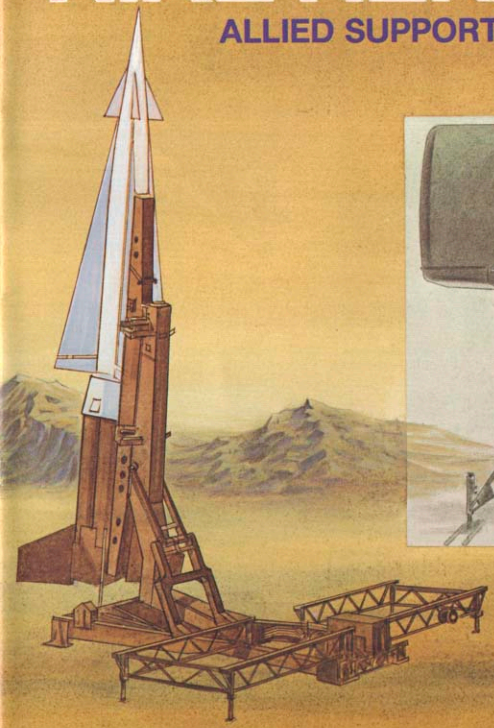
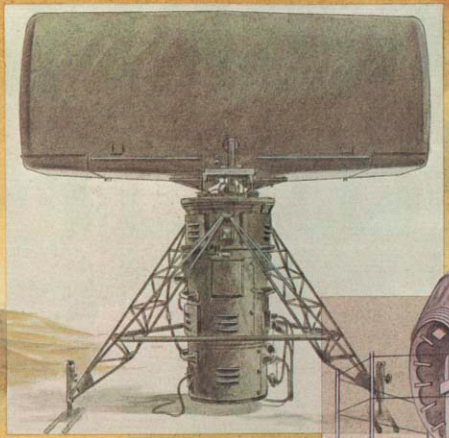
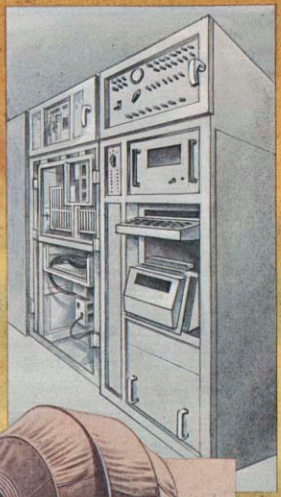
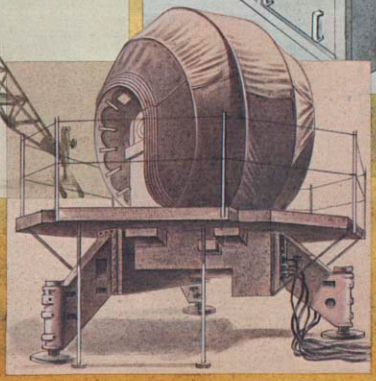
NIKE HERCULES

ALLIED SUPPORTABILITY PROGRAM









INTRODUCTION

The NIKE HERCULES System, first fielded in the late 50's, represents one of the most successful Air Defense systems ever used by the U.S. and its Allies. The system represented the most sophisticated state-of-the-art and immediately became the first line of air defense in the free world. Technological changes, especially in the electronics industry, have caused a significant impact on the life cycle of the system by creating problems associated with parts availability and future logistical and supportability plans.

The NIKE HERCULES Allied Supportability Program was developed under the direction of the United States Army Missile Command (USAMICOM) as a result of a study conducted on behalf of the NATO Maintenance and Supply Agency (NAMSA). The program addresses the supportability problems and provides an orderly cost-effective approach to logistics improvements while maintaining system capability. The baseline for the HERCULES Supportability Program is the NIKE HERCULES SAMCAP System design configuration as of June 17, 1979. This baseline includes the addition of the Range and Angle Encoder Modification (RAEMOD).

The Supportability Program specifically addresses subsystems and units within the subsystems. It also encompasses the test equipment used to test various system units (Type IV) and the Depot Augment test equipment where the test capability of the equipment is impacted by system modifications. The training program is also updated as part of the total consideration of all logistical support programs.

In arriving at the Supportability Program goals, four major problem areas were considered:

