Edited extract from: *Department of the Army Historical Summary, FY 1981* (Washington, D.C.: U.S. Army Center of Military History, 1983, pp. 244-251.)

Ballistic Missile Defense

A variety of factors provided impetus to the U.S. Army ballistic missile defense (BMD) research and development program this year. Some of these factors were the growing uncertainty of this nation's ability to influence the buildup of Soviet strategic weapons through negotiation, an increased awareness at all government levels of the BMD potential and the significant contributions it could make in the offensive defensive strategic equation, confidence based on successful experimental and analytical verification of BMD concepts and hardware since the deactivation of the SAFEGUARD system in 1976, and the decision to proceed with full-scale engineering development of the Air Force MX inter-continental ballistic missile (ICBM) system. The BMD organization, in its research and development efforts, emphasized the more advanced, maturing projects in both the Advanced Technology and Systems Technology Programs.

The efforts of the more mature Advanced Technology Program included the designating optical tracker program, the endoatmospheric non-nuclear kill program, the forward acquisition program, the optical aircraft measurements program, the miniature kill vehicle technology program, investigation of directed energy weapons, investigation of the applicability of distributed data processing, preparation of a millimeter-wave radar, and preparation of the Cobra Judy shipborne radar.

The Designating Optical Tracker (DOT) program provided data to verify the capability of long wavelength infrared sensors to perform generic BMD functions of designation and tracking under realistic conditions of engagement and the environment. Four flights in the program have successfully deployed the sensor above the atmosphere and obtained the required data on reentry targets. In fiscal year 1981, plans were completed for the remaining flights. Plans were also developed for future use of the program hardware.

The purpose of the endoatmospheric non-nuclear kill program is to establish a coordinated technology base to demonstrate a homing guided intercept and non-nuclear kill of representative reentry vehicles in the endoatmosphere. The U.S. Army BMD Advanced Technology Center (BMDATC), faced with budget cuts and other priorities for fiscal years 1981 and 1982, reduced this program to development of critical component hardware. Development of critical component hardware progressed, as did the effort to upgrade the three-degrees-of-freedom simulation to a six-degrees-of-freedom high fidelity simulation. BMDATC initiated design and validation of a gas reaction maneuver control system and began warhead-target interaction ground rocket sled tests.

The forward acquisition system program showed progress. The program is an integrated technology effort designed to resolve critical system and technology issues associated with the BMD forward acquisition function through a comprehensive ground test program. All necessary hardware was placed under contract and an integration contractor selected. The contractor will also furnish a wide-field-of-view, long-way infrared test chamber.

The Miniature Kill Vehicle (MKV) program, which ended this fiscal year, developed solutions to technology issues concerning application of the homing interceptor (spinning kill vehicle) concept. This year's effort demonstrated that the regenerative piston injection liquid propulsion engine would meet requirements of mission durability and spin environment. Designs were completed for both a tactical tracking sensor and a data processing system to permit vehicle operation in high-target density and nuclear environments. The kill vehicle requirements were updated concurrently with evolving threat descriptions, and a miniature kill vehicle responsive to the scenarios was designed.

Directed energy weapons exploiting either high-energy laser or particle beam technology have considerable potential for future BMD application. Space, aircraft, ground, and hybrid basing concepts have been investigated. Army BMD interest focused on space-based concepts offering unique potential for the engagement and destruction of both inter-continental ballistic missiles (ICBMs) and sea-launched ballistic missiles. BMDATC analyses indicated a definite preference for use of space-based directed energy weapons as the leading edge of a multiple-layer defense system. These investigations emphasized the use of high-energy lasers because of a lag (on a relative basis) in particle beam technology. Using simulated ICBM components, the BMDATC successfully demonstrated viable kill mechanisms for the space-based laser. A number of high-energy laser candidates have been identified which, if successfully developed, could provide the basis for major increases in the cost-effectiveness of any future BMD space-based laser system. In addition to this high-energy laser activity, BMDATC continued to serve as technical manager and procurement agent for two efforts in the Defense Advanced Research Projects Agency's (DARPA's) particle beam program: the Los Alamos Scientific Laboratory exoatmospheric neutral particle beam accelerator program and the Austin Research Associates collective ion accelerator proof-of-principle experiment.

BMDATC directed research to exploit, for BMD applications, the many potential advantages of the distributed data processing computer concept, such as increased throughput, availability, reliability, fail-soft capability, growth capability, and load sharing. Also investigated was use of distributed systems of microprocessors interconnected with various schema. A six-micro-processor by twelve-memory-board distributed data processing system connected by a crossbar switch was implemented, and testing was initiated. Investigation began of designs for ring and banyan interconnected systems. At BMDATC's Advance Research Center, the Control Data Corporation 6400/7600 mainframe computers were augmented with ten Virtual Address Extension (VAX) 11/780 minicomputers to provide a distributed data processing capability. This testbed was used to support multiple concurrent BMD distributed data processing experiments in hardware architecture, algorithm development, and software engineering. Significant progress was made in the development of a computer-aided design system to support development of high quality software for BMD systems, which will most likely require fault tolerance and a high degree of flexibility.

