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| APPROPRIATION/BUDGET ACTIVITY RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P) | R-1 NOMENCLATURE 0603897C BMD Hercules |
|---|---|

| COST ($ in Thousands) | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 |
|---|---|---|---|---|---|---|---|---|
| Total PE Cost | 0 | 49,674 | 53,658 | 54,264 | 54,405 | 55,142 | 53,355 | 54,198 |
| 0505 Hercules | 0 | 47,952 | 51,214 | 51,721 | 51,336 | 52,541 | 50,772 | 51,596 |
| 0602 Program-Wide Support | 0 | 1,722 | 2,444 | 2,543 | 3,069 | 2,601 | 2,583 | 2,602 |

*Note: Starting in FY07, 0505 Hercules moved to this new Program Element from the BMDS Products Program Element (PE 0603889C). In FY06, Hercules was associated with the three projects 0802, 0902, and 0002. In FY08, the Applied Data Analysis Center (ADAC) project will move to the BMD Hercules Program Element from Program Element (060388C).*

## A. Mission Description and Budget Item Justification

### A.1 System Element Description

The BMD Hercules Program Element develops and tests tomorrow's discrimination, counter-counter measures, and tracking algorithms for integration into the BMDS, thereby allowing us to outpace the evolving ballistic missile threat. In particular, Hercules develops algorithms that improve sensor and weapon element tracking and discrimination, improve integration of sensor data within Command and Control, Battle Management and Communications (C2BMC) and fire control, and expand integrated battle management capability. This national effort to develop robust, physics-based detection, tracking, and discrimination algorithms is based on the intelligence community's assessment that the evolving ballistic missile threat may include planned or unplanned countermeasures in all phases of their flight. Project Hercules then transfers these algorithms to BMDS elements for integration and provides technical assistance during the algorithm integration. These algorithms support existing BMDS Engagement Sequence Groups (ESG) and enable new Engagement Sequence Groups; will significantly improve the ability of the BMDS sensors, weapons, and C2BMC to detect, track, and identify ballistic missiles and potentially lethal objects. These activities are critical to keep pace with the evolving ballistic missile threat.

Applied Data Analysis Center (ADAC) identifies critical phenomenology from U.S. and foreign missile flights, ground tests, and laboratory measurements. ADAC provides MDA, particularly Project Hercules, with new concepts for algorithm, sensor, and weapon development. ADAC exploits analysis to develop appropriate fidelity models that are then used for algorithm, element, and system testing leading to improvements in future BMD Systems. ADAC characterizes evolving threats and environments to identify relevant BMDS implications.

Hercules exploits physical phenomenology associated with observable characteristics of warheads to develop more sophisticated algorithms (software) that improve the capability of existing and emerging BMDS hardware. Hercules algorithms: enhance the capability of sensors for tracking and object characterization; enhance the C2BMC in system target selection and sensor and weapon resource management; improve the fire control

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capability supporting launch of Ground-Based Midcourse Defense (GMD) interceptors; and enhance kill vehicle ability to process focal plane data for target selection. Previous Hercules projects developed preliminary capability for boost intercept fire control; however, due to budget constraints these projects were terminated. Hercules algorithms involves several phases of development and test. These phases are concept exploration, concept development and concept test. Hercules conducts both digital testing and flight testing of its algorithms as part of the development process. At any particular time, the Hercules portfolio contains algorithms that are in each phase of development. Algorithms in the concept exploration area will enable emerging capability and provide the core algorithm development; this is currently a small but critical portion of the Hercules portfolio. The algorithms that are in test support BMDS near-term capabilities and are associated with specific projects that work in collaboration with the integrating element. Through dedicated projects, Hercules will deliver: 1) multi-sensor target selection to C2BMC to combine AN/TPY and SBX target observations to include supporting system track capabilities as required as well as the next level of weapon / sensor management capability; 2) an initial CCM capability for the AN/TPY-2 and SBX; 3) adapted FBS capability to the AEGIS SPY-1; 4) EO/IR tracking, correlation, and discrimination capability to the Space Tracking  and Surveillance System (STSS) and Airborne Infrared Sensor (AIRS) programs.

ADAC experts in the fields of optical and radar phenomenology analyze flight test and laboratory data to better understand phenomenology associated with missiles, re-entry vehicles, and countermeasures.  ADAC experts analyze data from BMDS flight tests with particular emphasis on results from critical measurement program and countermeasure critical measurement flight tests for exploitable phenomenology.  The ADAC experts also review foreign flight tests and legacy flight tests to identify exploitable trends and validate the utility of identified phenomenology.  ADAC experts also assess laboratory and ground testing that measure complimentary phenomena.  They then apply the ADAC expertise to validate BMDS engineering models and identify areas for improvement.  ADAC provides the BMD technology development community with the results of their analysis to stimulate algorithm and hardware development with the capability to exploit the phenomenology.

**A.2 System Element Budget Justification and Contribution to the Ballistic Missile Defense System (BMDS)**
Hercules algorithms support existing BMDS Engagement Sequence Groups (ESG) and enable new Engagement Sequence Groups. In particular, Hercules develops algorithms that improve sensor and weapon element discrimination, improve integration of sensor data within C2BMC, and expand integrated battle management capability. Hercules developed key discrimination algorithms included in the AN/TPY 2 radar, system tracking algorithms used in the C2BMC and the GMD Fire Control (GFC), and system engagement planning algorithms used in the C2BMC. To provide capability identified in the Block 08 Test Bed Description Document (TBDD), Hercules will mature and transition algorithms for clutter mitigation, improved AN/TPY-2 radar discrimination, AEGIS discrimination, and C2BMC target selection capabilities.

