THE BALLISTIC MISSILE DEFENSE ORGANIZATION'S CONSOLIDATED TARGETS PROGRAM

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Abstract

The Ballistic Missile Defense Organization's (BMDO) Consolidated Targets Program (CTP) provides threat-representative targets and related items for test and evaluation (T&E) activities associated with Theater Missile Defense (TMD), National Missile Defense (NMD) and other Department of Defense (DoD) technology and demonstration programs. The CTP was instituted to centralize planning, management, acquisition, and operations for all BMDO target systems. Through it's primary executing agency, the U.S. Army Space and Strategic Defense Command (USASSDC), this consolidated approach facilitates improved management of target requirements, validation, verification and accreditation (VV&A) processes, and the acquisition and development of credible and cost-effective targets. Based on the test objectives, the user develops and provides target requirements to the CTP. The targets program executing agent, in coordination with the user, analyzes, refines, and costs the target requirements to ensure the user receives the most cost-effective targets which meet the test requirements. The targets program acquisition strategy emphasizes the use of off-the-shelf and excess government equipment in order to reduce development and focus on target systems which allow maximum test flexibility with minimal infrastructure support. Foreign Military Acquisition (FMA) assets are also integrated whenever available and appropriate.

1. Introduction

The Ballistic Missile Defense Organization (BMDO), under the authority, direction, and control of the Under Secretary of Defense (Acquisition and Technology), is responsible for managing and directing the Department of Defense's Ballistic Missile Defense (BMD) programs. These programs include a Theater Missile Defense (TMD) family of systems and a National Missile Defense (NMD) system for the United States. The BMDO is also responsible for the research and development of follow-on technologies that are relevant for long-term ballistic missile defense. These programs build a technical foundation for the evolutionary growth of future ballistic missile defenses. In developing these acquisition and technology programs, the BMDO utilizes the Services of the Military Departments, the Department of Energy, private industry, and educational and research institutions.

The BMDO Test and Evaluation (T&E) program is designed to assess technology, reduce acquisition risk, verify attainment of technical performance objectives, ensure systems are operationally effective and suitable, and provide essential and timely information to support decision making[1]. This paper discusses the BMDO's Consolidated Targets Program (CTP) which provides targets for the testing of all ballistic missile defense programs.

2. Ballistic Missile Defense Program Overview[2]

The Ballistic Missile Defense Program is structured to respond to existing and emerging ballistic missile threats to the United States, its forward deployed forces, allies, and friends around the world. The highest priority is Theater Missile Defense (TMD), followed by National Missile Defense (NMD), and finally investment in BMD advanced technologies.

2.1 Theater Missile Defense Program

Since a single TMD system cannot defend against all of the potential theater missile threats, the Defense Department is pursuing a "family of systems" (FoS) approach to TMD. This FoS approach provides defense in depth, using multi-tiered defenses against short to long range theater class ballistic missiles. The BMDO-managed programs include the PATRIOT Advanced Capability-3 (PAC-3), Navy Area Theater Ballistic Missile Defense (TBMD) System, Medium-Extended Air Defense System (MEADS), Theater High Altitude Area Defense (THAAD), and the Navy Theater-Wide TBMD System. The U.S. Air Force, in coordination with the BMDO, is developing a boost-phase intercept system called the Airborne Laser (ABL). Also, the BMDO is developing the command and control (C2) mechanisms that will coordinate the TMD FoS engagements.

2.2 National Missile Defense (NMD) Program

The NMD program is in a deployment readiness posture that involves developing hardware for use in an integrated

system test in Fiscal Year 1999 to demonstrate a NMD capability. The acquisition strategy is to complete development of the NMD elements which include an exo-atmospheric kill vehicle (EKV), a ground based interceptor (GBI), an Anti-Ballistic Missile treaty-compliant testbed radar, a NMD Ground Based Radar Prototype, and a prototype Battle Management, Command, Control, and Communications (BM/C3) demonstrator. The Air Force funded Space Based Infrared System (SBIRS) Low Component is directly supporting the NMD program.

2.3 BMDO Advanced Technologies

Technologies that provide options for improvements to the planned and deployed defenses must be explored and matured to maintain the viability of the BMD architecture. Current technological requirements include the development of capabilities to defeat countermeasures and counter threat evolution. Advanced technology programs are investing in promising concepts focused on improved capabilities in kinetic energy interceptors, directed energy systems, and advanced sensors.

3. Background

The DoD designated the BMDO as the Reliance organization responsible for the acquisition of ballistic missile defense targets. The BMDO established the CTP to execute the activities necessary to acquire ballistic missile targets with the goal of providing cost-effective and threat-representative targets appropriate for BMD applications.