In fiscal year 1981, component development and fabrication continued on a millimeter-wave radar for use at Kwajalein Missile Range (KMR) in collecting data on BMD targets. Major components, procured and tested in the continental United States, were shipped to Roi-Namur Island. Installation of the antenna tower and radome support was completed in July 1981. Late delivery of drive gears for the gear boxes delayed shipment of the pedestal and caused a slippage in the original operational date for the radar.

Preparation of Cobra Judy, a shipborne S-band radar (that operates on a wavelength of 8-15 cm and a frequency of 2-4 GHz) signature collection system to provide intelligence data for the U.S. Air Force Foreign Technology Division (FTD) and the BMDATC, also continued. For this effort, jointly funded by the Air Force Systems Command and the BMDATC, the U.S.S. Ob*servation Island* has been outfitted and made seaworthy. It now meets all the standards required for the Cobra Judy platform. Construction of a radar array turret was completed in 1981, and all electronic, computer, and recording equipment was installed on board the ship.

Major activity in the Systems Technology Program focused on the definition and development of systems for two principal efforts: the endoatmospheric Low-Altitude Defense (LoAD) System and the homing overlay experiment (HOE) with technology for an exoatmospheric interceptor. The Systems Technology Project Office (STPO) of the BMD Systems Command also worked toward integration of endoatmospheric and exoatmospheric concepts into a layered defense system and toward the collection of data to support systems studies and concept evaluations.

Design and development of the HOE, a two-phase demonstration to prove technology associated with an exoatmospheric interceptor, showed significant progress. Critical design reviews of flight experiment equipment and various hardware flight items were completed and fabrication of flight hardware was begun. Development testing and manufacture of the first HOE flight experiment units were completed for the axial propulsion system, the fixed-fragment-net kill mechanism, and the back-up kill mechanism. Fabrication of the first HOE interceptor Flight Hardware-1 (FH-1) was initiated. The HOE simulation laboratory facility was completed for validating the HOE flight software by exercising flight experiment hardware and software in a dynamic hardware in-the-loop simulation. Testing of the HOE flight experiment hardware was begun during the last quarter of the fiscal year.

Engineering and development problems appeared in the sensor, requiring extensive management reviews and resulting in cost growth to Lockheed's contract, but no delay in the HOE flight experiment schedule. The design development hardware performed successfully in laboratory tests for flight vibration; however, difficulties continued in the development of the test hardware for design verification.

All activities relating to KMR preparations for the HOE were on schedule. A missile access stand obtained from the Navy's Polaris program with Lockheed was shipped to KMR and erected on Meck Island. Ground support equipment for the HOE booster, a modified Minuteman I, was shipped from Hill Air Force Base (AFB), Utah, an Air Force Materiel Command base. Using test launch software at Lockheed's Missile Space Center; Lockheed and McDonnell Douglas completed integration tests to verify that the equipment was compatible with the interceptor ground test unit.

The LoAD system, expected to be valuable in defending either the MX missile or silo-based ICBMs, gained attention and support from both the Department of Defense (DOD) and the U.S. Congress. Early in the year, the Secretary of Defense approved increased funding by approximately $346 million to ensure LoAD compatibility with the MX missile; later, Congress authorized an additional $15 million in fiscal year 1981 funds to protect the option of accelerating LoAD development.

The BMD organization and the Air Force Ballistic Missile Office worked together to ensure LoAD-MX compatibility. The two signed a memorandum of agreement on 7 October 1980 which established a formal relationship, outlined policy and responsibilities, and provided for the exchange of technical, operational, and program information. Similar relations were established with the Air Force's Strategic Air Command and Test and Evaluation Command. Later in the year, ties were formed with the Defense Nuclear Agency for coordination and resolution of LoAD technical issues and with the Department of Energy (DOE) for a joint feasibility study on a nuclear warhead for the LoAD interceptor.

In November 1980, the BMD Systems Command changed the acquisition strategy for the LoAD effort from an associate contractor structure to a prime and subcontractor structure. McDonnell Douglas received the prime contract; Martin Marietta Aerospace, Orlando, and the Raytheon Company received major subcontracts for the interceptor and the sensor and engagement controller efforts, respectively.

Testing to refine LoAD definition and development progressed. High explosive testing was performed on a scale model of the LoAD defense unit, and wind tunnel testing was done on the interceptor airframe configuration. The signature measurement radar installed at KMR to gather X-band (that operates on a 2.5-4 cm wavelength and a frequency of 8-12 GHz) signature data on incoming objects from ICBM flights was also tested. The radar successfully tracked and recorded data on a decoy that was specifically designed and flown for the test.

