Missile Defense Agency

Report to Congress

Roadmap for the Ground-based Midcourse Defense System

April 2016

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1. Executive Summary

~~(FOUO)~~ The Missile Defense Agency (MDA) is executing numerous improvements to the Ground-Based Midcourse Defense (GMD) system and other elements of the overall Ballistic Missile Defense System (BMDS) for homeland defense (HLD)[1]. MDA's HLD activities focus on arming the Warfighter with a weapon system capable of defending the U.S. homeland against the current threat of a limited intercontinental ballistic missile (ICBM) attack (whether accidental, unauthorized, or deliberate) from countries like North Korea and Iran. To hedge against potential evolutions of the threat (e.g., increased quantities, increased ranges, and more complex, survivable, and accurate ballistic missiles), MDA recommends a number of time-phased improvements to the BMDS using a methodical and systematic approach.

MDA's vision includes an integrated plan that would increase GMD system reliability and enhance operational readiness through a significant number of system engineering and programmatic activities, including:

- Continuing flight and ground testing focused on characterizing the design and reliability of the existing Ground Based Interceptor (GBI) fleet
- Growing the currently deployed GBI fleet to 44 by the end of calendar year (CY) 2017
- Developing the Re-designed Kill Vehicle (RKV) and modifying the current boost vehicle to increase survivability and hardness into an integrated All-Up Round (AUR)
- Upgrading the GMD Ground System through hardware obsolescence replacement and software improvement programs
- Continuing development of a robust command and control network and sensor architecture to provide persistent coverage and improve discrimination capabilities against threats to the homeland
- Investing in advanced technology development and future capabilities to counter proliferation of increasingly complex threats

These activities will significantly improve GMD systems reliability and capability against future threats. The GMD system will have fewer fielded GBI configurations, modernized ground system hardware and software, improved system design, and increased system reliability and availability, providing more operational flexibility to the combatant commander for employing BMDS options.

In order to provide the Warfighter the most effective capability as soon as possible, MDA has developed a deliberate improvement strategy and synchronized all of MDA's homeland defense activities. One of the technologies we are exploring for potential future deployment decisions is the Multi-Object Kill Vehicle (MOKV). MDA is currently assessing applicable technologies and working with industry to reduce development risk.

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[1] MDA Report to Congress, "Status of Current and Planned Efforts to Improve Homeland Ballistic Missile Defense", September 11, 2015, provides status of several GMD initiatives to incorporate fixes from previous GM flight test failures as well as improve the overall reliability and confidence in the interceptor fleet.

2. Report Scope

This report responds to language contained in the House Armed Services Committee's (HASC) Report (H. 114-102) on the National Defense Authorization Act (NDAA) for Fiscal Year 2016. The report requires the Director, MDA, in coordination with the Under Secretary of Defense for Acquisition, Technology, and Logistics, to "provide a roadmap of recommended time-phased improvements that should be incorporated into the Ground-Based Midcourse Defense (GMD) program from 2016 to 2025 to ensure the viability of the GMD system paced ahead of the threat to the U.S. homeland from the growing threat of ballistic missiles."

3. Roadmap for the Ground-based Midcourse Defense System

~~(FOUO)~~ GMD is a strategically important system responsible for defense of the U.S. homeland against a limited ballistic missile attack from North Korea and from future threats from Iran. These threats and their threat scenarios are becoming increasingly viable and more complex as both nations continue to improve and expand their ballistic missile capabilities. As part of the overall BMDS, GMD continues to evolve its systems, operation, and capabilities to support HLD and provide operational flexibility to the Commander, United States Northern Command. MDA utilizes a HLD integrated product team (IPT) to coordinate and plan future BMDS capabilities and synchronize development efforts across the Agency. The HLD IPT identifies gaps between BMDS program capabilities and characterizes system improvements required to stay ahead of the threat.

