ROADMAP FOR THE BALLISTIC MISSILE DEFENSE ORGANIZATION GROUND TEST FACILITIES

Chet DeCesaris[a] and Paul Millner[b]

[a] Ballistic Missile Defense Organization,
Test and Engineering Resources Directorate,
Pentagon, Washington, DC 20301

[b] SRS Technologies,
1401 Wilson Boulevard, Suite 1200,
Arlington, VA 22209-2248

ABSTRACT

The Ballistic Missile Defense Organization (BMDO) is committed to providing cost effective, timely test and evaluation infrastructure, facilities, and resources to meet the needs of ballistic missile defense programs. The ability to thoroughly test and evaluate the advanced weapon systems under development within the BMDO is an essential element in their success. Ground testing plays a major role in addressing key technical issues and examining the system's operational characteristics. However, recent funding constraints have resulted in incremental budget cuts in the institutional funding allocated to the operation and maintenance of many of our key test resource infrastructure. With the erosion in this funding, test resource managers are forced to increase user test fees. This often leads to a reduction or elimination of testing at the facility, leading to further budget cuts due to the lack of testing, and ultimately closure of the resource. The BMDO Test and Engineering Resources Directorate has formed a Test and Evaluation Working Group (Resources) [TEWG(R)] to address the test resources infrastructure needs of BMDO programs. The TEWG(R) has instituted several key initiatives to address near term cost shortfalls and develop guidance to ensure test and evaluation infrastructure and activities are available to provide effective and efficient support to the ballistic missile defense acquisition and technology programs.

In support of the TEWG(R), three working integrated product teams have been formed to address ballistic missile target, test range and instrumentation, and ground test facility issues. This paper will address the role and activities of the Ground Test Facilities (GTF) Working Integrated Product Team (WIPT). The purpose of the GTF WIPT is to reduce test and evaluation costs through integrating test requirements, sharing development costs, and building on resident expertise and experience within the BMDO community, and reduce program risk by taking advantage of the benefits gained through repetitive test planning, setup, and execution. This paper describes the strategic plan and associated investment strategy developed by the GTF WIPT.

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 family of systems and a National Missile Defense system for the United States. The BMDO is also responsible for research and development of follow-on technologies that are relevant for long-term ballistic missile defense that will build a technical foundation for the evolutionary growth in future ballistic missile defenses. In developing these acquisition and technology programs, 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 and objectives, ensure systems are operationally effective and suitable, and provide essential and timely information to support decision making[1]. This paper discusses a newly instituted, consensus based process which will provide a strategic plan or "roadmap" to guide investment in ballistic missile defense test infrastructure.

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. BMDO-managed programs include the PATRIOT Advanced Capability-3 (PAC-3), Navy Area Theater Ballistic Missile Defense System, Medium-Extended Air Defense System (MEADS), Theater High Altitude Area Defense (THAAD), and Navy Theater-Wide TBMD System. The Air Force, in coordination with the BMDO, is developing a boost phase intercept system called the Airborne Laser (ABL). Simultaneously, 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, the ground based interceptor (GBI); an Anti-Ballistic Missile treaty-compliant testbed radar, the NMD Ground Based Radar Prototype; and a prototype Battle Management, Command, Control, and Communications (BM/C3) demonstrator. Directly supporting the NMD program is the Air Force funded Space Based Infrared System (SBIRS) Low Component .

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.

3.0 BACKGROUND

3.1 Test Concept
The diversity, complexity, and wide-range of performance characteristics of systems under development within the BMDO require innovative test concepts and techniques. While flight testing of these missile systems provides the opportunity to evaluate their performance under realistic conditions, the complexity, cost, and inherent test range restrictions require system developers and testers to employ a variety of test methodologies to fully characterize, and understand the unit or system under test's performance characteristics. These test methodologies span an array of test techniques from simulations, through component level calibration and characterization, to real-time, integrated hardware-in-the-loop testing.