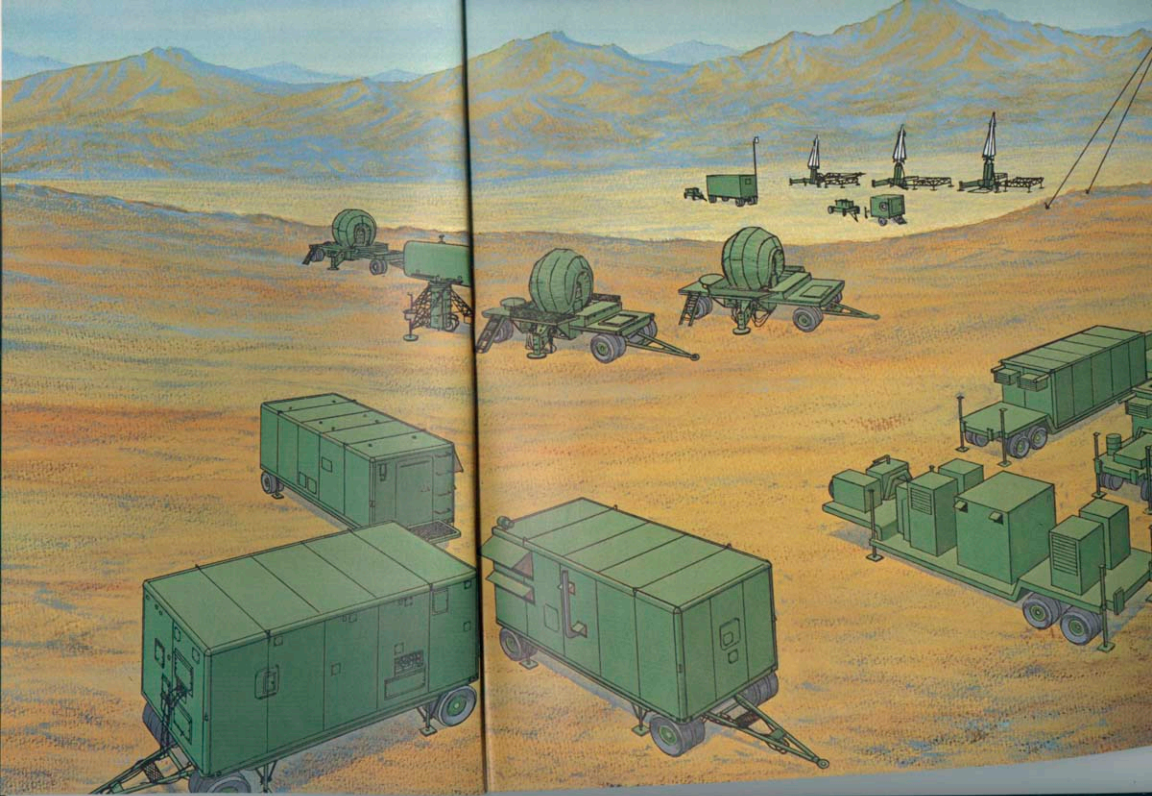
- Difficulties encountered in the user/supply chain
- Items introduced under Engineering Services Memorandums since original system deployment
- Engineering judgments of potential future problems
- Support problems resulting from possible areas of outmoded technology

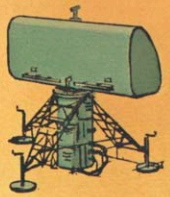
Recommended modifications being implemented impact the following major subsystems:

- Low Power Acquisition Radar
- Tracking Radars
- Computer
- Missile and Launch Area

These modifications incorporate solid-state technology and are designed to minimize procurement difficulties in a cost-effective manner and increase the reliability, availability, and maintainability of the system.

The Supportability Program addresses the total problem of logistics, technological advances, and training programs; however, this brochure primarily addresses the equipment modifications.



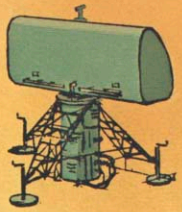


RECEIVER/TRANSMITTER

The present Receiver/Transmitter subassembly is replaced by a completely new solid-state R/T unit. The new R/T unit converts the S-Band received signals to an IF frequency for use in the new Digital Moving Target Indicator (DMTI) and in the LOPAR receiver.

Benefits Derived Are:

- *MTBF (included in Digital Moving Target Indicator)*
- *Battery adjustments, unscheduled maintenance, and periodic checks reduced (included in DMTI)*
- *AFC search and acquire reduced from approximately 12 seconds to less than 2 seconds, plus automatic reinitiation if target is lost; therefore, critical target tracking radar acquisition time is reduced by about 10 seconds*
- *BITE continuously monitors eight critical circuits and lights Fault Lamps when trouble conditions occur*



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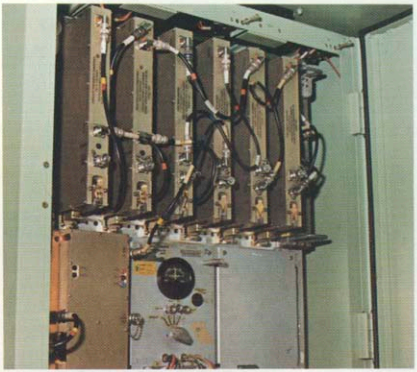
LOW POWER ACQUISITION RADAR

The Low Power Acquisition Radar (LOPAR) is a microwave ranging and direction radar system designed to detect and designate targets prior to lock-on by the Target Tracking Radar (TTR). The Supportability Program requires the following system components to be redesigned:

- *Moving Target Indicator (MTI)*
- *Receiver/Transmitter Subassembly (R/T)*
- *All IF and Video Processing Vacuum Tube Units (Solid State Chassis)*
- *4KHz System*
- *Plan Position Indicator (PPI) and Precision Indicator (PI)*