3.1 Consolidated Targets Program Policy[3]

In order for the acquisition of test targets to be as efficient as possible, the Director of the BMDO consolidated the management of all target acquisition efforts in the Test and Engineering Resources Directorate (TOT). This approach provides for a single department to be responsible to the Director, BMDO for all target and target-related activities. This sole point-of-contact facilitates the management of target requirements, validation, verification and accreditation processes, and the development and acquisition of consistent credible targets in a cost-effective manner. The CTP uses a three-tiered management structure consisting of overall program management and direction by the BMDO, Service executing agents for technical management, and finally program execution by technical teams of Service field agencies, and contractors.

3.1.1. CTP Program Management

The BMDO Director of Test and Engineering Resources is responsible for the overall management of the targets program. In addition to being the Reliance lead for all BMD target-related activities, the BMDO is responsible for developing targets policy, defining the targets management structure, and performing targets-related planning, programming and budgeting activities. The BMDO participates in many forums amongst the test and evaluation community, including the Joint Target Oversight Council (JTOC). Finally, the Director, TOT serves as the interface for target-related matters between the BMDO and other organizations, including the U.S. Congress and the Office of the Secretary of Defense's test and evaluation offices, primarily the Director, Test, Systems Engineering, and Evaluation, and the Director, Operational Test and Evaluation.

3.1.2 CTP Technical Management

The BMDO designates a Service executing agent to perform the technical direction and management required to implement the targets program. The program executing agent works with the user to define the target and test requirements and performs most of the planning and management for test events. The target hardware configuration, as well as the use of Government-Furnished Equipment (GFE), are defined by the executing agent. Due to their active roll in the target's presentation, the executing agent provides the interface with both the test range and all users. Finally, post-flight analysis of target performance is the responsibility of the BMDO designated executing agent.

3.1.3 CTP Technical Execution

The executing agents use technical teams, consisting of either Service field teams or contractors, to execute the targets program. Key duties of these technical teams are:

- Target design and development
- Contract execution
- Target fabrication
- Final target integration
- Launch operations
- Post flight analysis

3.2 Targets Definition

The two main components of ballistic missile targets are the re-entry vehicle (RV) and the delivery system. In many scenarios, the re-entry vehicle section is the only part of the test missile that is viewed by detection radar and sensors, therefore it is the re-entry vehicle that is the actual "target." In other test scenarios, the booster delivery system remains connected to the re-entry vehicle.

4. Target Requirements

Test targets are acquired based on the needs of BMD programs that require targets to satisfy objectives of their test and evaluation programs. The policies and procedures used to acquire these test targets are detailed in the BMDO Consolidated Targets Program Plan (CTPP)[4]. The CTPP specifies a well-defined series of procedures to divide the

process of defining target requirements into a workable operation. The major steps for developing threat representative targets are:

1. Identification of threat
2. Determination of threats to be included in a baseline target set
3. Specification of threat characteristics
4. Target verification
5. Target validation
6. Target accreditation

4.1 System Threat Assessment

The TMD System Threat Assessment identifies approximately 30 Theater Ballistic Missile threats which BMDO developed weapons systems could encounter. Selected TMD threat capabilities are shown in Figure 1. Each of these threat systems can be flown in multiple configurations at ranges from 80 to 3,500 kilometers, using solid and/or liquid boosters, separating and unitary re-entry vehicles, maneuvering and non-maneuvering re-entry vehicles, diverse payloads, and various penetration aids including simple radar decoys and jammers.

The potential strategic threat set consists of seven systems with ranges greater than 3,500 kilometers, re-entry velocities greater than 5 kilometers per second with some carrying multiple warheads and penetration aids. The CTP provides a comprehensive ensemble of test targets to adequately represent the spectrum of both the theater and strategic threats.

4.2 Baseline Target Set

Due to the vast number and configurations of threat systems, it is neither practical nor affordable to develop targets representative of each potential threat. The acquisition, intelligence, and test and evaluation communities including the Theater Targets Working Group, the BMDO Test and Evaluation Working Group, the Test and Evaluation Integrated Product Team for each BMDO major defense acquisition process, and the Operational Testing Community, have agreed to a set of five theater targets which adequately represent the set of threats, Figure 2. This baseline target set allows for a comprehensive evaluation of the operational and technical performance characteristics of BMDO weapons systems against the spectrum of threat systems. The BMDO baseline target set has been defined as these five targets which represent the broad signature and operating characteristics of the identified threats.