ADAC is the only MDA organization chartered to perform detailed analyses of phenomenologies observed on U.S. flight and ground tests, as well as on data collections from foreign launches.  Understanding the physics behind these observations -- during all phases of flight (boost, through

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midcourse, and terminal) -- leads to robust new algorithm concepts, which are subsequently exploited by Project Hercules. ADAC also develops appropriate fidelity models used in algorithm testing, as well as testing for the Hercules Decision Architecture and the Elements. By this, ADAC plays a key role in the MDA spiral technology development and in the support of the BMDS Block Development efforts

**A.3 Major System Element Goals**
Hercules has two major goals:
- Develop, deliver and support integration of algorithms that provide new or expanded capability to include;
  o Multi-sensor target selection to C2BMC to combine AN/TPY and SBX target observations to include supporting system track capabilities as required as well as the next level of weapon / sensor management capability.
  o An initial CCM capability for the AN/TPY-2 and SBX;
  o Adapted FBS capability to the AEGIS SPY-1.
  o EO/IR tracking, correlation, and discrimination capability to the STSS program.
- Assess algorithm needs and begin development of concepts that support new emerging and known future technology needs, such as new weapon systems and sensors or address evolving threat counter measures.

ADAC has three major goals:
- Provide in-depth analysis of domestic and foreign flight data. Understand the physics behind observed phenomenologies and assess potential implications to the BMD critical functions resulting from new threat developments.
- Develop robust new algorithm concepts for Project Hercules, with a particular emphasis on discrimination and mitigation of countermeasures. Develop forward-looking sensor design concepts for MDA, based on likely threat, scene, and weapon-capability environment.
- Leverage flight and ground test data to develop appropriate-fidelity digital models for Hercules algorithm, Element, and System testing. Use software tools/models to test Hercules Decision Architecture concepts through Red-Blue games.

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|---|---|

| B. Program Change Summary | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| Previous President's Budget (FY 2007 PB) | 0 | 0 | 0 | 0 |
| Current President's Budget (FY 2008 PB) | 0 | 49,674 | 53,658 | 54,264 |
| Total Adjustments | 0 | 49,674 | 53,658 | 54,264 |
| Congressional Specific Program Adjustments | 0 | 49,884 | 0 | 0 |
| Congressional Undistributed Adjustments | 0 | -210 | 0 | 0 |
| Reprogrammings | 0 | 0 | 0 | 0 |
| SBIR/STTR Transfer | 0 | 0 | 0 | 0 |
| Adjustments to Budget Years | 0 | 0 | 53,658 | 54,264 |

FY07 increase of $49.674 million includes the congressionally directed creation of a new Program Element for Hercules, and a portion of the MDA congressional undistributed reduction.

FY08 increase of $53.658 million and FY09 increase of $54.264 million reflects the congressionally mandated creation of a new Program Element for Hercules.

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|---|---|
| **RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P)** | **0603897C BMD Hercules** |

| COST ($ in Thousands) | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 |
|---|---|---|---|---|---|---|---|---|
| 0505 Hercules | 0 | 47,952 | 51,214 | 51,721 | 51,336 | 52,541 | 50,772 | 51,596 |
| RDT&E Articles Qty | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Note: Starting in FY07, 0505 Hercules moved to this new Program Element from the BMDS Products Program Element (PE 0603889C). In FY06, Hercules was associated with the three projects 0802, 0902, and 0002. In FY08, the Applied Data Analysis Center (ADAC) project will move to the BMD Hercules Program Element from Program Element (060388C)*

**A. Mission Description and Budget Item Justification**
Hercules is a national effort to develop robust, physics-based detection, tracking, and discrimination prototype software (algorithms), and transfers them to BMDS elements in order to improve the performance of C2BMC, sensor, and weapon functions. Hercules algorithms improve sensor and weapon element detection, tracking and discrimination, improve integration of sensor data within C2BMC, and expand integrated battle management capability in a countermeasure environment. They are critical in keeping pace with the evolving threat. Further, Hercules algorithms aid BMDS decision logic and enable the BMDS to make better battle management decisions, thus optimizing the utility of scarce resources. Hercules provides technical assistance to the BMDS elements during algorithm integration. Flight test data (domestic and foreign) is exploited to develop appropriate high fidelity models that are used for algorithm, element, and system testing that leads to improvements to the future BMDS Blocks. Hercules will provide requirements for and participate in BMDS system, element, and component tests as test opportunities arise. Dedicated Hercules tests for clutter mitigation and FBS algorithms, similar to CMCM tests are in planning and expected to occur in FY08 or FY09.

Hercules has several major functional areas:
- Decision Architecture applies advanced decision theory to improve real-time BMDS command and control, battle management and communications (C2BMC) capability. The Decision Architecture develops multi-sensor tracking and discrimination algorithms that use the output of other Hercules algorithm development efforts and develops resource management algorithms that coordinate the use of BMDS weapons and sensors. Multi-sensor discrimination permits target selection based on information gained from multiple sensors. Since sensors observe different characteristics of threat objects, the Discrimination Fusion Engine (DFE) combines data to provide a more complete picture of the threat missile complex. The coordinated sensor and weapon management provides decision aids to the missile defense commander that will improve the use of different BMDS sensors and weapons. This capability will lead to better situational awareness, sensor resource allocation, and weapon magazine management options for integration into Global Integrated Fire Control (GIFC).
- The Forward Based Sensors (FBS) effort develops discrimination algorithms that take advantage of unique FBS observables to provide robust discrimination solutions. FBS develops algorithms for both radar sensors and electro-optical sensors. The initial Hercules radar discrimination algorithm suite enables the AN/TPY-2 to perform the forward based discrimination function. Additional Hercules radar discrimination algorithms

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|---|---|

expand the AN/TPY-2 discrimination capability. Hercules will also support the integration of these algorithms on the Sea-Based X-Band (SBX) radar. Hercules works with the MDA Sensors program to integrate the initial passive optics algorithms into an AIRS. Hercules also works with the Aegis program to provide an adapted FBS capability for the SPY-1 radar.