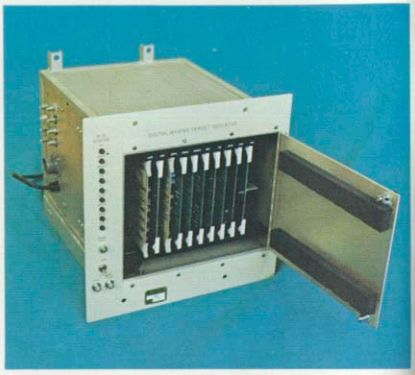
SOLID-STATE CHASSIS

Solid-state units replace these vacuum tube LOPAR units:

- *Acquisition IF Preamplifier*
- *Main Frequency Converter*
- *Auxiliary Frequency Converter*
- *Wideband Amplifier*
- *Amplifier - Limiter*
- *Frequency Discriminator*
- *Sensitivity Time Control (STC)*
- *Pulse Generator*
- *Alarm Control*
- *Low Power Servo Amplifier*
- *Cathode Follower (Line Driver)*

Benefits Derived Are:

- *MTBF increased from 250 to 3500 hrs*
- *Time required for unscheduled battery maintenance reduced by 70 percent*
- *BITE continuously monitors power levels on each chassis plus output pulse presence on the STC and lights Fault Lamps when trouble conditions occur*

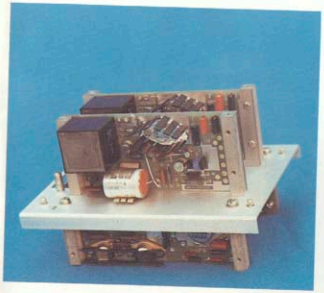


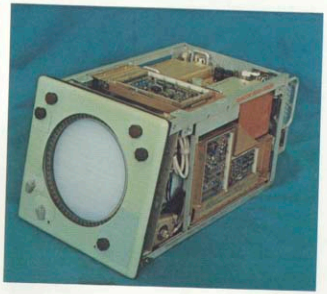
DIGITAL MOVING TARGET INDICATOR

The function of the Moving Target Indicator (MTI) circuitry is to enhance the moving target resolution in the presence of clutter caused by stationary targets. The present MTI circuitry uses analog non-coherent techniques to provide this function. The new Digital Moving Target Indicator (DMTI) replaces existing units with a solid-state design using digital processing techniques.

Benefits Derived Are:

- *MTBF increased from 150 to 1500 hrs (includes Receiver/Transmitter)*
- *Battery adjustments reduced by 90 percent*
- *Time required for unscheduled battery maintenance reduced by 95 percent*
- *Time required for periodic checks and adjustments reduced:*
  - *Daily, 70 percent*
  - *Weekly, 90 percent*
  - *Monthly, 90 percent*
- *Manually initiated Built-In Test Equipment (BITE) completely checks DMTI circuits*
- *Improved MTI performance.*





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- *Moving Target Indicator (MTI)*
- *Receiver/Transmitter Subassembly (R/T)*
- *All IF and Video Processing Vacuum Tube Units (Solid State Chassis)*
- *4KHz System*
- *Plan Position Indicator (PPI) and Precision Indicator (PI)*

4KHz SYSTEM

A precision 4KHz signal system is used throughout the LOPAR system to provide resolver signals for the LOPAR video display and target designation functions. Solid-state units replace the present vacuum tube chassis used to generate, amplify, and provide test functions for the 4KHz system.

Benefits Derived Are:

- *MTBF increased to 30,000 hrs*
- *Reduced signal distortion from 3-5 percent to 1 percent*
- *Reduced azimuth errors in target designation by 6 angular mils*
- *Time required for unscheduled battery maintenance reduced by 85 percent*

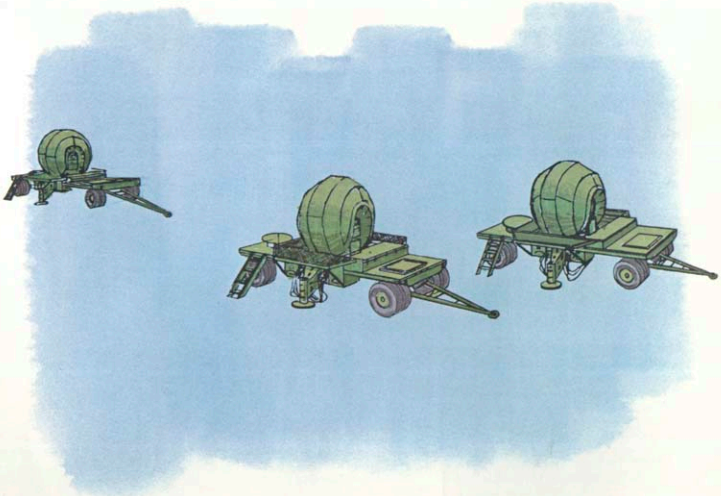
PLAN POSITION & PRECISION INDICATOR

The Plan Position Indicator (PPI) and Precision Indicator (PI) are used to provide a video display of target position data in terms of range and azimuth. Modifications to the present PPI and PI consist of new design plug-in solid-state subassemblies.

The PPI DC Amplifier, Video Amplifier, Symbol Generator, and Intensity Regulator are also used in the "B" scope display unit located in the Radar Control Trailer.