4.3 Threat Characteristics

Before the acquisition of BMD targets can commence, it is vital to obtain complete data profiles on the threat missiles to be emulated. The Defense Intelligence Agency creates threat descriptions from various sources that characterize ballistic missile threats from around the world. These technical profiles include information regarding the specific properties of each threat including basic projectile properties like mass, trajectory, and spatial size, and more complex properties like radar cross section, infrared signature, re-entry vehicle and payload configurations, and possible countermeasures. With this information, the BMDO can develop targets that represent actual threats.

4.4 Target Verification, Validation and Accreditation (VV&A)

A critical aspect of the CTP is the requirement that all targets used for the testing of ballistic missile defense systems are constructed to meet strict specifications set forth by the BMD programs. All targets developed under the BMDO CTP are required to follow a well-defined target verification, validation and accreditation process[5]. This ensures that the target meets the prescribed test requirements.

4.4.1 Target Verification

Target verification is the process that the BMDO uses to ensure that BMDO target designs are consistent with Defense Intelligence Agency (DIA) threat descriptions and

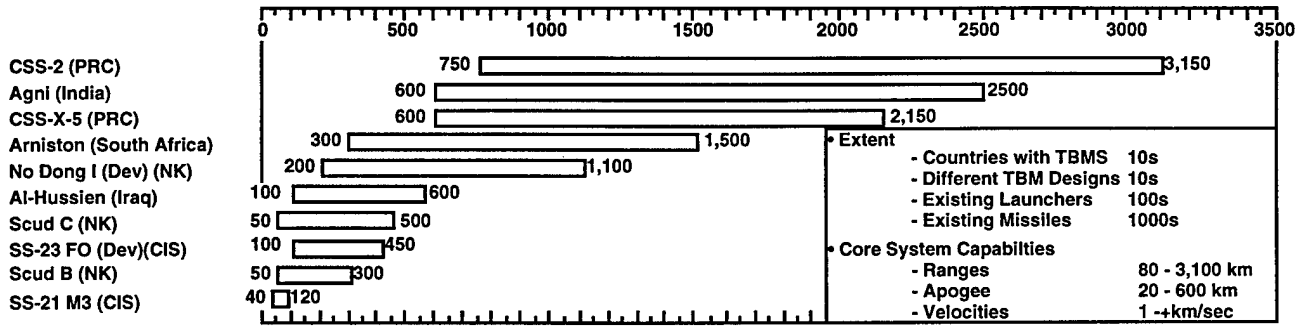


Figure 1. Theater Ballistic Missile Threat Systems

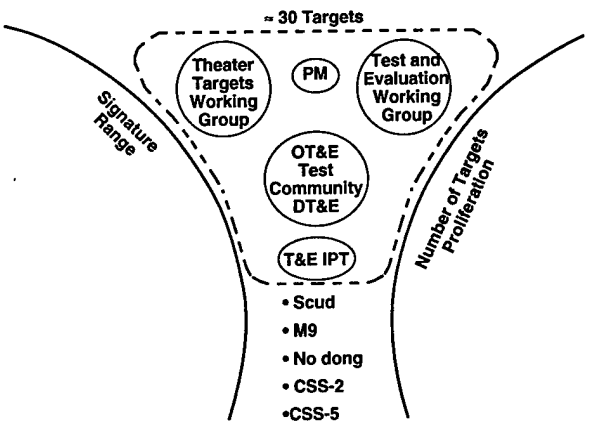


Figure 2. BMDO Baseline Target Set Selection Process

user test requirements. Verification includes the confirmation that all data inputs, logic, calculations and engineering representations of a target accurately portray the characteristics and interactions of the target item under evaluation. Target verification is performed when a target is required to represent a "new" threat, or one that is currently not represented in the CTP's baseline target set. Once these designs are verified, they may require updating as new information becomes available on relevant threat characteristics.

4.4.2 Target Validation

Target validation is the process used to ensure the ballistic missile target accurately represents the real-world threat based upon DIA descriptions by characterizing the developed target and comparing it with the intended threat target performance. Physical tests of components, prototype, and flight test units are conducted to show that a target interacts with the BMDO system in a technically and operationally realistic manner. Target validation commences when verified target design characteristics are provided to the CTP's lead executing agent, U.S. Army Space and Strategic Defense Command (USASSDC). At that time, the BMDO T&E community drafts a Validation Plan which outlines the threats to be compared to the target, the parameters needed for comparison, and a schedule of validation process milestones. A government agency or contractor is then designated to construct a prototype target object. Finally, the target undergoes comprehensive testing to collect and analyze the performance data required to characterize the target. This characterization process culminates in a flight test where an array of sensors collect data on the various phenomena associated with ballistic missile flight. These data are used as the final data element in the validation of the target and are provided to BMD programs to update their target signature models.