- The Hercules Blue Team develops advanced algorithms that exploit a wide range of radar and electro-optical sensor technology areas. The Blue Team algorithms provide fire control, tracking, discrimination, and control algorithms with a primary focus on single sensor or kill vehicle applications and track management among BMDS sensors and weapons. These algorithms will improve surveillance sensors [Sea-Based X-Band Radar and Space Surveillance & Tracking System (STSS)], kill vehicles [including the Exoatmospheric Kill Vehicle (EKV), THAAD kill vehicle and the Multiple Kill Vehicle (MKV)], and weapon systems [including AEGIS BMD and the Kinetic Energy Interceptor (KEI)].

- The Corporate Clutter Working Group (CCWG) develops algorithms to mitigate the effects of countermeasures used to reduce the effectiveness of BMDS sensors. These algorithms support tracking and discrimination in the presence of clutter countermeasures. In many cases, this group has the only effort within MDA working to mitigate a specific clutter issue. For each of the above task areas, a number of efforts have been identified to deliver tangible products to the BMDS Elements that address MDA strategic goals, such as birth-to-death track, forward-based sensor (FBS), multiple kill vehicles (MKV), battle management (C2BMC), and discrimination.

- The Engineering and Integration supports all Hercules development, provides an independent test capability within Hercules, and performs system engineering functions with the BMDS elements to facilitate algorithm transition. The Threat Engineering group generates realistic, simulated threat data for algorithm development and provides threat data to Hercules developers and BMDS elements in the form of Threat Data Packages (TDPs). The Digital Test Group conducts capability testing of developed algorithms to verify algorithm robustness and identify BMDS functions that require improvement prior to integration in operational systems. The Flight Test Group enables Hercules algorithm testing during BMDS flight test events using the BMDS Fusion Toolbox (BFT) sidecars. The Integration and Systems Engineering group reviews technical progress of the algorithms, provides recommendations to algorithm developers for improvements during the development process, and provides technical details to engineers in MDA System Engineering and the elements to perform system benefit analysis and integration of Hercules algorithms into the BMDS. Technical progress reviews occur at Algorithm-to-Test Transition (ATT) meetings, where developers certify their algorithms are ready for test, and at Characterization and Transition (CaT) meetings, where the test team presents results of their algorithm digital testing.

The Applied Data Analysis Center (ADAC) provides the seed corn for the future development of the BMDS. Rooted in forward-looking analysis of both domestic and foreign data collections on all classes of missiles systems, ADAC identifies critical phenomenologies with the potential to drive the performance of threats, countermeasures, and sensors. Analysts identify advanced concepts that exploit available phenomenology. These concepts are transferred to Project Hercules and other MDA organizations. Both algorithm and sensor concepts from ADAC focus on such areas as: birth-to-death track; FBS; countermeasure mitigation; MKV, KED, and ADI; and Decision Architecture.

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## B. Accomplishments/Planned Program

| | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| Decision Architecture | 0 | 4,950 | 5,625 | 5,681 |
| RDT&E Articles (Quantity) | 0 | 0 | 0 | 0 |

FY07 Planned Program:
- Conduct joint engineering and development with C2BMC to develop specific requirements and demonstrate interfaces for C2BMC Block 08 target selection capability (multi-sensor discrimination fusion for AN/TPY-2 / SBX fusion).
- Extend the target selection development to include emerging sensor observations (new features from adjunct sensor and from STSS).
- Support integration of the Integrated Engagement Planner into the Global Integrated Fire Control.
- Extend the development of the integrated engagement planning capability to include sensor-target pairing.
- Coordinate Digital and BFT flight tests of DFE and tracking capability

FY08 Planned Program:
- Deliver to C2BMC and support integration of the target selection capability into the C2BMC
- Deliver to C2BMC the sensor target pairing capability.
- Expand flight test demonstrations of target selection capability to include expected features from emerging sensors (adjunct radar, STSS).
- Start extending the Decision Architecture to distributed operations.
- Continue digital and BFT flight test demonstration of evolving Decision Architecture components.

FY09 Planned Program:
- Support integration of the sensor target pairing capability into the C2BMC
- Conduct joint engineering and development with C2BMC of target selection algorithms that use additional sensor capability.
- Continue digital and BFT flight test demonstration of evolving Decision Architecture components.
- Continue extending the Decision Architecture to distributed operations.
- Modify target selection capability to include Hercules-developed lethal region (D3) identification capability.

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|  | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| Forward Based Sensors | 0 | 4,488 | 2,300 | 2,323 |
| RDT&E Articles (Quantity) | 0 | 0 | 0 | 0 |

FY07 Planned Program:
- Conduct digital and flight test of additional forward-based discrimination algorithms that will enhance radar (RF) and optical (EO/IR) sensor performance.
- Complete development of additional forward-based discrimination algorithms.
- Conduct joint engineering, development and integration with AEGIS of modified FBS Suite 1 algorithms for AEGIS Block 08 discrimination capability. Use at-sea demonstration of AEGIS sidecar for AEGIS discrimination algorithm development.
- Support integration of passive optics discrimination algorithms into AIRS and the STSS Test Bed.
- Begin development of more general target region identification algorithm (D3) to support emerging weapon capabilities.