~~(FOUO)~~ To ensure GMD remains ahead of the threat for the 2016 to 2025 timeframe, MDA is investing in several areas, including a new kill vehicle, improved boost vehicles, and numerous ground systems updates. MDA is also investing in other BMDS capabilities that support the GMD system. MDA plans to accomplish these actions in three phases: (1) Enhanced, (2) Robust, and (3) Advanced Homeland Defense.

a. Enhanced, Robust, and Advanced Homeland Defense

(1) Enhanced Homeland Defense (EHD) is a set of development and fielding activities that align to BMDS Capability Increments 3 and 4 and deliver BMDS architecture components and capability for Homeland Defense in the FY 2015 to FY 2018 timeframe.[2] EHD includes the fielding of 44 GBIs by the end of CY 2017, increasing reliability for the Exo-atmospheric Kill Vehicle (EKV), and improving discrimination of incoming missile threats. The EHD schedule goal for demonstrating operational capability is the first quarter of FY 2018, following planned execution of the Distributed Ground Test (GTD)-07a (see the enclosed Annex for EHD milestones).

(2) Robust Homeland Defense (RHD) is an additional set of development and fielding activities, aligned to BMDS Capability Increments 5 and 6, planned to deliver BMDS architecture components for HLD in the FY 2018 to FY 2021 timeframe[3]. RHD plans include: developing the RKV with a two or three-stage selectable, Configuration 3 (C3)

[2] BMDS Phased Implementation Plan, January 8, 2016
[3] Ibid

boost vehicle, improving algorithms for off-board discrimination of incoming missile threats, modernizing ground system architectures, and developing engagement management tools to maximize operational flexibility for the combatant commander. Additionally, the RHD plan includes integration of the Long Range Discriminating Radar (LRDR), kill vehicle-to-kill vehicle communications, and on-demand communications for the RKV (see the enclosed Annex for RHD milestones).

(3) Advanced Homeland Defense (AHD) is a further set of development and fielding activities to deliver future BMDS architecture components for homeland defense that could include: MOKV, advanced-air or space-based electro-optical/infrared sensors, and improved track and discrimination software capabilities from multiple radars and other sensor platforms. AHD planning scope is beyond the current BMDS Phased Implementation Plan, but it will logically align to BMDS Capability Increments 7 and 8[4] (see the enclosed Annex for AHD milestones).

b. Improved Booster Architecture

(1) MDA is implementing the appropriate actions needed to meet the Secretary of Defense's mandate to grow the GBI fleet to 44 by the end of CY 2017. In addition to the booster development activities discussed below, MDA is also implementing an enhanced design and reliability characterization (D&RC) program to ensure confidence in system reliability, capability, long-term sustainment, and influence future interceptor design and development. Focused D&RC efforts began in FY 2014, and the FY 2016 budget provides for D&RC and reliability growth in future years.