4.4.3 Target Accreditation

Target accreditation involves the review and determination by the cognizant test authority that a target has met established standards of verification and validation, is acceptable for its designed purpose, and will meet their intended test requirements. Upon completion of target accreditation, the user may proceed with the acquisition of the target objects necessary for test use.

5. BMDO Target Acquisition Strategy

The BMDO's Targets Program develops and procures ballistic missile targets based upon an acquisition plan that stresses the need for highly reliable, threat-representative, and cost efficient targets. The acquisition strategy for BMD targets consists of four basic principles: 1) Use of excess government and commercial off-the-shelf equipment whenever possible, 2) Integration of Foreign Materiel Acquisition (FMA) assets whenever available and appropriate, 3) Use of target delivery methods which provide the tester maximum flexibility, and 4) Selection of target systems which require minimal infrastructure support. It is the challenge of the Targets Program to execute the acquisition strategy while meeting the user's requirements. Many factors must be taken into consideration in procuring ballistic missile targets. The basic requirements of a target include specifications for the flight environment, signature, threat fidelity, and target instrumentation. These specifications must be met for the target to be an effective test tool. Yet, an effort must be made to produce affordable targets and the target must comply with provisions of applicable missile and testing treaties. All of these factors must be considered as the BMDO's Targets Program procures targets.

Using this strategy, the Consolidated Targets Program has developed numerous ballistic missile targets to support BMD systems. Typically, the target delivery system and the payload are developed separately and final target preparation involves the integration of these systems to form a cohesive test and evaluation tool.

5.1 Target Delivery Systems

5.1.1 Government Furnished Equipment

The CTP has instituted an aggressive program to identify excess government missile components which can be used in BMD target delivery systems. To implement this strategy, the CTP developed a comprehensive program to perform aging, surveillance, refurbishment, storage, and maintenance of a variety of excess government missile components including booster, guidance, and re-entry systems. The maintenance of target hardware of this nature is key to reducing target costs by making maximum use of available excess government hardware.

The booster systems used to deploy BMD targets are primarily decommissioned missile boosters, supplemented, where necessary, by commercial boosters. The three stages of the Minuteman (MM) II are used to support the Multi-Service Launch System target system. The second and

third stage boosters from the MMII/III, the SR-19, and the M-57, are used for many of the TMD targets. For this function, the SR-19 booster must be modified to perform at sea-level to have more trajectory control available. Similarly, the Strategic Target System (STARS) uses decommissioned Polaris A-3 boosters and a commercially developed ORBUS-1 motor.

In addition to simply supplying the rocket booster, the BMDO ensures the airworthiness of the booster through an extensive aging and surveillance program. Since decommissioned motors are more suspect to failure due to age, each motor is carefully monitored for defects.

5.1.2 Hera Target Delivery System[6]

The Hera is the primary TMD target delivery system, Figure 3. The system is composed of decommissioned Minuteman II/III boosters which are coupled with either a form of ballistic re-entry vehicle or a maneuvering target vehicle. (See Section 5.2)

The Hera target delivery system provides a flexible platform for target presentations. The Hera can be constructed with numerous re-entry vehicle configurations enabling various radar and infrared signatures. With a range of up to 1,173 km, the Hera target delivery system is capable of flying trajectories that accurately emulate many TBM flight profiles. This target can also perform a shaped trajectory flight, called the "Piledriver." When flown in this mode, the target is reoriented after the first booster has extinguished and the second stage accelerates the target towards the earth. This configuration emulates the higher re-entry velocity and shallower re-entry angle displayed by longer range TMD threats. The Hera target has been used successfully in eight flight tests in support of the THAAD program.

- Vehicle Characteristics And Capabilities
  - Propellant: Solid
  - # Stages: 2
  - Stage 1 Motor: SR-19 (MMs/ Stage 2)
  - Stage 2 Motor: M57A1 (MM1) / Stage 3
  - Payload: 2,000 lbm
  - Angle @ Burnout: 40 Deg
  - Vel @ Burnout: 2.86 km/sec
  - Reentry Vel @ 80 km: <3.00 km/sec
  - Apogee: 30 km
  - Range: 1,173 km
  - Exo-time: 479 sec (Above 100 km)
- Contractor
  - Coleman Research Corporation Orlando, FL
- Subcontractor
  - Space Vector
  - Kaman
  - Aerotherm