FY08 Planned Program:
- Complete joint engineering and development with AEGIS of modified FBS Suite 1 algorithms for AEGIS Block 08 discrimination capability. Use at-sea demonstration of AEGIS sidecar for AEGIS discrimination algorithm development.
- Continue development of D3 discrimination capabilities.
- Begin development of advanced tracking algorithm for STSS.

FY09 Planned Program:
- Continue development of D3 discrimination capabilities. Start coordination for delivery and transition of D3 discrimination capabilities.
- Complete integration of adapted FBS algorithms for operation on AEGIS SPY-1 sensor.
- Continue development of advance tracking algorithm for STSS.

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| | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| Blue Team | 0 | 8,613 | 5,813 | 5,708 |
| RDT&E Articles (Quantity) | 0 | 0 | 0 | 0 |

FY07 Planned Program:
- Support engineering integration of correlation and target object map algorithms into the GFC/C that will improve the GMD system use of AN/TPY-2 data in the presence of evolving threat countermeasures.
- Continue development of discrimination and kill vehicle enhancements that will improve GMD target designation and negation capability.
- Continue development and integration of AEGIS BMD radar and seeker correlation, handover and discrimination enhancements.
- Continue joint development and integration of tracking algorithm into the STSS.
- Improve the capability of existing tracking, correlation, and discrimination algorithms in conjunction with the use of advanced discrimination techniques (DADs), and develop new algorithm capabilities that enhance the use of these DADs.
- Continue algorithm development efforts for MKV. NOTE: Due to funding limits, algorithms will be transferred "as-is" at the end of FY07 with no additional Hercules development in FY08.
- Start coordination for delivery and transition of MKV discrimination and engagement management capabilities. NOTE: Due to funding limits, algorithms will be transferred "as-is" at the end of FY07 with no additional Hercules development in FY08.
- Continue development of advanced physics based discrimination techniques. Continue algorithm development to enhance EKV operations and start coordination for delivery and transition of enhance EKV algorithms.
- Continue advance radar architecture algorithm development and start coordination for delivery and transition of radar architecture algorithms.

FY08 Planned Program:
- Conduct joint requirement and interface definition for advanced radar resource management and data processing (radar architecture).
- Conduct joint algorithm insertion / assessment with STSS.
- Continue support of AEGIS BMD algorithm integration.
- Continue development of enhanced tracking, correlation, and discrimination algorithms.
- Start coordination for delivery and transition of enhanced tracking, correlation, and discrimination algorithms.
- Continue development of advanced physics based discrimination techniques.
- Coordinate Digital and BFT flight tests of algorithms.

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FY09 Planned Program:
- Complete AEGIS BMD algorithm integration.
- Deliver and support integration of enhanced tracking, correlation, and discrimination algorithms.
- Start coordination for delivery and transition advanced physics based discrimination techniques.
- Coordinate Digital and BFT flight tests of algorithms.

|  | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| Corporate Clutter Working Group | 0 | 3,200 | 3,257 | 3,233 |
| RDT&E Articles (Quantity) | 0 | 0 | 0 | 0 |

FY07 Planned Program:
- Extend capability of radar clutter mitigation to additional forms of clutter. Continue development of robust algorithms for CT-2 masking mitigation and transition to Green Team. Develop enhancements to the IMC algorithms.
- Conduct joint engineering requirement and interface specification for FY08/FY09 transition and integration of the IMC into the BMDS systems.
- Continue development of electro-optical sensor counter-countermeasure algorithms for EO/IR surveillance sensors.
- Continue rapid prototype insertion of clutter mitigation capability into radar string facilities.
- Continue integration of clutter mitigation algorithms into sensor string facility for Block 08 RF Electronic Counter-Countermeasure capability and extend to Block 10 RF Electronic Counter-countermeasure capability.
- Continue coordination and support delivery and integration of an initial CCM capability for AN/TPY-2 and SBX.

FY08 Planned Program:
- Support integration of an initial CCM capability for AN/TPY-2 and SBX.
- Improve clutter mitigation capability in response to joint engineering effort and digital test effort.
- Continue integration of clutter mitigation algorithms into sensor string facility for Block 10 RF Electronic Counter-Countermeasure capability.
- Operate clutter mitigation algorithms during appropriate BMDS flight test.
- Start development of enhanced algorithms for detection and tracking in advanced RF clutter.
- Support engineering planning for transition and integration of the Block 10 CCM capability into the BMDS systems

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FY09 Planned Program:
- Complete integration support of initial CCM capability.
- Continue support of integration of Block 10 clutter mitigation capability.
- Continue development of enhanced algorithms for detection and tracking in advanced RF clutter
- Improve clutter mitigation capability in response to joint engineering effort and digital test effort.
- Define requirements for future RF and EO/IR clutter mitigation capabilities.

|  | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| Engineering and Integration | 0 | 26,701 | 24,875 | 25,131 |
| RDT&E Articles (Quantity) | 0 | 0 | 0 | 0 |

FY07 Planned Program:
- Develop enhancements to Threat Data Packages (TDPs) to support algorithm development.
- Develop and deliver to MDA System Engineering threat data packages to support ECP-289 effort.
- Support deployment of AEGIS sidecar and conduct at-sea live-time testing operations.
- Participate in BMDS flight tests using sidecars to support algorithm development and transition/integration risk reduction. Support planning for future BMDS flight tests support.
- Define sidecar requirements for future BMD test range sensors.
- Continue identification and discussion of potential new Engagement Sequence Groups (ESGs) with MDA System Engineering.
- Review MDA interface and specification documents.
- Continue to conduct independent digital characterization testing of algorithms.
- Conduct at least four ATT and CaT algorithm technical reviews per year to support transition additional algorithms form development to independent testing.
- Conduct congressionally mandated plume studies.