One area of BMDO emphasis and innovation has been in the area of ground test facilities. The demanding performance characteristics of BMDO systems require specialized facilities that are configured and instrumented to address the critical aspects of the entire ballistic missile defense engagement process. The BMDO uses a set of facilities selected from premier test centers across the Services (and in some instances industry) to meet these test needs. The BMDO works closely with the Services to consolidate test requirement in areas of mutual interest and to develop, in a cost efficient manner, a series of sophisticated, modern test capabilities. As a result, BMDO programs have access to a collection of premier test facilities. While the BMDO, by Charter, is prohibited from owning and operating facilities of this nature, BMDO provides corporate funding to the owners of these facilities to ensure they are available, properly configured, and ready to meet BMDO test requirements.

3.2 Erosion of Test Capabilities[3]
Recent budget constraints across all BMDO elements have forced reductions or shifts in funding responsibility in several key areas. One area where significant reductions have occurred is in test resource infrastructure. These funding reductions led to incremental cuts in the institutional funding allocated to the operation and maintenance of key BMDO test resources and infrastructure. These cuts threaten, and in some cases have already impacted, the viability of these critical assets. As institutional

reductions occur, facility managers often are forced to increase the fees charged to resource users to offset their loss of this source of revenue. As user test fees increase, program test managers, also operating under very real funding constraints, may choose to conduct fewer tests or eliminate lower priority tests. In many instances, this decrease in the test workload and the reduced number of customers at a particular test facility is used to justify more incremental budget cuts. This reduces the technical capability of the facility as reduced funding leads to staff reductions, deferred modernization programs, and ultimately can lead to closure of the facility.

The decline in institutional support for BMDO test resource infrastructure, which is manifested in funding reductions, can be attributed to the segmented manner in which test resources requirements were identified, developed, and funded. Given the diverse nature and heritage of the BMDO, and an organizational shift in emphasis from technology development to system acquisition, the lack of a consolidated resource management program left individual resource infrastructure assets vulnerable to budget reductions.

3.3 Test and Evaluation Working Group (Resources)[4]

A joint cooperative group of test managers has been formed to address and advise on test infrastructure issues related to BMDO. This group of empowered test managers, designated the Test and Evaluation Working Group (Resources) [TEWG(R)], uses an integrated product team approach to develop and recommend a minimum, essential level of test resource infrastructure to fully support current and future ballistic missile defense test and evaluation requirements. Through this process the TEWG(R) will reduce risk to BMDO programs throughout the acquisition cycle while increasing the operating efficiency of these test resources.

The Core Group, Figure 1, of the TEWG(R) includes a broad membership base which ensures consideration of the viewpoints of all parties involved in BMD testing. The TEWG(R) will identify test and evaluation resources, provide a balanced assessment of user requirements, technical merit, and affordability, and document integrated positions for submission to technical, budgetary, and program objective memorandum (POM) decision making processes.

These products will be reviewed, adjudicated, and approved within the BMDO using the ballistic missile defense (BMD) test and evaluation structure

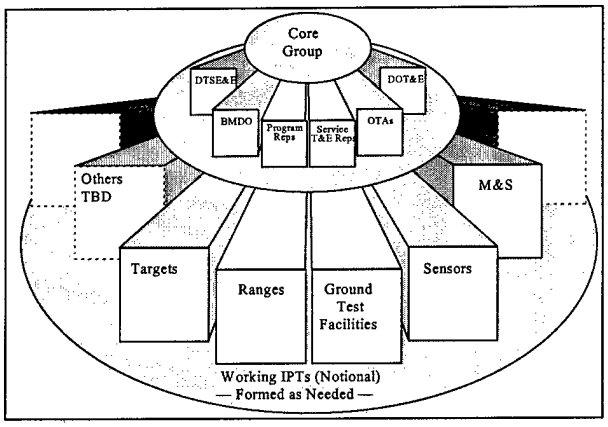

Figure 1. TEWG(R) Composition

shown in Figure 2.