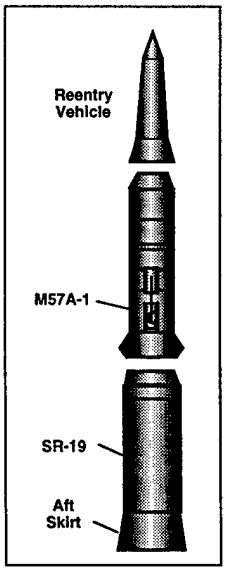


Figure 3. Hera Target Delivery System

5.1.3 Air Launch Target Delivery Systems

The TMD test scenarios require the presentation of the target in a variety of complex geometries and situations. Among these are requirements for targets to be flown into the defended area from multiple distances and varying azimuths. Additionally, the target delivery system must have the capability to test the weapon system's ability to engage multiple targets by presenting targets for engagement in the defended area battlespace simultaneously. While the current procedure of launching targets from existing ground based launch sites is adequate for early-on developmental testing during the demonstration and validation phase, the current launch sites are not adequate to support the threat representative test scenarios required during Engineering and Manufacturing Development Phase testing. The BMDO performed an in-depth analysis and evaluation of several concepts to determine viable candidate solutions to this issue[7]. Seven concepts were studied and three preferred options were selected for further analysis. The BMDO sponsored an in-depth analysis of the cost, schedule, and performance aspects of these three options. Of the three, the air launch option, meaning extracting ballistic missile targets from an unmodified Air Force cargo aircraft and subsequently air launching the target on the desired trajectory, was deemed superior[8]. There are many advantages to the air launch of BMD targets including the reduced infrastructure necessary to support testing and the use of a mobile launch platform greatly increasing the flexibility of the test environment by allowing for threat-representative trajectories without the constraint of launching the target from a fixed location.

The air launch target delivery concept can be used to meet the short range, 80-600 km, and long range, 700-3,500 km, theater target requirements. Although the target delivery systems required for the short range and long range target will be of different configurations, their development and procurement will be managed as a single integrated air launch targets program with USASSDC serving as the lead executing agent. Integrating the management of the two air launch targets facilitates standardizing the development and operational procedures, fosters commonality of support equipment, and enhances configuration management and control of common equipment. Selection of this concept allows the target developer to leverage off of existing expertise with the reuse of GFE for targets and saves developmental and additional infrastructure costs since standard military cargo aircraft and existing missile assembly areas can be used.

5.1.3.1 Short-Range Air Launch Target

The Short-Range Air Launch Target is designed to emulate short-range ballistic missile threats. This concept involves dropping a single stage SR-19 booster and re-entry vehicle out of a standard military cargo aircraft, preferably a C-130, Figure 4. Using parachutes to stabilize

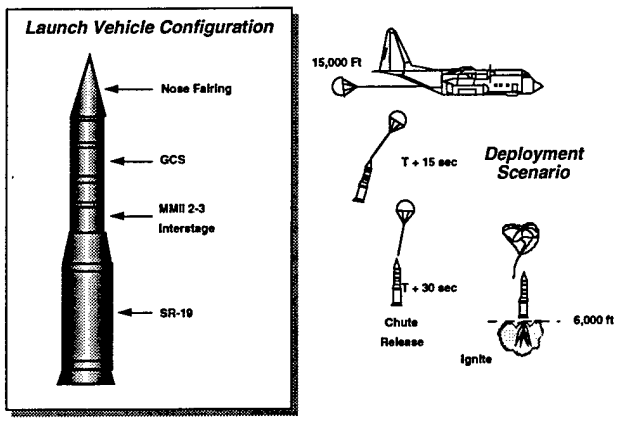


Figure 4. Short Range Air Launch Target Concept

the drop, the missile falls to 5,000 feet in a vertical position before the parachutes are released and the booster is ignited. The BMDO sponsored a demonstration of the concept using the National Air Intelligence Center as the executing agent. After a series of ground and airborne tests, a flight demonstration was conducted on January 30, 1997 which achieved near nominal performance throughout aircraft ejection, parachute deployment, descent, parachute release, rocket motor ignition, and 24 seconds of powered flight. A flight anomaly caused by a guidance and control program error, unrelated to the air launch operation, required command destruct of the target at that point. The assessment of the flight test was that 8 of the 9 major program objectives were achieved and all objectives relating to the viability of the air drop concept were achieved.

Due to treaty constraints, the short range launch target cannot fly a trajectory of more than 600 kilometers. In order to ensure a sufficient error margin, the Short-Range Air Launch Target will be designed to travel no more than 550 kilometers.

5.1.3.2 Long-Range Air Launch Target (LRALT)

The CTP has no target which can satisfactorily meet test requirements for TBMs in the 1,200-3,500 km range. The Long-Range Air Launch Target is being developed to emulate long-range theater ballistic missile threats. The LRALT (Figure 5) will fill a current void in the Consolidated Targets Program's target inventory. The LRALT, like it's short-range counterpart, will increase test flexibility and reduce launch site development and infrastructure. The LRALT will also be capable of supporting multiple simultaneous engagement scenarios.