FY08 Planned Program:
- Continue development and delivery of evolving Threat Data Packages (TDPs) to support algorithm development and capability insertion.
- Participate in BMDS flight tests using sidecars to support algorithm development and testing. Support planning for future BMDS flight tests.
- Begin procurement of an additional sidecar for new BMD test range sensors.

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| APPROPRIATION/BUDGET ACTIVITY | R-1 NOMENCLATURE |
|---|---|
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- Continue identification and discussion of potential new ESGs with MDA System Engineering.
- Conduct digital characterization testing of algorithms.
- Conduct at least four ATT and CaT algorithm technical reviews per year.

FY09 Planned Program:
- Continue development and delivery of evolving Threat Data Packages (TDPs) to support algorithm development and capability insertion.
- Participate in BMDS flight tests using sidecars to support algorithm development and testing. Support planning for future BMDS flight tests.
- Complete procurement of an additional sidecar for new BMD test range sensors.
- Continue identification and discussion of potential new ESGs with MDA System Engineering.
- Conduct digital characterization testing of algorithms.
- Conduct at least four ATT and CaT algorithm technical reviews per year.

| | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| ADAC | 0 | 0 | 9,344 | 9,645 |
| RDT&E Articles (Quantity) | 0 | 0 | 0 | 0 |

FY08 Planned Program:
- Analyze relevant new data collections. Perform phenomenology analysis and data exploitation in support of Advanced Technology goals. Provide algorithm and sensor concepts to Project Hercules and the Elements.
- Continue analysis of MASINT radar data collected to characterize new, evolving, and high tech threats, with a concentration on countermeasure characterization. Continue analysis of back-logged MASINT radar data relevant to current BMD issues such as forward-based discrimination algorithms, countermeasures, and RCS threat modeling.
- Complete the Forward-Based Sensors (FBS) Study.
- Complete assessing optical features for burnout estimation. Addresses a specific request to include liquid fuel propellants in the effort.
- Perform threat modeling supporting the Hercules Threat Engineering group: certain applications requiring threat signature data have been identified by the Project Hercules, STSS, MKV and THAAD. ADAC has identified an approach for bridging the gap between the (relatively slow) high-fidelity-data-anchored model and the (low fidelity) fast-running or table-look-up requirements. The effort will focus on continued development of this alternative approach.

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- Host a number of MDA community-wide forums, an annual Clutter Type 4 (CT4) Workshop, two new Red/Blue games which will combine RF and IR as well as applied Project Hercules algorithms and Decision Architecture.
- Continue an anti-simulation countermeasure effectiveness study. The work in this area will focus on examining the suitability of certain correlated EO/IR and RF phenomenologies for possible exploitation by BMDS systems.
- Complete investigation of non-parametric motion solution using passive optics, expanding on the current radar efforts.
- Continue low thrust phenomenology analysis and modeling in support of Project Hercules FBS PO-2 algorithm.
- Continue developing and testing several new RF techniques, including clutter mitigation and target characterization for Project Hercules.
- Improve fidelity in existing models.
- Conduct study of potential impact to BMDS functions such as track, FBS, discrimination, countermeasures.
- Provide RF and EO/IR flight test data collection requirements support to Systems Engineering.

FY09 Planned Program:
- Analyze relevant new data collections. Perform phenomenology analysis and data exploitation in support of Advanced Technology goals. Provide algorithm and sensor concepts to Project Hercules and the Elements.
- Continue analysis of MASINT radar data collected on to characterize new, evolving, and high tech threats, with a concentration on countermeasure characterization. Continue analysis of back-logged MASINT radar data relevant to current BMD issues such as forward-based discrimination algorithms, countermeasures, and RCS threat modeling.
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- Complete an anti-simulation countermeasure effectiveness study. The work in this area will focus on examining the suitability of certain correlated EO/IR and RF phenomenologies for possible exploitation by BMDS systems.
- Complete low thrust phenomenology analysis and modeling in support of Project Hercules FBS PO-2 algorithm.
- Continue developing and testing several new RF techniques, including clutter mitigation and target characterization for Project Hercules.
- Improve fidelity in existing models.
- Continue study of potential impact to BMDS functions such as track, FBS, discrimination, countermeasures.

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| | | Date |
|---|---|---|
| **Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification** | | **February 2007** |
| APPROPRIATION/BUDGET ACTIVITY<br>**RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P)** | | R-1 NOMENCLATURE<br>**0603897C BMD Hercules** |

- Provide RF and EO/IR flight test data collection requirements support to Systems Engineering.