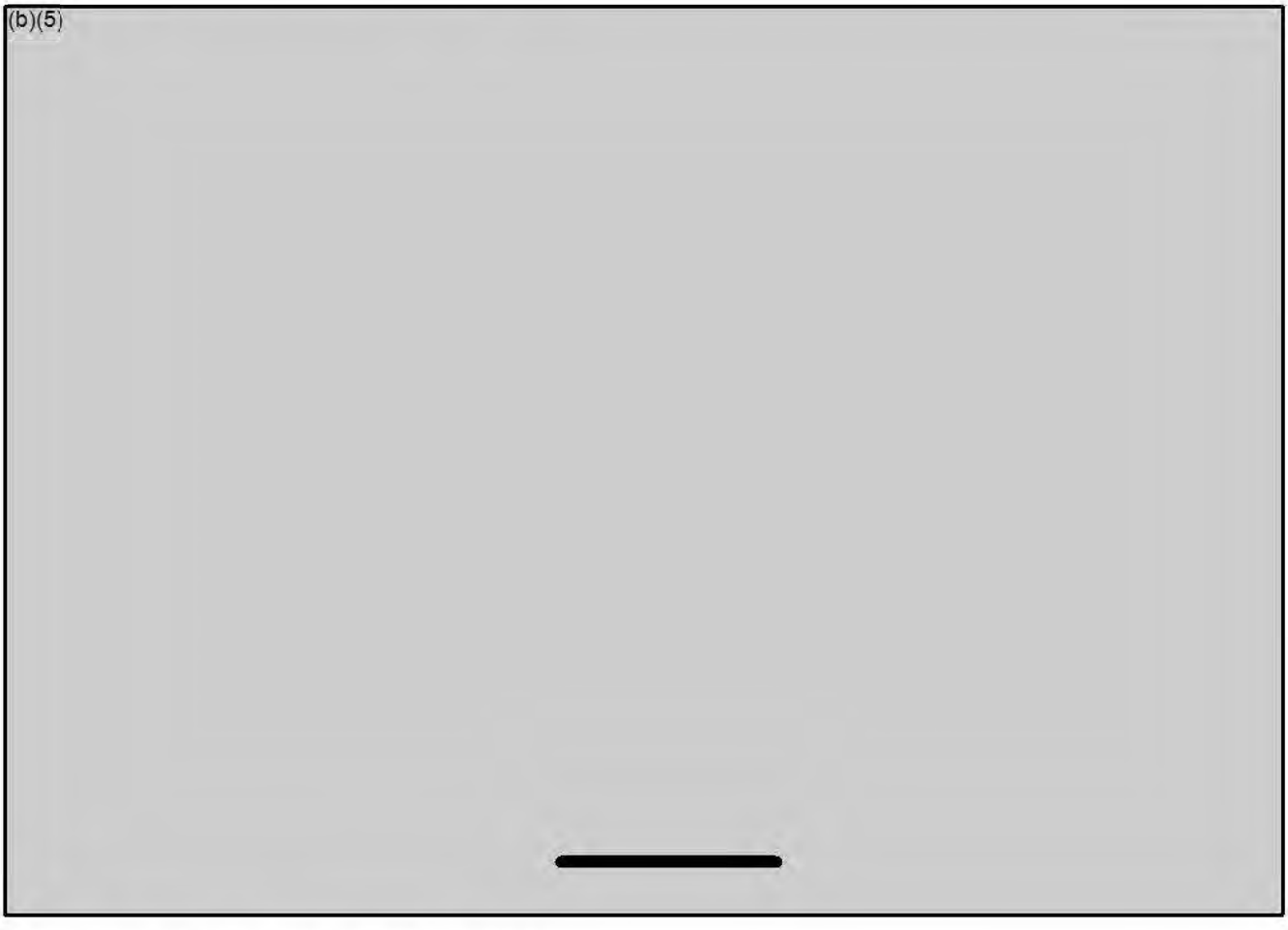
(2) The Configuration 1 (C1) boost vehicle is the boost vehicle, currently deployed in the GMD architecture. The Configuration 2 (C2) boost vehicle is the boost vehicle in development under the Consolidated Booster Avionics Upgrade (CBAU) program. The CBAU design maintains booster reliability through design and producibility improvements and addresses obsolescence in C1 boost vehicle components. The GMD program is qualifying the redesigned boost vehicle components and is on schedule to support the emplacement of 44 GBIs by the end of CY 2017.

(3) The C3 is a 3-stage boost vehicle with hardened components and increased shielding to protect against hostile environments, which improves reliability and addresses hardware obsolescence from previous boost vehicle components. The GMD program will provide a system selectable 2- or 3-stage mode (software configurable) flight option for all boost vehicle configurations. The system selectable 2- or 3-stage mode, which is backwards compatible with the C1 and C2 boost vehicles, provides the option for the baseline 3-stage boost vehicle to operate in the shortened mission timeline of a 2-stage booster. This capability increases the defended area and reduces cost by eliminating the need to develop and test a separate 2-stage boost vehicle. The GMD ground software (GS) upgrade for the 2- or 3-stage mode, GS 7B, will be tested

[4] Ibid

in the Ground Test Integrated (GTI)-07b and GTD-07b campaign. The boost vehicle software will be flight tested in GMD Controlled Test Vehicle (GM CTV)-03 prior to fielding in FY 2018. The 2-stage mode will then be "field-loaded" on C1 and C2 boost vehicles. Software modifications to both the GBI and ground systems are necessary to implement this functionality. This 2- or 3-stage system selectable option provides additional battlespace for the operator, maximizing engagement opportunities while the additional environmental hardening for the C3 improves GBI survivability in harsh environments.