Benefits Derived Are:

- *MTBF increased from 905 to 9,000 hrs*
- *Time required for unscheduled battery maintenance reduced by 95 percent*
- *Time required for periodic checks and adjustments reduced:*
  - *Daily, 85 percent*
  - *Weekly, 85 percent*
  - *Monthly, 85 percent*
- *Operator detectable display jitter eliminated*



TRR COAXIAL MAGNETRON

The magnetron, located in the TRR antenna, is used to generate high power RF energy. A new coaxial magnetron design replaces the current conventional design.

Benefits Derived Are:

- *MTBF increased from 400 to 2500 hrs*
- *Time required for unscheduled battery maintenance reduced by 75 percent*
- *Capability of rebuild up to three times; current magnetron cannot be rebuilt.*

FERRITE SWITCH

The Ferrite Switch is used in the receiver-transmitter assembly to electronically switch RF power between the transmitter and receiver channels. A new ferrite switch has been incorporated into the TRR receiver-transmitter.

Benefits Derived Are:

- *MTBF increased from 900 to 3600 hrs*
- *Time required for unscheduled battery maintenance reduced by 75 percent*
- *RF Power handling capability doubled*
- *Reduced RF leakage from the magnetron into the antenna.*

MIXER DIODE/TR TUBE

The Mixer Diode used in the MTR and TTR converts RF energy to a 60 MHz signal. The TR tube is used to provide RF burn-out protection.

The new specially designed Transmit-Receive-Limiter (TRL) tube replaces the conventional TR tube.

Benefits Derived Are:

- *Time for unscheduled battery maintenance reduced by 60 percent*
- *TR tube "keep alive" power supply eliminated*
- *Waveguide shutter assemblies eliminated*
- *Peak RF voltage spikes reduced by 90 percent, reducing the possibility of RF burn-out.*

TRACKING RADAR SYSTEMS

The NIKE HERCULES tracking radar function is accomplished by three separate radar systems. A Target Tracking Radar (TTR) supplies range, azimuth and elevation information to the NIKE HERCULES computer. A Target Ranging Radar (TRR) is a precision echo ranging radar used to provide range information when it is not available from the TTR. The Missile Tracking Radar (MTR) tracks the NIKE HERCULES missile from launch to intercept and provides steering and burst information to the airborne missile guidance system.

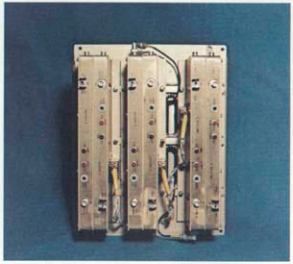
The tracking radar systems comprise the following equipment areas:

- *Radar Control Trailer (RCT)*
- *Target Tracking Radar Antenna Group (TTR)*
- *Target Ranging Radar Antenna Group (TRR)*
- *Missile Tracking Radar Antenna Group (MTR)*
- *Radar RF Test Set (RRFTS)*

The Supportability Program required the following system components to be redesigned:

- *Track Radar Receivers*
- *Radar RF Test Set*
- *MTR Coder*
- *"B" Scope*
- *TRR Magnetron*
- *Ferrite Switch*
- *Mixer Diode/TR Tube*

TRACKING RADAR SYSTEMS

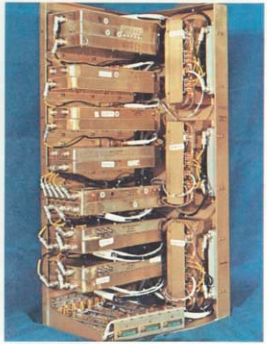


TARGET RANGING RADAR RECEIVER

A solid-state TRR receiver replaces the current tube version. Solid-state units also replace the tube versions of the TRR pan amplifier, preamplifiers, and local oscillators.

Benefits Derived Are:

- *MTBF increased from 615 to 3600 hrs*
- *Battery adjustments reduced by 20 percent*
- *Time required for unscheduled battery maintenance reduced by 85 percent*
- *Time required for periodic checks and adjustments reduced:*
  Daily, 30 percent
  Weekly, 30 percent
  Monthly, 30 percent



TARGET TRACKING RADAR RECEIVER

A new design solid-state TTR receiver, with several units interchangeable with the MTR and TRR receivers, replaces the current tube version. Twelve solid state chassis used in 44 different applications replace a total of 59 separate vacuum tube chassis.

Benefits Derived Are:

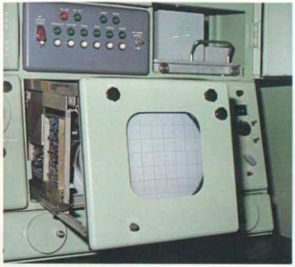
- *MTBF increased from 275 to 2900 hrs*
- *Battery adjustments reduced by 30 percent*
- *Time required for unscheduled battery maintenance reduced by 85 percent*
- *Time required for periodic checks and adjustments reduced:*
  Daily, 75 percent
  Weekly, 50 percent
  Monthly, 50 percent

MISSILE TRACKING RADAR RECEIVER

A new design solid-state MTR receiver replaces the current tube version. This new receiver is identical to the new TTR solid-state receiver with the exception of the long pulse receiver circuitry.