The LRALT is currently under development and will require treaty compliance certification before it can be used as a target. Since the STARS can be flown as a theater ballistic missile, the BMDO will maintain STARS until LRALT is developed and successfully demonstrated. The LRALT demonstration is currently scheduled for first quarter fiscal year 2001.

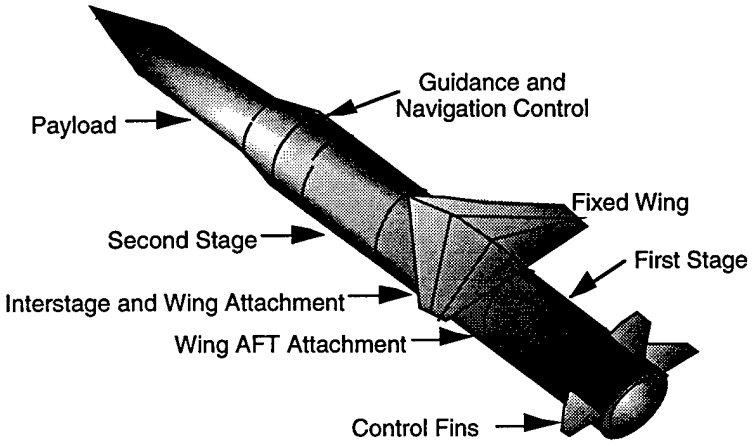
5.1.4 Other Theater Ballistic Missile Targets

5.1.4.1 Lance

The Lance target is a liquid fueled TBM that was used by the U.S. Army until 1993. It is now used to support TMD programs by providing low-cost per presentation targets for short range tests, under 100 km. Like the Hera target, the Lance can be equipped with various instrumentation to measure its performance and the performance of the interceptor.

5.1.4.2 Low Fidelity Test Target (LFTT)

For a number of BMD tests, highly instrumented and threat-representative targets are not necessary. Thus, the BMDO has begun to develop a Low Fidelity Test Target. The LFTT will be a baseline version of the Hera target. While less instrumented, the LFTT will serve the test and evaluation community by providing a less-expensive target for maintenance and training tests.



Benefits of the LRALT

- -Variable Azimuth, Range, Reentry Angle
- - Multiple Axis and Simulation Engagements
- - Threat Representation
- - Reduces Requirements for Ground Facilities
- - Reasonable Per Target Costs

Figure 5. Long Range Air Launch Target Concept

5.1.5 Strategic Delivery Systems

For threats ranging above 3,500 kilometers, the CTP provides targets to support the National Missile Defense program. Although the variance of threats in the NMD arena is not as great, other factors challenge the CTP to provide appropriate targets. The NMD target is more complex due to increased re-entry velocities, greater than 5 km/sec, capacity for multiple warheads, and various penetration aids.

5.1.5.1 Minuteman II / Multi-Service Launch System (MSLS)

With the decommissioning of the MMII Inter-Continental Ballistic Missile (ICBM), the MSLS has become available for use in test and evaluation as a target for the NMD program, Figure 6. Using the complete booster stack from the MMII, the MSLS is a payload platform for presenting multiple targets in an inter-continental trajectory over 3,000 km.

5.1.5.2 Strategic Target System (STARS)

The Strategic Target System is another target used by the BMDO in testing the NMD system, Figure 7. Consisting of refurbished Navy Polaris A-3 submarine launched ballistic missile boosters configured with a commercially developed ORBUS-1 third stage, the STARS rocket has been used as a target for the Midcourse Space Experiment flying from the Kauai Test Facility to the Kwajalein Missile Range. With a range of 2,600-4,200 km, STARS can also be used as a long range TMD target.

The Strategic Target System is the only land-based target system capable of deploying multiple independently targeted re-entry vehicles (MIRVs) that is compliant with the START I and START II treaties. The deployment of the MIRVs is provided by the STARS II Operational and Deployment Experiments Simulator Post-Boost Vehicle.

