FM-6 – Only Direct Hit on Warhead
How the Pentagon Has Been Rigging the Testing of the the SM-3 Missile Defense
Current Testing of Missile Defense Systems

6 Foot Man
Current Testing of Missile Defense Systems

Terrier orion
Has the Department of Defense Tested the SM-3 Defense System Adequately to Determine that It Will Be Robust and Reliable in Combat Conditions?

SM-3 Intercept Test Trajectory Used by Department of Defense to Determine that the System is “Proven and Effective”
Current Testing of Missile Defense Systems

Location Off Kauai Island Where SM-3 Tests Have Been Conducted
Current Testing of Missile Defense Systems
Current Testing of Missile Defense Systems

Estimated Distances and Geometry of SM-3 Flight Tests
Current Testing of Missile Defense Systems

Estimated Distances and Geometry of SM-3 Flight Tests
Projected Over Northeast of the United States for Perspective

Estimated Test Target Altitudes and Ranges Based on Statements Made in MDA Videos and Rocket Target Calculations
Current Testing of Missile Defense Systems

Missile Locations Shown at 5 Second Intervals
## Current Testing of Missile Defense Systems

### Last Five SM-3 Tests are Exact Replicas of the Same Experiment

Even Though The Tests Were Exact Replicas of the same Simplified Experiment, the DoD Advised the President that the Tests Prove that the SM-3 Would be Effective Against Varied Missile Targets

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### Exact Replicas of the Same Experiment

- Targets exactly the same length
- Warheads located in the same position
- Tail fins large and located in same position
- Targets always perpendicular to the line-of-sight of the closing interceptor
- Large tail fins allow identification of front from back ends
- Targets not tumbling perpendicular to interceptor line-of-sight
- Targets not tumbling in direction of interceptor line-of-sight
- Targets not broken into multiple pieces
- Warhead locations and appearances not distorted by inflated balloons
- Gulf War of 1991 – Targets Tumbled at High Altitudes, Targets Broke Into Pieces During Interceptor Homing

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**Last Five Experiments**

Exact Replicas of the Same Experiment
Current Testing of Missile Defense Systems

Time to Impact

Less than 0.1 seconds to Impact

Roughly 0.5 seconds to Impact

Roughly 1.0 seconds to Impact
Current Testing of Missile Defense Systems
Current Testing of Missile Defense Systems

Warhead Locations After One Second

Rotation Rate
2.5 Revolutions per Minute

Rotation Rate
5 Revolutions per Minute

Rotation Rate
7.5 Revolutions per Minute
Conclusion from US Navy Videos of “Successful Intercepts

Simple countermeasures that disguise the location of the warhead from the infrared homing sensors are very easy to implement and Will Drastically Reduce the Chances of Hitting a Target

These Could Be Used as Decoys
or to Surround Warheads Disguising Them as Balloons

Balloons that Have Been Flown in Space
The Kill Vehicle Must Determine Which of These Are Warheads and Which are Decoys from 500 Kilometers Range!

The IEO, an inflatable erectable decoy for Minuteman (L'Garde, Inc. Photo)

Mk 12A Minuteman III Reentry Vehicle
Current Testing of Missile Defense Systems

Launch Gross Weight with 1000 kg Warhead is 21,500 kg

First Stage Solid Propellant

Second Stage Solid Propellant

1.7m

18.21

7.4m

3m
Current Testing of Missile Defense Systems

10.9 m
Reentry-Phase Defense Systems

Characteristics of Aircraft and “Short-Range” Ballistic Missiles Engaged by Patriot in the Gulf Wars of 1991 and 2003
Location of Objects
Shown Every 20 Seconds

$\theta_0 = 22.55$ degrees
$V_0 = 7.177, 7.1935, \text{ and } 7.21 \text{ km/s}$

Altitudes Where ICBM is in Powered Flight
(200 to 300 seconds)

Altitudes Where Reentry Effects May Be Observable
(60 to 90 seconds)
The Challenges Posed by Ballistic and Aircraft Targets

![Graph showing the location of various missiles and aircraft.]

- **Al Husayn Scud**
- **Al Fatah / Al-Samoud Short-Range Ballistic Missile**
- **Mach 2.5 Airplane**
- **Frog Ballistic Missile**
- **Mach 0.85 Airplane**
- **Mach 0.85 Cruise Missile**

Location of Missiles and Aircraft Shown at 5 Second Intervals
Why Intercepting Airplanes is Much Less Challenging than Intercepting Ballistic Missiles (1 of 2)
Why Intercepting Airplanes is Much Less Challenging than Intercepting Ballistic Missiles (2 of 2)
Debris Cloud from Explosion of Patriot Interceptor

Undamaged Warhead Section of "Intercepted" Lance

Forward Thrown Debris from Explosion of Patriot Interceptor

Damaged Lance Continuing to Fall After Patriot "Intercept"

Direction of Approach of Patriot Interceptor

Patriot "Intercept" Where Damaged Lance-Target Continues to Fall to the Ground With Its Undamaged Warhead

Patriot "Intercept" Where Damaged Lance-Target Continues to Fall to the Ground With Its Undamaged Warhead
Patriot Intercept Attempt Against a Lance Short-Range Ballistic Missile
Note that the Lance is Hit on the Back End of the Patriot and is Only Slightly Damaged. In This Situation the Lance Warhead Will Be Undamaged and It Will Still Fall to the Ground and Explode. This Intercept Test Was Reported as Successful.

Note that the Patriot Fireball Will Eventually Double in Diameter Relative to Its Size in This Video Frame.
The PAA is an ill-defined program that appears to have no limits. It unleashes powerful bureaucratic forces, particularly those for a significant expansion of the number of interceptors and for additional navy ships to carry the interceptors.