Benefits Derived Are:

- *MTBF increased from 300 to 3400 hrs*
- *Battery adjustments reduced by 30 percent*
- *Time required for unscheduled battery maintenance reduced by 85 percent*
- *Time required for periodic checks and adjustments reduced:*
  Daily, 60 percent
  Weekly, 40 percent
  Monthly, 40 percent



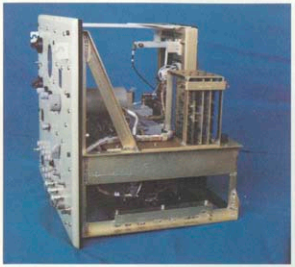
SOLID-STATE "B" SCOPE

The azimuth-range indicator, commonly called "B" Scope, is used in the transfer of targets from the acquisition radar to the target tracking radar.

The new solid-state "B" Scope achieves the required presentation accuracy and stability.

Benefits Derived Are:

- *MTBF increased from 800 to 12,500 hrs*
- *Battery adjustments reduced by 20 percent*
- *Time required for unscheduled battery maintenance reduced by 90 percent*
- *Time required for periodic checks and adjustments reduced:*
  Daily, no change
  Weekly, 85 percent
  Monthly, 85 percent
- *All of the "behind panels" checks and adjustments have been deleted from the periodic list (daily, weekly, monthly) and are performed as non-periodic only*
- *The periodic checks and adjustments consist of only front panel adjustments*

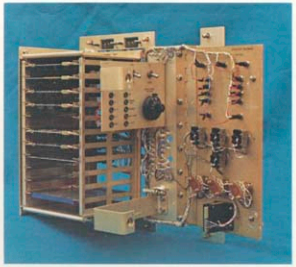


RADAR RF TEST SET

The RF Test Set generates RF test signals that are used to align and test the target tracking, target ranging, and missile tracking radar systems. A new solid-state design replaces the current vacuum tube version.

Benefits Derived Are:

- *MTBF increased from 580 to 5800 hrs*
- *Time required for unscheduled battery maintenance reduced by 90 percent*
- *Time required for periodic checks and adjustments reduced:*
  Daily, 90 percent
  Weekly, 90 percent
  Monthly, 50 percent
- *Number of range rates increased from 1 to 4*
- *Double pulse mode provided*
- *CW mode of operation provided*
- *Mechanical servo mechanisms, variable attenuators, waveguides, and hybrids eliminated*

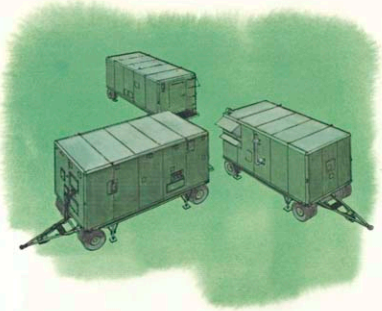


MTR CODER

The MTR Coder converts the intercept computer commands into steering and burst orders which are transmitted to the NIKE HERCULES missile. A new solid-state design MTR coder replaces the current vacuum tube version.

Benefits Derived Are:

- *MTBF increased from 850 to 27,000 hrs*
- *Battery adjustments reduced by 90 percent*
- *Time required for unscheduled battery maintenance reduced by 90 percent*
- *Time required for periodic checks and adjustments reduced:*
  Daily, 50 percent
  Weekly, 50 percent
  Monthly, 25 percent
- *LED status indicators provided to improve fault isolation and reduce maintenance time.*



INTERCEPT COMPUTER PROCESSOR GROUP

The ICPG will provide a solution to the intercept problem, and will generate gyro azimuth, steering orders and burst order for transmission to the missile during a tactical engagement. The ICPG will also perform interactive system checks and record mission data. The ICPG includes a Central Processor Unit (CPU) and Input/Output (I/O) Expansion Chassis, Flexible Disk Subsystem, Time-of-Year Clock, Plotting Board Controller and Interface Card Assemblies. A description of the ICPG equipment follows.

CPU AND I/O EXPANSION CHASSIS

The CPU and I/O Expansion Chassis constitute a high-speed militarized minicomputer (PDP-11/34M) which provides central processing, memory, input/output and reserve capacity for future expansion. The minicomputer will solve the intercept problem and perform diagnostics for fault isolation to major system subassemblies and DCS peripherals.

Benefits Derived Are:

- *Mounted on sliding frames for easy access for card removal*
- *No periodic adjustments required*
- *Diagnostics will allow fault isolation to the card level with an 85 percent confidence factor*

FLEXIBLE DISK SUBSYSTEM

The flexible disk subsystem is comprised of a controller containing Built In Test Equipment (BITE), and two identical disk drive units. One disk drive unit is used for storing and inputting the tactical program and the other is utilized for mission recording or inputting diagnostic programs.

Benefits Derived Are:

- *Utilization of either drive for storing or loading tactical program*
- *Fault isolation for total subsystem*

TIME-OF-YEAR CLOCK

A commercial digital clock is incorporated as part of the ICPG. The clock display will include day of year, hours, minutes, and seconds in real time. An alarm feature (not previously provided), will sound periodic warnings for possible IFF code changes.