Vehicle Characteristics And Capabilities

• MM II	
- Propellant	Solid
- # Stages	3
- Stage 1 Motor	M55A1
- Stage 2 Motor	SR-19
- Stage 3 Motor	M57A1
- Range	7,780 km
- Apogee	1,310 km
- Guidance System	LN-100, Inertial, GPS Aided
• MSLS	
- Payload	279-358 kg
- Type Mission	RV Target Launch VAFB to KMR
- Contractor	Lockheed Martin
- Agency	Air Force (SMC)
- Status	R&D, Proof-of-Concept Demo in 4Q FY 96
- Launch Mode	Hot from Silo

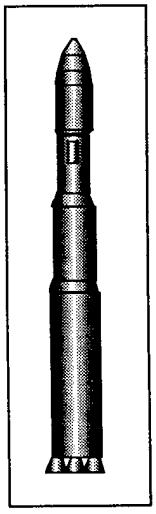


Figure 6. MMII / Multi-Service Launch System

Performance Capabilities

Payload:	300 - 900 lbs (135 - 400 kg)
Range:	1600 -2300 nm (2600 - 4300 km)
Apogee:	2 - 6 million ft (600 - 1800 km)
Max. Velocity	14,700 - 23,000 fps (4.5 - 7 km/sec.)

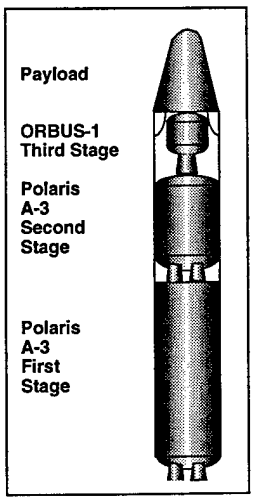


Figure 7. Strategic Target System

STARS is exempt from restrictions on the use of encrypted telemetry packages, therefore based on program requirements, STARS telemetry data can be encrypted.

5.2 Target Payloads

In addition to developing the target booster delivery system, the CTP is responsible for the development and acquisition of target payloads. Depending on the users' test requirements, a target payload consists of a re-entry vehicle which can be equipped with an assortment of mission assessment equipment and instrumentation. Much of the research done by the BMDO for target development is concentrated on work with target payloads. The focus of this effort is to offer more test flexibility with lower payload costs while still providing the desired target signature. While the target delivery system places the target on the desired trajectory with the proper flight conditions, the proper presentation of the re-entry vehicle in the electromagnetic spectra of interest to the sensor under test is essential. Precise characterization and construction of the re-entry vehicle is necessary to provide the desired signature. Early in the development cycle of a sensor, the primary test objective is typically the demonstration of the viability of a concept under development. Hardware and software designs are immature and often incapable of accommodating robust or complex target presentations such as would be encountered under normal operating conditions. For this reason, a very well defined target signature is desired. The result is that most re-entry vehicles used for testing BMDO systems in the early stages of development are designed specifically for each test event. While the CTP builds re-entry vehicles with the desired fidelity and characteristics for these tests, the practice of customizing re-entry vehicles on a case by case basis is not cost effective and is discouraged.

5.2.1 Theater Target Payloads

For theater missile defense system testing, different types of re-entry vehicles are currently used for integration with

the aforementioned payload delivery systems. These re-entry vehicles do not necessarily provide threat representative signatures but are designed, developed, modified if necessary, and instrumented on a test-by-test basis to provide a target with signatures consistent with meeting test requirements.

a) The Ballistic Re-entry Vehicle (BRV) is a non-maneuvering steel structure which flies a conventional ballistic trajectory. The dynamics of the BRV, trajectory, radar cross section and infrared signature, are adjusted using varying quantities of ballast and changing nose tips and heat shields. These target re-entry vehicles are well instrumented for test and evaluation purposes but do not emulate any particular threat.

b) The Maneuvering Target Vehicle is a target re-entry vehicle with the capability to maneuver after being separated from the target delivery system. This maneuvering is achieved with the use of air vanes and an attitude control hardware package. The unit that is integrated with the Hera target system is a modified government-furnished Pershing II re-entry vehicle.

5.2.1.1 Matching Ballistic Re-Entry Vehicles (MBRV)

As the BMDO programs mature, the required target signatures will evolve to a state where they must provide realistic representations of complex threat re-entry vehicles. The BMDO is developing a set of re-entry vehicles consistent with the baseline target set. The initial concept was the development of a re-entry vehicle with a common, fully instrumented mid-section and interchangeable fore and aft sections which could be configured to provide the desired signature. In theory, since every re-entry vehicle would use the same mid-section, the result would be a highly versatile modular, yet cost effective, vehicle. However, preliminary analysis showed that developing the desired signature using this modular approach was not feasible and the concept was dropped.

The CTP is developing four distinct re-entry vehicles referred to as matching ballistic re-entry vehicles (MBRV). These re-entry vehicles will be capable of emulating the five threats identified in the BMDO target set. The re-entry vehicles are being developed sequentially according to the required use date. All of the re-entry vehicles will be compatible with both ground and air launch target delivery systems. The MBRV program will provide the threat fidelity required to verify the performance of ballistic missile defense weapon systems.