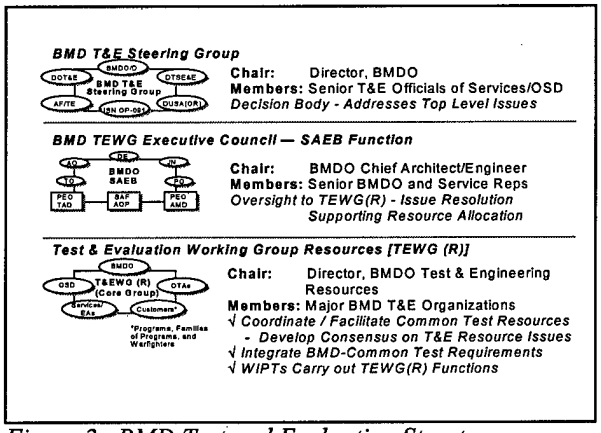

Figure 2. BMD Test and Evaluation Structure

The BMDO Director of Test and Engineering Resources (TER) chairs the TEWG(R). The Director of TER is BMDO's principal manager and focal point for test and evaluation (T&E) resources, civil engineering, and environmental planning and compliance. The Directorate exercises functional responsibilities and authorities on all T&E resources, civil engineering, and environmental matters pertaining to BMD programs, including Theater Missile Defense, National Missile Defense, and technologies. The Directorate is responsible for the overall planning, programming, budgeting, and execution of the T&E resources function, and the facilities, siting, and environmental functions within the BMDO.

3.4 Working Integrated Product Teams[5]

The TEWG(R) relies on working integrated product teams (WIPT), consisting of empowered representatives of the ballistic missile defense community. Initially, WIPTs formed along the lines

of what has been the traditional BMDO test infrastructure functional areas, e.g. ballistic missile targets, ground test facilities, and test ranges and instrumentation. However, WIPTs will be created, refocused, or disbanded, as community concerns and issues dictate. The WIPTs will serve as the primary action arm of the TEWG(R) and will:

1. Identify test resource requirements and issues;
2. Establish consensus across the test, acquisition, and acquisition oversight communities on test resource affordability and technical adequacy for risk reduction; and
3. Formulate, implement, and institutionalize test resource investment guidance to ensure the future availability of national, state-of-the-art test resource capabilities.

Each WIPT is charged with developing and recommending a cost effective, essential level of test resource infrastructure to fully support current and future BMD test and evaluation and technology requirements.

4.0 Ground Test Facilities WIPT Roadmap

The BMDO is committed to supporting a set of ground test facilities that are deemed critical to the development, analysis, and test and evaluation of Theater and National Missile Defense Programs, and supporting technology programs. By identifying and supporting these essential or "core" resources BMDO will 1) provide their programs access to the best technologies and techniques; 2) preserve technical expertise in ballistic missile defense specialties; and 3) leverage knowledge and time invested in ballistic missile defense technologies and testing across all programs. The definition, identification, right-sizing, and periodic adjustment of the composition of these core facilities will be accomplished using a consensus based process with community-wide membership via the Ground Test Facilities (GTF) WIPT. The membership of the GTF WIPT is shown in Figure 3.

This consolidated approach to ground test resource management will:

1) Reduce test and evaluation costs to programs by:
   a) Integrating the ground test requirements of all programs and sharing development costs between the programs and BMDO in those areas where similar needs exist; and
   b) Sharing the experiences of both program test personnel and facility operators to:
      i) Reduce the time required to integrate hardware and software into a facility
      ii) Reduce the learning curve for test participants
      iii) Promote more efficient testing by building and continually refining sound test procedures.
2) Reduce risk to BMDO acquisition and technology programs by:
   a) Exploiting the lessons learned through repetitive, comprehensive test planning, setup, and execution; and
   b) Using the experience of facility personnel to isolate and identify problems and tailor test matrices to provide insight into critical issues in the most effective manner.[6]

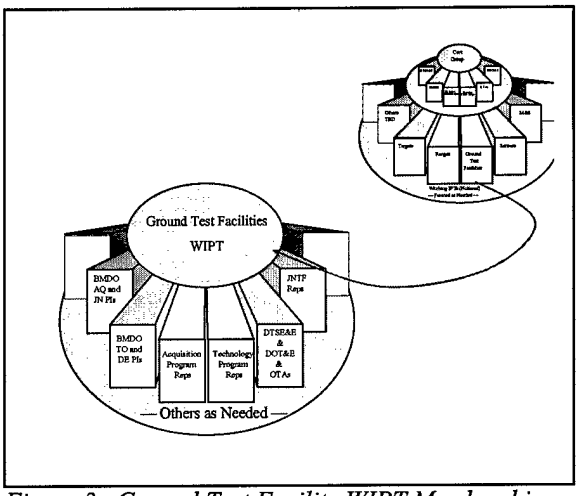

Figure 3. Ground Test Facility WIPT Membership

4.1 Ground Test Facility Working Integrated Product Team Roadmap

The identification of the core set of facilities was divided into three distinct steps with each step contributing to POM or budget submissions. The three steps and status are shown in Figure 4.