Benefits Derived Are:

- *Alarm setting capability of up to four per hour, repeated each hour*
- *Time-of-year available to the computer for inclusion on mission recording and plotting board records*
- *Internal batteries provide 24 hours of reserve power to operate the clock, exclusive of the display, in the absence of primary power*

DIGITAL COMPUTER SYSTEM

The NIKE HERCULES computer receives missile and target position inputs from the tracking radars, solves the intercept problem, and generates gyro azimuth, steering orders and burst order for transmission to the missile.

As part of the NIKE HERCULES Supportability Program, a new Digital Computer System (DCS) and associated software replaces the existing analog computer.

The DCS consists of the following:

- *Intercept Computer Processor Group (ICPG)*
- *Intercept Computer Control Group (ICCG)*
- *Battery Control Console Subsystems*
- *Track Data Processor (TDP)*

Benefits Derived Are:

- *MTBF increased from 55 to 800 hrs*
- *Battery adjustments reduced by 80 percent*
- *Time required for unscheduled battery maintenance reduced by 85 percent*
- *Time required for periodic checks and adjustments reduced:*
  - *Daily, 60 percent*
  - *Weekly, 60 percent*
  - *Monthly, 75 percent*
- *Capability for rapid onsite evaluation of post-mission results and diagnostic data is provided*

GROWTH POTENTIAL

The Digital Computer System is flexible and adaptable to future growth requirements through modular construction, software control, extra I/O capacity, memory expansion, and additional program capacity.

Future enhancements possible are:

- *Improved guidance techniques*
- *Computer-aided target acquire*
- *Command and Control facility compatibility*
- *Increased fire power*
- *Adaptability to different missiles*

INTERCEPT COMPUTER CONTROL GROUP

The ICCG includes the Printer/Plotter, Keyboard, Display, Control/Status Panel, Power Supplies, and Power Control Panel. A description of the ICCG equipment follows.

PRINTER/PLOTTER

The Printer/Plotter is a digitally interfaced electro-mechanical device used to print and plot mission data and diagnostic results. This device, along with the mission recording disk drive unit, replaces the event recorder and developing equipment.

Benefits Derived Are:

- *Eliminated the requirement for the wet chemical developing equipment by utilizing dry pressure-sensitive paper*
- *Self-test features operating in conjunction with the Computer Control Group software are incorporated*
- *Hard copy plots and listings of recorded mission data are provided at the site for evaluation*
- *Plots are annotated and scaled (not provided by the analog event recorder)*
- *BITE self-checks are available*

KEYBOARD AND DISPLAY

A keyboard and gas discharge display unit are interfaced with the Intercept Computer to input both tactical and diagnostic instructions and to provide visual monitoring. All intercept computer periodic tests are performed and monitored utilizing the keyboard and display units.

Benefits Derived Are:

- *Ready operator access to selectable preprogrammed target and missile dynamic tests*
- *Self-checks provided for testing the subsystem of the printer/plotter, keyboard and display units independently of the other computer subsystems*
- *Reduced dependence on technical manual during periodic checks and adjustments*
- *Capability of selecting preprogrammed surface-to-surface targets provided through use of keyboard and display*
- *Manual calculations and technical manuals are not required to determine surface-to-surface parameters*
- *Manual positioning of the TTR antenna for inputting target data in the surface-to-surface mode eliminated*

CONTROL/STATUS PANEL

This panel controls the operational mode of the inte cept computer and displays subsystem stat information.

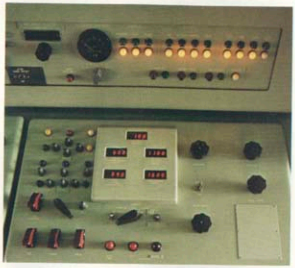
The modes of operation, initiated by an operator, a Action, Standby and Diagnostics.

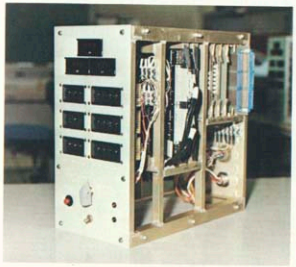
Benefits Derived Are:

- *Faults detectable by use of software contained on th tactical disk are displayed to the subsystem level*
- *Any fault displayed on the Control/Status Panel relayed to a single fault light on the tactical contr panel that is readily visible to the battery control offic*
- *LED status lights for the Processor, Plotting Board Disk Drive Subassembly, Range and Angle Data Lin and the MTR Coder Data Link display Ready/Fau status*

BATTERY CONTROL CONSOLE SUBSYSTEM

The Battery Control Console Subsystems requiring modifications include the Horizontal and Altitude Plotting Boards and the Tactical Control Indicator Panel.





PLOTTING BOARDS

The plotting boards (horizontal and altitude) provide a map-scale display of missions. Modifications are made to achieve digital compatibility with a microprocessor based plotting board controller located in the ICPG. The processor group servo motors and feedback potentiometers are replaced with digital stepping motors and positioning reference sensors.