(4) The following chart highlights the GMD interceptor delivery schedule and includes the milestones necessary to achieve 44 GBIs by CY 2017, as well as the upgrade schedule for future boost vehicles.



c. Redesigned Kill Vehicle (RKV)

(1) The RKV is a key component of the BMDS RHD architecture, capitalizing on Discrimination Improvements for Homeland Defense (DIHD), deployment of the LRDR, and upgrades to GMD ground systems. The RKV will replace the current EKV with a modular, producible, reliable, and capable kill vehicle that leverages mature technologies to meet BMDS requirements. The RKV increases operational effectiveness (reliability and maintainability) in an affordable way (producibility,

maintainability, and testability) compared to the current GBI kill vehicle. The RKV development program includes three flight-test articles (one for GM CTV-03, one for Flight Test GBI (FTG)-17), and one for FTG-18) plus eight initial production RKVs. MDA will expend one of the initial production RKVs in a BMDS/GMD-level flight test event, Flight Test Operational (FTO)-04, in FY 2021. MDA will use an additional RKV as a production/flight test spare or as an inventory maintenance unit if not needed during production or flight test. MDA will deploy the remaining six units to the operational fleet.

(2) MDA will utilize the GMD Development and Sustainment Contract (DSC) for the RKV development program. MDA competitively awarded this contract to Boeing in December 2011, with Raytheon Missile Systems as a primary subcontractor and Lockheed Martin brought on as a subcontractor for the development effort. The scope of work under this contract includes, but is not limited to, future development, fielding, testing, systems engineering, integration and configuration management, equipment manufacturing and refurbishment, training, and operations and sustainment support for the GMD Weapon System and associated support facilities.

(3) After completion of the development phase and delivery of the initial production units, MDA plans to competitively award a full rate production contract for additional RKVs. The GBI AUR integration for full rate production RKVs will occur in this RKV competitive production contract.

d. Future Options

(1) ~~(FOUO)~~ The next potential technology is an MOKV payload to (b)(3):10 USC § 130,(b)(5) (b)(3):10 USC § 130,(b)(5) As such, MDA plans to mature technology that will support MOKV development and assess possible MOKV concepts for a Department-level decision. (b)(3):10 USC § 130,(b)(5) (b)(3):10 USC § 130,(b)(5) (b)(3):10 USC § 130,(b)(5) If the technology proves viable, MDA believes MOKV may become a significant element in our (b)(3):10 (b)(3):10 USC § 130,(b)(5) an MOKV payload can decrease the cost per kill by (b)(3):10 USC § 130,(b)(5) (b)(3):10 USC § 130,(b)(5) thus providing greater operational flexibility to the combatant commander.

(2) ~~(FOUO)~~ In FY 2015, MDA awarded several contracts with industry to define MOKV concepts. As industry matures those concepts for presentation in FY 2016, (b)(3):10 USC § (b)(3):10 USC § 130,(b)(5)

e. GMD Ground System and GMD Fire Control

(1) The GMD ground system hardware and software will significantly influence future operational readiness and cybersecurity posture. Through the CY 2016-2025 timeframe, MDA plans numerous enhancements to modernize and improve the GMD ground system to ensure high reliability and long-term sustainability, add system capabilities to counter the emerging threat, and increase protection against cyber-attack. MDA will redesign the ground system architecture by integrating the functionality of the Command Launch Equipment (CLE) into the GMD Fire Control (GFC) system. The CLE, which prepares GBIs for launch, is a critical link in the firing chain. The CLE re-architecture will remove aging equipment, reduce operating and sustainment costs, improve availability, and add auto-failover capability (the ability to control the interceptors with a virtual CLE function in the GFC system), eliminating obsolete hardware from the firing chain. The re-architecture will provide improved system control and warfighting capabilities to GFC operators and will alleviate significant sustainment burden by:

- Eliminating 171 racks of CLE hardware, decreasing system failure opportunities
- Using the GFC auto-failover capability to mitigate system availability risks
- Reducing manpower requirements
- Providing interceptor inventory control and improved GBI health and status reporting to the Warfighter
- Providing geographic diversity of critical functions (CLE functionality will no longer be site-specific)
- Providing cybersecurity upgrades

(2) MDA plans to address obsolescence, reliability risk, and performance limitations through replacement of the GFC Warfighter workstations and installation of new GFC server hardware by the first quarter of FY 2017, following the GTD-06 Part 2 ground test.

(3) MDA installed a new In-Flight Interceptor Communication System (IFICS) Data Terminal (IDT) site at Fort Drum, New York, in FY 2015 to expand the GMD communication capability. MDA also plans to upgrade hardware components at other IDT sites to mitigate critical issues with IDT sparing and improve cybersecurity posture. MDA will deliver new IDT servo control units and IDT time-servers to mitigate reliability and obsolescence risks by the first quarter of FY 2016. After the GTD-07a ground test event, MDA will field the upgrade of IDT processors to improve the cybersecurity posture across the GMD ground system.