41 of 61 DDG-51 destroyers ($2.6 B each) are or will be capable of launching SM-3 ballistic missile defense interceptors.

Roughly 436 SM-3 Block IA interceptors are requested and will likely be built.

The Block IA interceptor’s infrared discrimination is so poor that it cannot tell the difference between a hot piece of unspent solid rocket fuel and a flare or warhead target.

The Block IB will be able to tell the difference between hot and cold bright targets, but it will not replace the Block IA until about 2015. Even with this additional discriminatin capability it will still be vulnerable to the same simple infrared countermeasures as the GMD Kill Vehicle.
A Mystifying Technical Question

The choice to go to many interceptors implies an emphasis on defending against conventionally armed ballistic missiles.

At $10 million + per interceptor, it is hard to understand why there is no emphasis on passive defense, which worked very well in Israel during the Gulf War of 1991.

Possible Political Explanation

Putting interceptors into client states is a political mechanism for drawing those states into a closer alliance with the US (Poland and Romania)
The job of the military planner is to evaluate evolving threats and to recommend timely actions to deal with them.

Military planners will see the PAA as an “open ended” system that will be constantly expanded and modernized towards achieving “war winning” capabilities.

Currently, the number of interceptors ~ 436 on ~ 41 DDG-51 platforms will initially be Block IA/IB interceptors with limited to low burnout speeds and essentially no practical level of discrimination capability (It measures only brightness) (3.2 to 3.3 km/sec Burnout Speed).

Foreign military analysts will be studying the ambitious upgrades planned for the PAA:

- SM-3 Block IB (Kill Vehicle measures temperature and brightness),
- SM-3 Block IIA (4.5 km/sec Burnout Speed),
- SM-3 Block IIB (5 to 5.5 km/sec Burnout Speed),
- Conversions of additional DDG-51s and the design choices for the DD(X), Mk 57 58”Peripheral VLS (Much larger and more capable interceptors)
- A thousand or more interceptors in the future cannot be ruled out.

The recommendations of foreign military analysts with regard to the US threat of foreign military analysts to their political leadership could be problematic for the US and its allies and friends.
The Technical Achievements Presumed by the Ballistic Missile Defense Review are Codified in Numerous Statements

- The United States is currently protected against limited ICBM attacks. This is a result of investments made in the ground-based midcourse defense system (GMD) by the Bush and Clinton administrations over the past decade.

- This advantageous position of the US has made it possible to counter the projected ICBM threat from North Korea and Iran for the foreseeable future.

- However, given the uncertainties about the future ICBM threat, including the time-period in which it could mature, the United States will have to continue to invest heavily in the GMD system so as to maintain this advantageous position.

- In the area of regional ballistic missile defenses “recent successes” have demonstrated that the US can now rely on missile defense systems like the Navy’s Standard Missile 3 (SM-3) ballistic missile defense system and the Army’s Patriot and THAAD systems.

- The Navy’s SM-3 system has proven so reliable in its tests that the US will push hard for major upgrades and deployments.

- The SM-3 Block IA will be upgraded to the Block IB (in 2015), to the IIA (in 2018) and to the IIB (in 2020). These upgrades will enhance the already substantial US capability to defend the Continental US from ICBM attack.
Basic Outline Obama Missile Defense Plan
(Announced on Thursday, September 17, 2009)

- Put Aside (NOT Scrap Flawed) Plan to Deploy 10 Interceptors in Poland and an X-Band Radar in the Czech Republic (Change one flawed plan for another).
- Immediately Use Aegis Ships Armed with SM-3 Block IA Interceptors to Provide Some Defense for Southeastern Europe
- Deploy SM-3 Block IB Interceptors on the Ground As Needed to Enhance Defense Coverage and Number of Interceptors
- Deploy Forward-Based X-Band Radars to Provide Tracking, Discrimination and Engagement Functions for the Defense
- Continue Modernizing the SM-3 Series of Interceptors Towards the Eventual Deployment of SM-3 Block IIA for Full Defense-Coverage of Europe by 2018
- Develop and Use a New SM-3 Block IIB Interceptor for Enhancing Interceptor Firepower Against ICBMs for Defense of the US
- No Mention of Boost-Phase Against Non-Mobile ICBMs Launched from Fixed Sites
Issues Addressed and Raised by the Obama Missile Defense Plan
(Announced on Thursday, September 17, 2009)

- The Plan “Puts Aside” a Defense System that had No Chance of Working and that Addressed a Threat from Iran that Does Not Now, and May Never, Exist.

- The Plan Focusses Attention on Iran’s Short-Range Conventionally-Armed Ballistic Missiles.

- It Uses Much Lighter, Less Expensive, and Therefore Potentially Many More Interceptors to Address Existing Iranian Capabilities to Launch Many Tens of Shorter Range Conventionally-Armed Ballistic Missiles that Could be Used to Attack Targets in Southeastern Europe (Turkey, Greece, etc.)

- The Choice to Go to Many Interceptors Implies an Emphasis on Defending Against Conventionally Armed Ballistic Missiles. At $10 million + per Interceptor, It Is Hard to Understand Why There is No Emphasis on Passive Defense.

- The Interceptors Could be Readily Deployed on Ships or on Land, Where They Can Be Located for Optimal Defense of Potential Targets.
• The Interceptors, Which Home on the Infrared Signals from Attacking Missiles at High-Altitude Will Still Be Susceptible to Certain Infrared Countermeasures. However, As Long As the Attacking Ballistic Missiles are Not Nuclear-Armed, the Effects of Successful Countermeasures Will be Much Diminished Relative to Attacks that Utilize Nuclear-Armed Ballistic Missiles.