Benefits Derived Are:

- *Critical clutch and feedback potentiometer adjustments have been eliminated*
- *Use of plotting board controller allows perpendicularity, zeroing and scale checks to be performed on operator command*
- *Capability of plotting site identification and time of year on both plotting board records (not previously provided)*
- *The long, spiral cords used in the analog system are eliminated*
- *Refillable pen assemblies replaced by disposable felt tip pens*

TACTICAL CONTROL INDICATOR PANEL

This panel has been modified to replace meter indications for Target Ground Speed, Missile Velocity, Target Altitude and Gyro Azimuth with digital displays. In addition, the computer overload indicator light used in the analog system is replaced with a fault indicator light.

Benefits Derived Are:

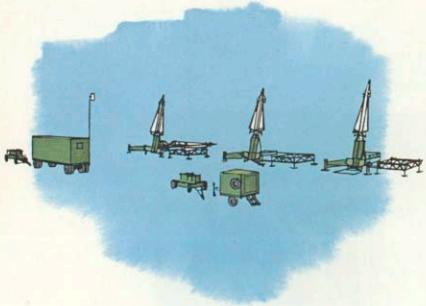
- *Consolidated digital readouts*
- *Fault Indicator Light to alert the operator of malfunctions in the Intercept Computer*
- *Digital display of time to intercept (not previously provided)*

TRACK DATA PROCESSOR

The TDP is a microcomputer based subsystem used to compute TRR range parallax corrections. The TDP is located in the coder cabinet of the Radar Control Trailer. During simultaneous tracking missions, it calculates and displays parallax- corrected TTR to MTR position differences.

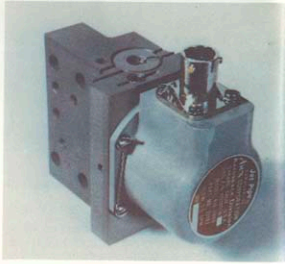
Benefits Derived Are:

- *Performance of simultaneous tracking tests (without data recording) independent of the Battery Control Trailer*
- *Verification of parallax settings by use of LED digital readouts*
- *Thumb wheel switch entry of TRR range parallax correction for test purposes*
- *Self-check mode verifies microcomputer operation*



MISSILE AND MISSILE LAUNCHER AREA

The Missile and Launch Area equipment modified in the NIKE HERCULES Supportability Program consists of the Launcher Hydraulic Filter and the Missile Four-Way Valve and Filters.



LAUNCHER HYDRAULIC FILTER

The launcher hydraulic fluid filter is used in the missile launcher to maintain cleanliness of the fluid used in the launcher beam erecting system. The new replacement filter contains a rugged stainless steel reusable element which eliminates problems caused by filter collapse.

Benefits Derived Are:

- *Time required for unscheduled battery maintenance reduced by 60 percent*
- *Time required for periodic checks and adjustments reduced:*
  Quarterly, 65 percent
- *Reusable filter element (up to five times)*
- *Pop-up visual delta indicator shows when filter maintenance is required*

MISSILE FOUR-WAY VALVE

The missile uses an electro-hydraulic servo valve to provide a precisely metered flow of fluid to the missile fin actuators in response to electrical guidance signals. This valve is replaced with a new four-way valve.

Benefits Derived Are:

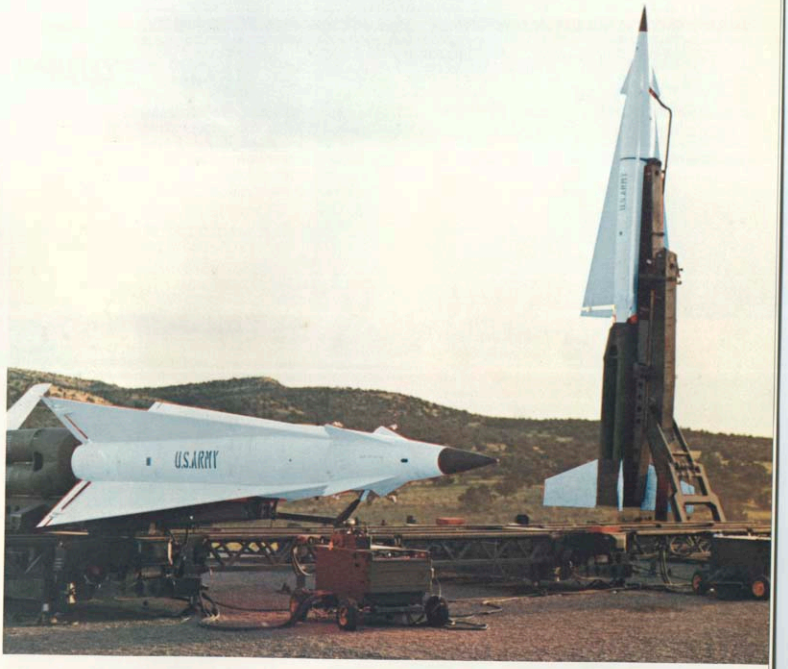
- *MTBF increased from 85 to 50,000 hrs*
- *Time required for unscheduled battery maintenance reduced by 95 percent*
- *Time required for periodic checks and adjustments reduced:*
  Daily, no change
  Weekly, 10 percent
  Monthly, 10 percent
- *AC voltage periodic checks and adjustments (buzz voltage) are eliminated*
- *Modified commercial unit provides broad supply base*