(4) MDA will perform a tech refresh of the high power amplifier in the IDT, beginning in FY 2019 and continuing into FY 2022, to address obsolescence issues. MDA will also field an IDT tech upgrade of the receiver/transmitter and modem, which MDA will initially field at Vandenberg Air Force Base, for flight tests in FY 2019, and to other IDT sites by mid-FY 2022.

(5) MDA plans a redesign and modernization effort of the GMD Communications Network (GCN) to address obsolete equipment, increase network capacity, and maintain compatibility with emerging Defense Information Systems Agency (DISA) long-haul communication transport requirements. The upgraded GCN will enable GMD to leverage information from additional BMDS assets to counter the emerging BMDS threat. MDA has initiated the requirements assessment and proof-of-concept phase for this effort.

(6) MDA plans to implement additional ground system infrastructure upgrades to provide uniform, conditioned power for greater reliability and sustainability of equipment and hardware at Fort Greely, Alaska; Vandenberg Air Force Base, California; and Eareckson Air Station, Alaska.

(7) MDA plans to implement an on-demand communication architecture that will leverage the RKV robust communications package, provide enhanced targeting details and more frequent health and status updates to the ground system, and improve operational flexibility for missile-field inventory management.

(8) MDA plans additional improvements to the GFC software to incorporate increased capabilities enabled by DIHD technologies, Space-Based Infrared System interoperability enhancements, and the LRDR. The DIHD improvements will enhance current and future sensor data for more accurate identification of lethal objects to address emerging threats. The GFC will provide battle management for the 2- or 3-stage flight-mode interceptor capability. Furthermore, the GFC will manage interceptor fields with multiple interceptors that have various boost vehicles and kill vehicle configurations. Additionally, the GFC software will undergo updates in capability and functionality to keep pace with the threat and the new performance capabilities of the ground system hardware upgrades.

f. (b)(5)

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(b)(5)

[redacted]

[5] Report to Congress, "Potential Future Homeland BMDS Options", August 11, 2015

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Under Exemption (b)(5)

(b)(5)

(e) ~~(FOUO)~~ C2BMC is also developing a Multi-Platform Post Intercept Assessment (PIA) capability to support senior leader decision-making and increase operational flexibility for the combatant commander. While the PIA capability is still experimental, the ability to determine if a second shot is necessary (by confirming target intercept) for each individual threat is critical for GMD to satisfy the homeland defense raid requirements specified within the BMDS System Specification.

(b)(5)