1) Initial : Baseline Ground Test Facility Infrastructure
   - Identify Scheduled Test Requirements
   - Identify Potential Test Requirements
   - Support Core Set of Facilities for POM 00

   Achieved! FY 98

2) Near Term : Identify Core Facilities for Next 5 Years
   - Identify Technical Test Requirements
   - Compare with Current Capabilities
   - Support Future POM Builds

   Ongoing FY98/99

3) Long Term : Identify Test Infrastructure for Next Generation of BMDO Programs
   - Look at Unconstrained Test Desires
   - Compare with Current Capabilities
   - Endorse Plan for Required Capabilities

   Objective FY 99...

Figure 4. GTF WIPT Roadmap Steps

4.1.1 Initial Term GTF WIPT Step; FY 98[7]

The initial goal of the GTF WIPT was to develop a baseline set of core ground test facilities and ensure these essential facilities were maintained in the appropriate operational state. The preferred approach would be to perform a bottom-up review of each program's GTF requirements to serve as the basis for facility requirements. However, the WIPT had a very short time line to meet the POM Fiscal Year 2000 (POM 00) submission suspense, so the abbreviated approach described below was used.

The initial step was to identify scheduled and potential tests, and identify the facilities where those tests are scheduled to be conducted. Per GTF WIPT consensus, this initial effort was limited to government facilities. An initial list of scheduled testing was compiled from a review of available test program documentation such as Test and Evaluation Master Plans, Cost Analysis Requirements Documents, Program Briefings, etc. This list was distributed to all members of the GTF WIPT for review of its accuracy and completeness. This step produced a validated listing of all government facilities where BMDO tests were either scheduled or potentially could be conducted. Due to the rather short range planning window of ground testing, these tests generally are scheduled to be conducted in the next 2-3 years.

The next step was to develop a process to determine which of the facilities on this all inclusive government test facility list should be designated as core facilities. Without a bottom-up requirements scrub based on an analysis of program test requirements, determination of which facilities were truly critical to the development, analysis, and test and evaluation of BMD programs was not possible. The GTF WIPT decided that for the immediate phase, the definition of the core facility set would be *"The set of facilities required to meet multiple BMD user test requirements"* and this definition would be reexamined when appropriate. Under this definition, the core set encompasses a wide variety of test functions, methodologies, and specialties covering the spectrum of BMD ground test facilities ranging from FoS level test capabilities, through weapon system level test capabilities, to individual end-item and component level test capabilities.

The next step was to develop criteria that could be used to set the priority among the core facilities. The consensus of the GTF WIPT members was that a *"1 to n"* rank ordering of the facilities was not feasible, as such an approach would essentially come down to ranking the priority of the programs which use the facilities. For example, due to their performance characteristics, lower tier TMD systems generally use one type of facility and upper tier TMD programs another. Therefore, the GTF WIPT agreed to divide the facilities into categories based on the criticality of the test data provided by the facility to acquisition and programmatic decisions. The categories developed by the GTF WIPT are in Table 1. The GTF WIPT reviewed the role and data type of each facility from the perspective of each program testing at that facility and categorized each facility on a program by program basis.

Category	Description	Definition
A	Critical	Must have to complete mission data (Milestone Data)
B	Important	Must have to address critical technical issues
C	Risk Reduction	Required for overall program risk reduction

Table 1. Core Ground Test Facility Categories

The categorized core ground test facilities list served as the basis for developing the POM 00 submission. In general terms, funding for facilities of this nature can be divided into two categories, indirect and direct. Indirect costs refer to those costs required to keep the facility in an up and running condition. Direct costs refer to actual test, and day of test costs. Under the core facility concept, indirect costs would be paid at the corporate level, and the facility user would pay direct costs. The GTF WIPT developed indirect funding profiles for the core facilities and developed a consolidated POM funding profile which recommended funding the Category A and B facilities. This profile was briefed to and endorsed by the TEWG(R) and the System Architecture/Engineering Board.