## C. Other Program Funding Summary

| | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| PE 0603175C Ballistic Missile Defense Technology | 147,270 | 193,307 | 118,569 | 109,540 | 116,014 | 121,008 | 127,917 | 131,291 | 1,064,916 |
| PE 0603881C Ballistic Missile Defense Terminal Defense Segment | 1,120,879 | 1,092,076 | 962,585 | 1,004,282 | 924,101 | 851,213 | 678,694 | 501,147 | 7,134,977 |
| PE 0603882C Ballistic Missile Defense Midcourse Defense Segment | 2,391,246 | 3,043,058 | 2,520,064 | 2,359,665 | 2,179,602 | 1,699,963 | 1,153,082 | 1,183,003 | 16,529,683 |
| PE 0603883C Ballistic Missile Defense Boost Defense Segment | 455,572 | 628,958 | 548,759 | 432,432 | 448,375 | 678,913 | 829,683 | 1,026,239 | 5,048,931 |
| PE 0603884C Ballistic Missile Defense Sensors | 284,297 | 514,129 | 778,163 | 984,963 | 939,417 | 791,701 | 723,843 | 603,585 | 5,620,098 |
| PE 0603886C Ballistic Missile Defense System Interceptors | 200,446 | 356,004 | 227,499 | 393,317 | 522,388 | 730,236 | 836,029 | 570,206 | 3,836,125 |
| PE 0603888C Ballistic Missile Defense Test and Targets | 610,619 | 601,782 | 586,150 | 628,364 | 662,984 | 681,511 | 696,037 | 705,210 | 5,172,657 |
| PE 0603889C Ballistic Missile Defense Products | 387,402 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 387,402 |
| PE 0603890C Ballistic Missile Defense System Core | 409,993 | 429,420 | 482,016 | 511,147 | 558,746 | 579,571 | 579,316 | 588,481 | 4,138,690 |
| PE 0603891C Special Programs - MDA | 271,021 | 353,031 | 323,250 | 305,409 | 369,073 | 526,966 | 789,017 | 792,271 | 3,730,038 |
| PE 0603892C Ballistic Missile Defense Aegis | 893,040 | 1,122,669 | 1,059,103 | 1,129,425 | 1,221,650 | 1,067,587 | 1,054,753 | 1,089,078 | 8,637,305 |
| PE 0603893C Space Tracking & Surveillance System | 220,048 | 322,220 | 331,525 | 347,811 | 412,623 | 501,197 | 778,067 | 981,424 | 3,894,915 |
| PE 0603894C Multiple Kill Vehicle | 48,370 | 144,362 | 271,151 | 352,741 | 461,179 | 618,263 | 673,477 | 842,905 | 3,412,448 |
| PE 0603895C BMD System Space Program | 0 | 0 | 27,666 | 35,093 | 46,849 | 56,183 | 133,617 | 157,117 | 456,525 |
| PE 0603896C BMD C2BMC | 0 | 246,852 | 258,913 | 294,627 | 300,847 | 282,615 | 267,275 | 269,420 | 1,920,549 |
| PE 0603898C BMD Joint Warfighter Support | 0 | 54,935 | 48,787 | 50,428 | 54,086 | 56,603 | 58,890 | 60,206 | 383,935 |
| PE 0603904C BMD Joint National Integration Center (JNIC) | 0 | 110,629 | 104,012 | 106,985 | 111,542 | 111,947 | 113,592 | 115,287 | 773,994 |
| PE 0603905C BMD Concurrent Test and Operations | 0 | 23,159 | 0 | 0 | 0 | 0 | 0 | 0 | 23,159 |
| PE 0603906C Regarding Trench | 0 | 0 | 2,000 | 3,000 | 5,000 | 5,000 | 9,000 | 9,000 | 33,000 |
| PE 0605502C Small Business Innovative Research - MDA | 133,105 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 133,105 |
| PE 0901585C Pentagon Reservation | 14,874 | 15,527 | 6,058 | 6,376 | 4,490 | 4,725 | 4,801 | 4,877 | 61,728 |
| PE 0901598C Management Headquarters - MDA | 98,609 | 87,059 | 85,906 | 86,453 | 70,355 | 69,855 | 69,855 | 69,855 | 637,947 |

Project: 0505 Hercules

MDA Exhibit R-2A (PE 0603897C)

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**UNCLASSIFIED**

| Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification | Date<br>**February 2007** |
|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>**RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P)** | R-1 NOMENCLATURE<br>**0603897C BMD Hercules** |

**D. Acquisition Strategy**

Hercules is key to MDA's capability-based acquisition strategy, which emphasizes assessment, spiral-development testing and evolutionary acquisition through the definition of two-year capability blocks. Hercules develops algorithms providing enhance and new capabilities through early TRL levels (TRL 1-5) into common baseline prototypes and supports transition and integration into specific BMDS Elements or Components.

Hercules algorithms are designed to provide improved or new capabilities to the BMDS and be common across a family of systems (i.e., X-band radars or EO/IR KV seekers) or applicable to BMDS level operations (i.e., C2BMC). The implementing elements or components will then engineer the common prototype into operational software. Hercules activities are performed by subject matter experts from government, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARC), private industry including major defense contractors, government laboratories, and System Engineering and Technical Assistance (SETA) contractors.