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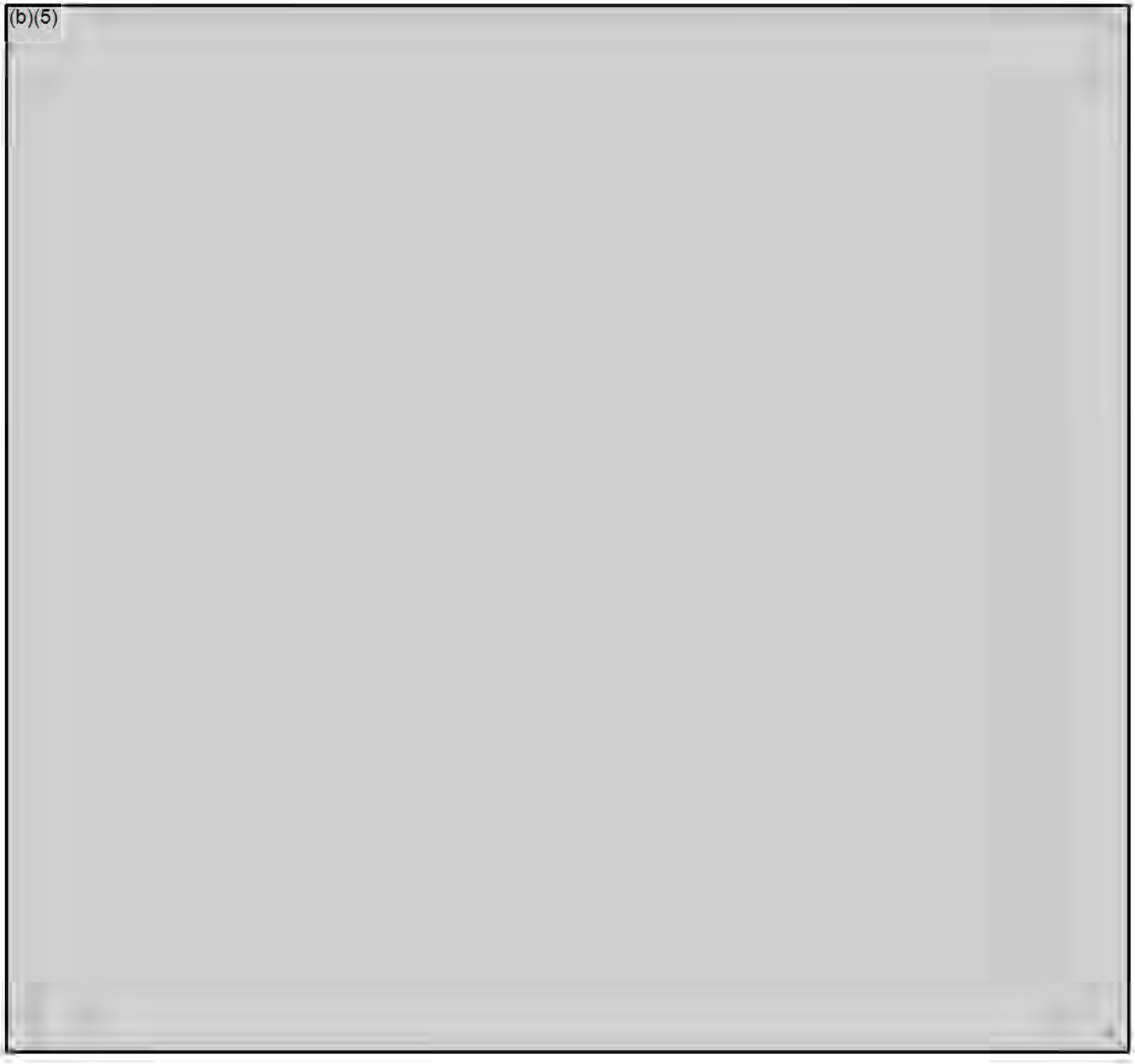

4. Conclusion:

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5. Acronyms

AHD	Advanced Homeland Defense
AN/TPY-2	Army Navy/Transportable Radar Surveillance and Control
AUR	All Up Round
BMDS	Ballistic Missile Defense System
C2BMC	Command and Control, Battle Management and Communications
CBAU	Consolidated Booster Avionics Upgrade
C1	Configuration 1 Boost Vehicle (currently deployed)
C2	Configuration 2 Boost Vehicle (boost vehicle under development)
C3	Configuration 3 Boost Vehicle (3 stage boost with upgrades)
CD	COBRA Dane
CE	Capability-Enhancement
CLE	Command Launch Equipment
CTV	Controlled Test Vehicle
DIHD	Discrimination Improvements for Homeland Defense
D&RC	Design and Reliability Characterization
DISA	Defense Information Systems Agency
DSC	Development and Sustainment Contract
EHD	Enhanced Homeland Defense
EKV	Exo-atmospheric Kill Vehicle
FBM	Forward Based Mode
FTG	Flight Test Ground Based Interceptor (GBI)
GBI	Ground Based Interceptor
GCN	GMD Communications Network
GFC	GMD Fire Control
GM	Ground-based Midcourse Defense Program Office
GMD	Ground-based Midcourse Defense Program
GTD	Distributed Ground Test
GS	Ground Software
GTI	Integrated Ground Test
HLD	Homeland Defense
ICBM	Intercontinental Ballistic Missile
IDT	IFICS Data Terminal
IHD	Initial Homeland Defense
IPT	Integrated Product Team
IFICS	In-Flight Interceptor Communication System
KV	Kill Vehicles
LRDR	Long Range Discrimination Radar
MDA	Missile Defense Agency
MOKV	Multi-Object Kill Vehicle
OPIR	Overhead Persistent Infrared
PIA	Post Intercept Assessment
RHD	Robust Homeland Defense
RKV	Redesigned Kill Vehicle
SBX	Sea-Based X-Band Radar

TOM	Threat Object Map
UEWR	Upgraded Early Warning Radar
USNORTHCOM	U.S. Northern Command

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Under Exemption (b)(5)