4.1.2 Near Term GTF WIPT Step; FY98/99[8]

As shown in Figure 4, the next step for the GTF WIPT is to identify that core set of facilities which is adequately sized and technically sufficient to meet BMDO program needs from a capacity and capability perspective. Inherent in this task is the identification of technical deficiencies across the community and overlap of capabilities among facilities. The GTF WIPT will use the four step process shown in Figure 5 to identify the near term core set of facilities. The foundation of this process is the identification of technical performance parameters and test requirements for each of the BMDO programs.

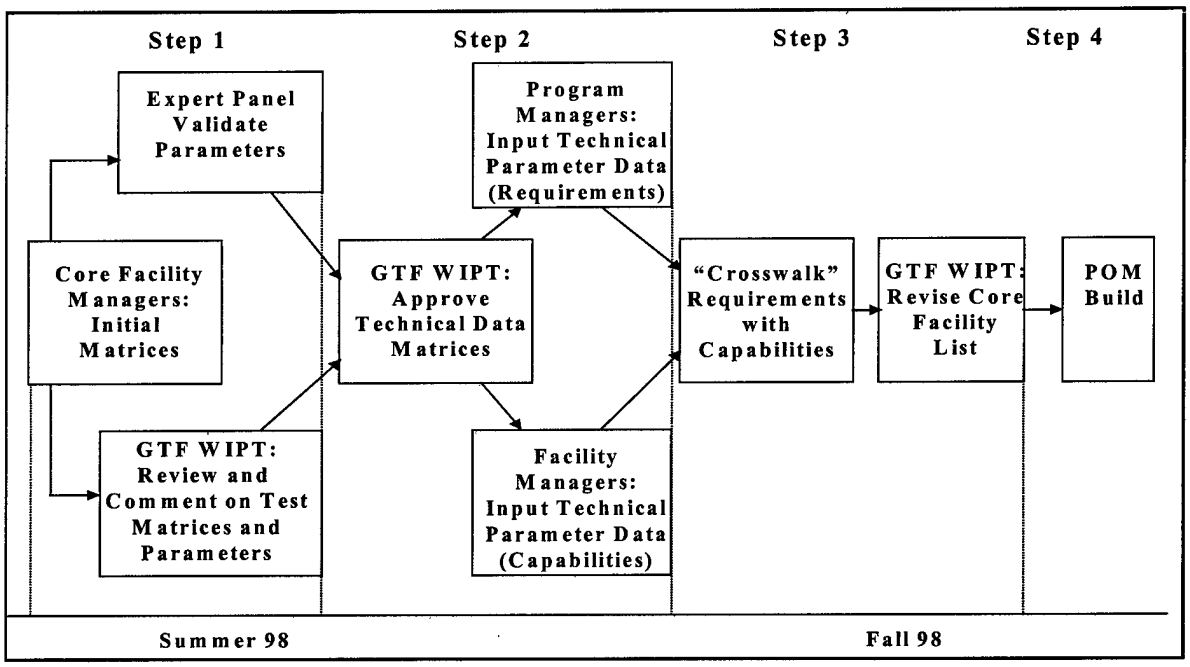

Figure 5. Near Term Core Facility Process

The first step in the near term process lays the groundwork for identifying the technical performance parameters by developing a set of matrices which define the critical performance characteristics for BMD systems and sub-systems. Managers from each of the current core facilities will develop the initial matrices. The managers will be divided into mission areas that roughly correspond to the Department of Defense (DoD) T&E Reliance Mission Areas of Aerothermal, Hardware-in-the-Loop, Space Chambers, Lethality, System and Family of Systems, and Radars. In parallel, a set of test matrices will be developed in each of these mission areas. The matrices will identify the critical performance and/or environmental requirements that must be met from a program perspective for specific test events, and the critical parameters from the facility perspective to properly exercise or place the unit under test in the proper environment.