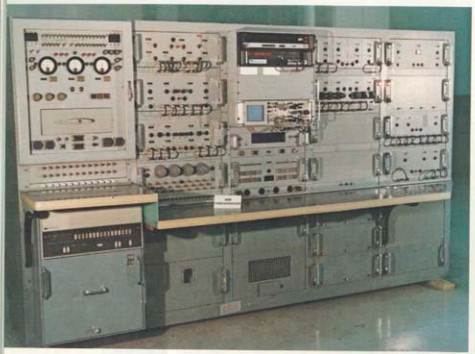
MISSILE FILTER

The missile hydraulic fluid filter is used to remove contaminants from the fluid used in servo actuators and the hydraulic pumping unit. The replacement filter uses a stainless steel element.

Benefits Derived Are:

- *Reduced maintenance of the servo actuator by 50 percent*
- *Reusable filter element (up to five times)*
- *Use of a 10 micron filter provides reduced abrasive wear and hydraulic leakage (current filter is 25 micron)*
- *Modified commercial unit provides broad supply base*





SUPPORT EQUIPMENT

TYPE IV TEST EQUIPMENT

The Type IV test equipment which includes Shop I, Shop II, Shop III, and the Digital Card Tester is used to test various units of the NIKE HERCULES System.

The Shop III test equipment is being updated to provide a current technology computer-controlled test system. The updated system incorporates a new digital multimeter, electronic counter, and real time oscilloscope.

The supportability modifications to the ground guidance equipment require associated modifications to the Type IV test equipment. These modifications consist primarily of new or modified patch cards, test adapters, wiring harnesses, mounting brackets, and test procedures.

Benefits Derived Are:

- *Reduced number of unique test adapters required*
- *Simplified test procedures on solid-state units*
- *Reduction in manual adjustments*
- *Reduced troubleshooting of test equipment through use of BITE*

SOFTWARE DEVELOPMENT LABORATORY

The NIKE HERCULES Digital Computer Software Development Laboratory is the primary development and validation facility for the software required by the current Supportability Program Computer Modification. The Laboratory consists of a PDP-11/34 Computer and associated peripheral equipment plus a PDP-11/34M Computer and associated militarized peripherals and system interfaces.

In addition to serving as the initial development and test environment for the software, the Laboratory will be the primary vehicle for performing investigations of problems related to both software and system troubles observed on recorded data. The Laboratory will also be utilized for future change proposals, development of software changes and new software to support future hardware changes.

The total Laboratory (both hardware and supporting software), as well as the deliverable software, will be maintained under a rigid configuration control plan to assure identical configuration to the fielded software.

DEPOT AUGMENT TEST EQUIPMENT

The Depot Augment test equipment consists of group of test sets, fixtures, and special tools designe to aid support personnel in the repair and rebuild o the Ground Guidance and Missile Guidance equip ment. The NIKE HERCULES System Supportabilit Program requires modifications to the Depot Aug ment test equipment. These modifications are limite to the four test sets used for testing the RF units of th MTR, TRR, and TTR antenna trailers.

SUMMARY OF BATTERY MAINTENANCE IMPROVEMENT

APPROXIMATE REDUCTION IN MAINTENANCE ACTIONS (PERCENT)

MODIFICATION	PREDICTED MTBF (HOURS)		BATTERY ADJUSTMENTS	UNSCHEDULED MAINTENANCE TIME	TIME REQUIRED FOR CHECKS & ADJUSTMENTS		
	PRE-MOD	POST-MOD			DAILY	WEEKLY	MONTHLY
LOPAR							
DIGITAL MTI	150	1,500	90	95	70	90	90
SS CHASSIS	250	3,500	NC	70	NC	NC	NC
4KHz SYSTEM	NA	30,000	NC	85	NC	NC	NC
PPI & PI	905	9,000	NC	95	85	85	85
TRACKING RADARS							
TTR RECEIVER	275	2,900	30	85	75	50	50
MTR RECEIVER	300	3,400	30	85	60	40	40
TRR RECEIVER	615	3,600	20	85	30	30	30
RF TEST SET	580	5,800	(30)	90	90	90	50
"B" SCOPE	800	12,500	20	90	NC	85	85
MTR CODER	850	27,000	90	90	50	50	25
TRR COAXIAL MAG	400	2,500	NC	75	NC	NC	NC
FERRITE SWITCH	900	3,600	NC	75	NC	NC	NC
MIXER DIODE/TRL	-	-	NC	60	NC	NC	NC
DIGITAL COMPUTER	55	800	80	85	60	60	75
MISSILE & LAUNCHER							
LAUNCHER HYDRAULIC FILTER	-	-	NC	60	NC	NC	65*
MISSILE FOUR-WAY VALVE AND FILTER	85	50,000	NC	95	NC	10	10

Legend: NA Not Available
NC No Change

*QUARTERLY REDUCTION

Western Electric