The preservation of location uncertainty (PLU) effort was marked by closer cooperation between the Air Force's MX program and the Army's BMD LoAD program. LoAD representatives participated as full members on all Air Force PLU working groups. Definition of PLU requirements for LOAD also received special attention in BMD studies.

Definition of a BMD layered defense system continued. Recent studies considered exoatmospheric, infrared non-nuclear interceptor technologies, as well as deep endoatmospheric, small radar, nuclear and non-nuclear interceptor technologies. A major study called "BMD Systems for the Nineties" added some credence to earlier assumptions that technology for exoatmospheric defense could be integrated into a tactical system in time to counter the threat projected for the coming decade, provided such developments were successful. The Undersecretary of Defense for Research and Engineering requested a BMD concepts study that would rely on a terminal endoatmospheric defense with an early deployment capability and low technological risk.

Because of the complexity and expense of existing overlay concepts, the BMD program manager formed a task force to study overlay concepts which were less costly and less complex. The possibility of a national decision to base the first MX missiles in silos rather than in multiple protective shelters underscored the need for an efficient defense system that could balance the advantages of advanced technologies with the demands of a deployment schedule like that of the MX missile. These requirements, together with the possibility of an early development of a robust terminal defense underlay, led to several new overlay concepts still in the formulation stage.

Results of the "Low Altitude Perturbation Study" funded by BMD through the Air Force's Foreign Technology Division, Wright Patterson AFB, Ohio, were presented at BMD Systems Command (BMDSCOM) on 10 October 1980. A follow-up meeting held at McDonnell Douglas on 15 October 1980 completed low altitude trajectory data requirements for LoAD radar data processing specifications and analysis. On 16 April 1981 representatives of Sandia National Laboratories, BMDSCOM, and the BMD contractors reviewed "white papers" on projected Maneuverable Reentry Vehicle (MARV) and Anti-Radiation Homer (ARH) threats. The MARV document has been completed and distributed; the ARH document has been delayed pending definition of LoAD program changes. The STPO Threat Office, Overlay Demonstration Task Force, and ATC personnel met with supporting contractors on 2-3 September 1981, and completed "Threat Parameters for Overlay Ballistic Missile Defense." This document defines the threat parameters for use in analyzing defense concepts considered in overlay BMD. Comparative BMD capabilities (red-blue) analysis continued to provide Soviet BMD information to support the BMD program manager at congressional and related briefings.

The STPO Weapons Office updated and published a two volume document in August 1981 that gave technical information on preferred life cycle hardening design and updated techniques to be avoided. Warhead lethality analyses were accomplished in support of the joint DOD-Department of Energy (DOE) Phase 2 Warhead Study for LoAD initiated in January 1981; lethality contours were developed for combinations of threat models and four different generic defense warhead types. The Attack Working Group of the Weapons Office completed an overlay laydown definition analysis and published the results. Laydown analyses are currently in progress with regard to the new LoAD concept definition.

During fiscal year 1981, Kwajalein Missile Range (KMR) supported development and operational testing of U.S. Air Force ICBMs and payloads launched from Vandenberg Air Force Base. The operational tests comprised various Minuteman III operational configurations; the development tests included nose tip evaluations, various decoy configurations, and maneuvering vehicles. The fourth Army designating optical tracker mission was also launched from KMR. The Army Optical Station on Roi-Namur was closed at the end of the fiscal year.

Most of the modifications to the ARPA (Advanced Research Projects Agency) long-range tracking and instrumentation radar (ALTAIR) to make it a contributing sensor to the Air Force Space Detection and Tracking System (SPADATS) were completed during fiscal year 1981. The interim system, which performs satellite catalog maintenance and detects new foreign launches, became operational.

During fiscal year 1981, construction began on a millimeter-wave radar, which had been under development since fiscal year 1979. It will be an adjunct to the ARPA Lincoln C-band Observable Radar (ALCOR) system and will provide 35 GHz and 95 GHz radar capability along with a 95 GHz radiometer capability.

Participants in the triservice Strategic Systems Test Support Study (SSTSS) developed an overall approach ensuring non-redundant, cost-effective, responsive support for testing offensive and defensive systems in both the Atlantic and Pacific. They recommended retention of KMR as a terminal area testing asset, but identified a contingency instrumented test area in the Pacific, in the event that the Kwajalein atoll became unavailable. The study group assessed the present KMR midatoll corridor boundaries and decided to retain them. A broad ocean area terminal scoring point would be developed north of Roi-Namur for MX testing. A terminal area support aircraft (TASA)--a modified C7A Caribou logistics support aircraft--would provide a surface missile impact location systems (SMILS), terminal telemetry, and optics data collection in lieu of P-3A/SMILS aircraft. Tugboats at KMR would be used to place and maintain deep ocean transponders in the KMR North array. The participants briefed the Deputy Director, Defense Test and Evaluation (DDTE), and the Major Range and Test Facility Committee on 24 July 1981.