Hercules uses annual task orders through various contracting methods (i.e., executing agents, direct contracts, modifications to other BMDS contracts) to fund and guide development activities. Battle manager, weapon, and sensor capability improvements will be transitioned into the future operational force structure by integrating the Hercules algorithms into BMDS components. BMDS component managers plan, budget, and procure the necessary hardware and software for deployed and sustained operational forces.

| | | | | | Date | | |
|---|---|---|---|---|---|---|---|
| **Missile Defense Agency (MDA) Exhibit R-3 RDT&E Project Cost Analysis** | | | | | **February 2007** | | |

| APPROPRIATION/BUDGET ACTIVITY | R-1 NOMENCLATURE |
|---|---|
| **RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P)** | **0603897C BMD Hercules** |

## I. Product Development   Cost ( $ in Thousands )

| Cost Categories: | Contract Method & Type | Performing Activity & Location | Total PYs Cost | FY 2007 Cost | FY 2007 Award/ Oblg Date | FY 2008 Cost | FY 2008 Award/ Oblg Date | FY 2009 Cost | FY 2009 Award/ Oblg Date | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| **Decision Architecture** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Arlington, Huntsville | 0 | 4,950 | 1/2Q | 5,625 | 1/2Q | 5,681 | 1/2Q | 16,256 |
| **Forward Based Sensors** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Arlington, Huntsville | 0 | 4,488 | 1/2Q | 2,300 | 1/2Q | 2,323 | 1/2Q | 9,111 |
| **Blue Team** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Lexington, Mass | 0 | 8,613 | 1/2Q | 5,813 | 1/2Q | 5,708 | 1/2Q | 20,134 |
| **Corporate Clutter Working Group** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Arlington, VA | 0 | 3,200 | 1/2Q | 3,257 | 1/2Q | 3,233 | 1/2Q | 9,690 |
| **Engineering and Integration** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Arlington, Huntsville | 0 | 1,277 | 4Q | 4,295 | 1/2Q | 7,264 | 1Q | 12,836 |
| **ADAC** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Arlington, Huntsville | 0 | 0 | 4Q | 9,344 | 1/2Q | 9,645 | 1/2Q | 18,989 |
| Subtotal Product Development | | | 0 | 22,528 | | 30,634 | | 33,854 | | 87,016 |

## Remarks

Project: 0505 Hercules

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| Missile Defense Agency (MDA) Exhibit R-3 RDT&E Project Cost Analysis | Date **February 2007** |
|---|---|

| APPROPRIATION/BUDGET ACTIVITY **RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P)** | R-1 NOMENCLATURE **0603897C BMD Hercules** |
|---|---|

## II. Support Costs   Cost ( $ in Thousands )

| Cost Categories: | Contract Method & Type | Performing Activity & Location | Total PYs Cost | FY 2007 Cost | FY 2007 Award/ Oblg Date | FY 2008 Cost | FY 2008 Award/ Oblg Date | FY 2009 Cost | FY 2009 Award/ Oblg Date | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| **Engineering and Integration** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercule/ Arlington, Huntsville | 0 | 2,450 | 1/2Q | 2,450 | 1/2Q | 2,432 | 1/2Q | 7,332 |
| Subtotal Support Costs | | | 0 | 2,450 | | 2,450 | | 2,432 | | 7,332 |

**Remarks**

## III. Test and Evaluation   Cost ( $ in Thousands )

| Cost Categories: | Contract Method & Type | Performing Activity & Location | Total PYs Cost | FY 2007 Cost | FY 2007 Award/ Oblg Date | FY 2008 Cost | FY 2008 Award/ Oblg Date | FY 2009 Cost | FY 2009 Award/ Oblg Date | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| **Engineering and Integration** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Arlington, Huntsville | 0 | 8,325 | 1/2Q | 9,525 | 1/2Q | 9,456 | 1/2Q | 27,306 |
| Subtotal Test and Evaluation | | | 0 | 8,325 | | 9,525 | | 9,456 | | 27,306 |

**Remarks**

Project: 0505 Hercules

MDA Exhibit R-3 (PE 0603897C)

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| | | | | | Date<br>**February 2007** |
|---|---|---|---|---|---|
| **Missile Defense Agency (MDA) Exhibit R-3 RDT&E Project Cost Analysis** | | | | | |

| APPROPRIATION/BUDGET ACTIVITY<br>**RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P)** | R-1 NOMENCLATURE<br>**0603897C BMD Hercules** |
|---|---|

### IV. Management Services   Cost ( $ in Thousands )

| Cost Categories: | Contract Method & Type | Performing Activity & Location | Total PYs Cost | FY 2007 Cost | FY 2007 Award/ Oblg Date | FY 2008 Cost | FY 2008 Award/ Oblg Date | FY 2009 Cost | FY 2009 Award/ Oblg Date | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| **Engineering and Integration** | | | | | | | | | | |
| Algorithm Development | C/Various | Hercules/ Arlington, VA | 0 | 14,649 | 1/2Q | 8,605 | 1/2Q | 5,979 | 1/2Q | 29,233 |
| Subtotal Management Services | | | 0 | 14,649 | | 8,605 | | 5,979 | | 29,233 |

**Remarks**

| Project Total Cost | | | 0 | 47,952 | | 51,214 | | 51,721 | | 150,887 |
|---|---|---|---|---|---|---|---|---|---|---|

**Remarks**

Project: 0505 Hercules

| Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification | | Date February 2007 |
|---|---|---|

| APPROPRIATION/BUDGET ACTIVITY RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P) | R-1 NOMENCLATURE 0603897C BMD Hercules |
|---|---|

| COST ($ in Thousands) | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 |
|---|---|---|---|---|---|---|---|---|
| 0602 Program-Wide Support | 0 | 1,722 | 2,444 | 2,543 | 3,069 | 2,601 | 2,583 | 2,602 |
| RDT&E Articles Qty | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## A. Mission Description and Budget Item Justification

Program-Wide Support provides funding for common non-headquarters support functions across the entire program such as strategic planning, program integration, business management, cost estimating, contracting, and financial management, to include preparation of financial statements, reimbursement of financial services provided by DFAS, internal review and audit, earned-value management, and program assessment. Includes costs for both government civilians performing these functions, as well as outside services and support contractors that augment government staff in these areas. Many of these costs reside within the Missile Defense Agency Executing Agents in the Services: Army Space and Missile Defense Command, Army PEO Space and Missile Defense, Office of Naval Research, and various Air Force laboratory and acquisition activities, although some functions and costs within this program element are performed by MDA employees assigned within the National Capital Region (NCR). Other costs included herein provide facility capabilities for MDA Executing Agent locations, such as physical and technical security, legal services, travel and training, office and equipment leases, utilities and communications, supplies and maintenance, and similar operating expenses. Also includes funding for charges on canceled appropriations in accordance with Public Law 101-510, legal settlements, and foreign currency fluctuation on a limited number of foreign contracts.