Once the matrices are developed, reviewed, and approved by the GTF WIPT, the second step will be to populate them with the actual program performance parameters and facility technical capabilities. This will be accomplished by simultaneously distributing the matrices to all BMDO acquisition and technology programs and to the core government BMD related test facilities. Each program and facility will complete the matrices and parameters as applicable. Concurrent with this process, the programs and facilities will identify their planned test requirements and schedules.

The third step involves consolidating the technical requirements by test type to determine the global set of technical test requirements required by BMDO programs. A comparison of the overall set of test requirements to the existing set of test capabilities will reveal the extent to which facilities best meet program test requirements, areas of unique capabilities and overlap, and will also reveal areas where current test capabilities are deficient. The test schedule information will be factored in to project the test workload for facilities supporting BMD programs and will be used to determine the required capacity. Integrating the technical facility analysis with the workload analysis will yield a list of the required BMDO core test capabilities.

The fourth step in the near term core facility development process will be to revise the core facilities list and update the POM submission for core ground test facility related funding lines. An essential step in this process will be translating the set of required core test capabilities into a prioritized set of core test capabilities. This prioritization process will be driven and influenced by factors such as test criticality, budget constraints, and unique facility test capabilities. Given the current budget realities, the funding allocated for ground test facilities will probability be inadequate to fund all of the capabilities designated and desired by the GTF

WIPT. Therefore, alternative funding solutions and cost reduction measures will be explored by the GTF WIPT to ensure those test capabilities identified as required are available and operational.

4.1.3 Long Term GTF WIPT Step; FY99[9]

The first two steps in the GTF WIPT roadmap focused on providing a stable ground test resource infrastructure and assembling the collection of available ground test capabilities that are required to adequately support existing BMD test requirements. With the requirements-validated core set of facilities in place and corporately supported, the GTF WIPT will turn to what will probably be the prime focus and major contribution of this group – *address the test infrastructure for the next generation of BMD programs.*

A projection of performance regimes for future systems, technologies under consideration for insertion into existing systems, and emerging weapon system technologies will be performed to anticipate future test requirements. Additionally, shortcomings in the current core facility set will be analyzed to identify potential areas for improvement.

Identification of the type and nature of ground test facilities that will be required to meet the requirements of the next generation of BMD systems will begin with a look at the test desires of the program and facility communities, unconstrained by cost or technology. Essentially, the group will proceed under the premise *"if we could perform any type of ground test to address the critical issues for our systems or best enhance our knowledge of how our systems will perform in environments of interest, what would that test, or set of tests be?"* This will produce an unconstrained set of test desires that will be compared to current and potential ground test facility capabilities. The GTF WIPT will recommend development of new test capabilities or upgrades to existing capabilities as results of this analysis warrant. All developmental or upgrade activities will be coordinated within the BMDO community through the TEWG(R), and within the DoD through processes such as Project Reliance and the Central Test and Evaluation Investment Program.

5.0 Summary

The Ballistic Missile Defense Organization is committed to supporting a core set of ground test facilities that are deemed critical to BMD programs. To meet this commitment, the BMDO has formed a Ground Test Facility Working Integrated Product Team. The GTF WIPT reports to the BMDO Test and Evaluation Working Group for Resources on all BMD issues relating to ground test facilities. The GTF WIPT is developing the core set of facilities using an evolutionary process consisting of three basic steps or phases. The initial focus of the WIPT was to identify a baseline set of core ground test facilities and ensure the required facilities were maintained in the appropriate operational readiness condition. The GTF WIPT reached consensus on the composition of that baseline core set of facilities and provided funding profiles in the POM 00 submission to cover routine operational and maintenance related costs. Currently, the GTF WIPT is conducting a bottom-up test requirement review of BMD programs and ground test facility capabilities to ensure the core set of facilities are technically capable and adequately sized to meet current test requirements. The final GTF WIPT step will be to identify the test infrastructure for the next generation of BMD programs. This will involve examining unconstrained test desires and developing a long term facility plan endorsed both by the TEWR(R) and the joint test community to develop or upgrade facilities to meet the emerging BMD test needs.

References

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[7]GTF WIPT Briefing to the TEWG(R), Mr. Chet DeCesaris, March 17, 1998.

[8] GTF WIPT Briefing to the TEWG(R), Mr. Chet DeCesaris, June 24, 1998.

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