5.2.1.2 CTP Foreign Material Acquisition (FMA)

The Foreign Material Acquisition program involves the purchase, exploitation, and conversion of foreign-made ballistic missiles for use as targets for sensor and interceptor test events and experiments. Due to the unique nature of the FMA program, use of these assets is subject to a test requirement for a specific FMA asset and the availability of that asset. Assets obtained through FMA can be either full-up foreign-made missiles which are modified for test purposes by properly instrumenting them with assorted telemetry packages, hit indicators, and miss-distance indicators or re-entry vehicle assets with appropriate instrumentation which are integrated with U.S. built boosters.

An additional benefit of using FMA assets is that they provide the opportunity to collect signature and performance data on actual, threat systems. Data collected during these tests provides excellent data on the target characteristics and signatures. These data are incorporated into estimates of the threat's characteristics and ultimately the non-FMA target payloads will be modified to reflect this updated threat data.

5.2.2 Strategic Target Payloads

For use with strategic target payload delivery systems, the BMDO has developed numerous targets to test the NMD system. The MSLS target platform has the ability to deploy both a re-entry vehicle and other target objects, including decoys and penetration aides, as dictated by the test requirements.

The BMDO has developed four penetration aids: a rigid light replica, an ultra light replica, a canisterized light replica, and a canisterized traffic balloon. These "penaids" are used to excite the system sensors and to test the ability of the system to detect multiple objects and discriminate the threat object.

5.2.3 Re-Entry Vehicle Instrumentation

For test and evaluation purposes, it is imperative that targets be well instrumented in order to accurately assess the test results. While for some tests, e.g., training tests, it is not necessary for a target to be highly instrumented, most test requirements include a need for detailed information regarding the environment of the engagement scenario.

Targets are fitted with complex electronics packages to serve these purposes. For range safety purposes, targets are equipped with on-board flight termination systems to safely terminate missions with observed anomalous behavior. Telemetry packages on the RV are used to track the target prior to engagement and to downlink data from onboard sensors. This capability is achieved with UHF, L-

band, S-band and C-band antennas which are integrated into the re-entry vehicle shell.

For engagement information, many targets are equipped with a photonic hit indicator (PHI) which provides detailed data of any collision of the target with a foreign object. The PHI consists of a fiber-optic grid embedded into the RV which is activated when a fiber is severed. This information is vital in pinpointing impact on the RV to assess the lethality of an interceptor.

Miss Distance Indicators (MDI) are often included to measure the relative distance of a close encounter between a target object and an interceptor when an engagement is either not planned or not achieved.

6. Target Launch Operations

Once the target is developed, the CTP is responsible for providing all phases of target launch services including storing, transporting, preparing, launching, and analyzing post-flight data. Target launch operations begin with the preparation of an adequate launch complex. For ground launched targets, a stool or rail launch platform is prepared. Additional infrastructure requirements may include road improvements, utility service and data transmission line service. Other range location support, such as range security, must be arranged and provided. For the air launch of targets, an aircraft must be prepared for use as a target delivery vehicle, i.e., the aircraft must be integrated with a launch pallet for target deployment.

Prior to testing, the components of a target are transported to the launch site from the government storage depot or contractor site and efforts to safely handle and store those components must be made. The final target assembly is performed after the individual components have been assembled and tested.

The CTP is also responsible for collecting and analyzing flight data. Targets are instrumented with on-board telemetry packages, and range assets such as optical sensors and radars are used to collect target performance and phenomenology data. This data is used to reconstruct the target flight, validate target signature characteristics, and support analysis of anomalous events during flight. Also, these data are provided to the BMD programs for use in evaluating critical functions associated with intercepts such as target detection, acquisition, tracking, etc., against actual target data.

7. Summary

The BMDO uses an innovative Consolidated Targets Program to provide a set of theater and strategic targets to support testing of BMD weapon systems at various levels of maturity and with a wide range of test objectives. The CTP stresses the use of excess GFE and commercial off-the-shelf components which are coupled with specialized hardware and software. These components are integrated using advanced design, development, and test processes to provide an extremely reliable yet cost effective target presentation. To date, the program has produced outstanding results with 51 of 53 successful flights. The CTP is in the process of developing short and long range air launch targets to meet the complex, threat representative test scenarios required for future testing. The program is dedicated to providing affordable targets which look and perform like actual threat systems. This allows testing of our ballistic missile defense system against realistic threat systems and operational scenarios and provides credible data for our leaders to make well-informed programmatic decisions.

References

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7 Theater Missile Defense Long Range Target Delivery System Study Findings, July 1995.

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