## B. Accomplishments/Planned Program

| | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|
| Civilian Salaries and Support | 0 | 1,722 | 2,444 | 2,543 |
| RDT&E Articles (Quantity) | 0 | 0 | 0 | 0 |

See Section A: Mission Description and Budget Item Justification

Project: 0602 Program-Wide Support

MDA Exhibit R-2A (PE 0603897C)

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification | | | | | | | Date<br>**February 2007** | |
| APPROPRIATION/BUDGET ACTIVITY<br>**RDT&E, DW/04 Advanced Component Development and Prototypes (ACD&P)** | | | | | R-1 NOMENCLATURE<br>**0603897C BMD Hercules** | | | |

## C. Other Program Funding Summary

| | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| PE 0603175C Ballistic Missile Defense Technology | 147,270 | 193,307 | 118,569 | 109,540 | 116,014 | 121,008 | 127,917 | 131,291 | 1,064,916 |
| PE 0603881C Ballistic Missile Defense Terminal Defense Segment | 1,120,879 | 1,092,076 | 962,585 | 1,004,282 | 924,101 | 851,213 | 678,694 | 501,147 | 7,134,977 |
| PE 0603882C Ballistic Missile Defense Midcourse Defense Segment | 2,391,246 | 3,043,058 | 2,520,064 | 2,359,665 | 2,179,602 | 1,699,963 | 1,153,082 | 1,183,003 | 16,529,683 |
| PE 0603883C Ballistic Missile Defense Boost Defense Segment | 455,572 | 628,958 | 548,759 | 432,432 | 448,375 | 678,913 | 829,683 | 1,026,239 | 5,048,931 |
| PE 0603884C Ballistic Missile Defense Sensors | 284,297 | 514,129 | 778,163 | 984,963 | 939,417 | 791,701 | 723,843 | 603,585 | 5,620,098 |
| PE 0603886C Ballistic Missile Defense System Interceptors | 200,446 | 356,004 | 227,499 | 393,317 | 522,388 | 730,236 | 836,029 | 570,206 | 3,836,125 |
| PE 0603888C Ballistic Missile Defense Test and Targets | 610,619 | 601,782 | 586,150 | 628,364 | 662,984 | 681,511 | 696,037 | 705,210 | 5,172,657 |
| PE 0603889C Ballistic Missile Defense Products | 387,402 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 387,402 |
| PE 0603890C Ballistic Missile Defense System Core | 409,993 | 429,420 | 482,016 | 511,147 | 558,746 | 579,571 | 579,316 | 588,481 | 4,138,690 |
| PE 0603891C Special Programs - MDA | 271,021 | 353,031 | 323,250 | 305,409 | 369,073 | 526,966 | 789,017 | 792,271 | 3,730,038 |
| PE 0603892C Ballistic Missile Defense Aegis | 893,040 | 1,122,669 | 1,059,103 | 1,129,425 | 1,221,650 | 1,067,587 | 1,054,753 | 1,089,078 | 8,637,305 |
| PE 0603893C Space Tracking & Surveillance System | 220,048 | 322,220 | 331,525 | 347,811 | 412,623 | 501,197 | 778,067 | 981,424 | 3,894,915 |
| PE 0603894C Multiple Kill Vehicle | 48,370 | 144,362 | 271,151 | 352,741 | 461,179 | 618,263 | 673,477 | 842,905 | 3,412,448 |
| PE 0603895C BMD System Space Program | 0 | 0 | 27,666 | 35,093 | 46,849 | 56,183 | 133,617 | 157,117 | 456,525 |
| PE 0603896C BMD C2BMC | 0 | 246,852 | 258,913 | 294,627 | 300,847 | 282,615 | 267,275 | 269,420 | 1,920,549 |
| PE 0603898C BMD Joint Warfighter Support | 0 | 54,935 | 48,787 | 50,428 | 54,086 | 56,603 | 58,890 | 60,206 | 383,935 |
| PE 0603904C BMD Joint National Integration Center (JNIC) | 0 | 110,629 | 104,012 | 106,985 | 111,542 | 111,947 | 113,592 | 115,287 | 773,994 |
| PE 0603905C BMD Concurrent Test and Operations | 0 | 23,159 | 0 | 0 | 0 | 0 | 0 | 0 | 23,159 |
| PE 0603906C Regarding Trench | 0 | 0 | 2,000 | 3,000 | 5,000 | 5,000 | 9,000 | 9,000 | 33,000 |
| PE 0605502C Small Business Innovative Research - MDA | 133,105 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 133,105 |
| PE 0901585C Pentagon Reservation | 14,874 | 15,527 | 6,058 | 6,376 | 4,490 | 4,725 | 4,801 | 4,877 | 61,728 |
| PE 0901598C Management Headquarters - MDA | 98,609 | 87,059 | 85,906 | 86,453 | 70,355 | 69,855 | 69,855 | 69,855 | 637,947 |

Project: 0602 Program-Wide Support

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