US ARMY AIR DEFENSE DIGEST

CPT McDaniel

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US ARMY
AIR DEFENSE DIGEST

The US Army Air Defense Digest is designed to keep commanders and other officers and men--especially those who are serving as instructors or who are principally occupied in the training of individuals and units--informed on trends, doctrine, and new weaponry in air defense.

In recognition of the other military services' interest in and responsibilities for air defense, this annual publication is available to elements of the Marine Corps, Navy, Air Force, and other US Government agencies as well as to the active and reserve components of the Army. Single copies of the Air Defense Digest sell for 35 cents in the US Army Air Defense School Bookstore, Fort Bliss, Texas.

New developments in materiel, doctrine, tactics, and techniques are constantly being introduced. Factual and unclassified, this Digest is an important supplement to air defense artillery training literature because it presents in unclassified terms the more recent developments and concepts in air defense weapons and employment. I hope that the information presented in this Digest will stimulate close and coordinated efforts among the various air defense activities and that it will keep artillerymen informed on the current state of their profession.

LLOYD L. LEECH
Brigadier General, USA
Assistant Commandant

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—IMPORTANT NOTICE—

Users of this publication should retain copies because it is tentatively planned, as an economy measure, that only changes to this issue will be published in the future—not the complete publication.

*UNITED STATES ARMY AIR DEFENSE DIGEST

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*Supersedes US Army Air Defense Digest, 1 Jul 69

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The US Army Air Defense Digest, 1970, may be purchased at 35 cents per copy (plus postage if mailed) by writing to Commandant, US Army Air Defense School, ATTN: Bookstore, Fort Bliss, Texas 79916.

Chapter 1
Air Defense Doctrine and Procedures

All services—Army, Navy, and Air Force—are involved in air defense operations. Current doctrine and operational procedures provide for integration of the weapon capabilities of all services.

ARMY AIR DEFENSE OPERATIONS

AUTHORITY

Specific authorization for the Army to engage in air defense operations is derived from the National Security Act of 1947, as amended, and Joint Chiefs of Staff Pub. 2, United Action Armed Forces (UNAAF), November 1959. These directives assign the Army primary functions as follows: "To organize, train, and equip Army forces for the conduct of prompt and sustained combat operations on land—specifically, forces to defeat enemy land forces and to seize, occupy, and defend land area." UNAAF assigns the Army the following air defense missions: "To organize, train, and equip Army air defense units, including provision of Army forces as required for defense of the United States against air attack, in accordance with doctrines established by the Joint Chiefs of Staff."

CONCEPT OF AIR DEFENSE OPERATIONS

The broad principles of Army air defense doctrine are stated in FM 44-1, U.S. Army Air Defense Artillery Employment. The provisions in FM 44-1 apply to US Army air defense artillery units with a unified command or serving in a combined force. The policies and procedures prescribed by the joint air defense commander will prevail when they conflict with doctrine and procedures described in FM 44-1.

NORTH AMERICAN AIR DEFENSE COMMAND

The North American Air Defense Command (NORAD) is a combined command exercising operational control of forces allocated for air defense of Canada, Alaska, and the continental United States. Its mission is "to defend the North American Continent against aerospace attack." Headquarters NORAD, located at Colorado Springs, Colorado, prepares operational plans, conducts tactical exercises and readiness tests, and coordinates plans and requirements for new air defense weapons. It is the supreme headquarters for directing the air defense of North America in the event of war.

EVOLUTION

NORAD was formed in September 1957 following an agreement between the governments of Canada and the United States which, in effect, was official recognition of the fact that air defense of the two countries is an indivisible task. A high-level Canadian-United States committee (Military Cooperation Committee) drew up an emergency plan for the common defense of North America and directed that air defense organizations of the two countries prepare detailed emergency air defense plans. The first of these was issued in 1950.

Early in 1954, the same committee authorized a combined planning group of representatives from the Royal Canadian Air Force and the US Air Force Air Defense Command. Studies conducted by this group indicated that the best air defense of North America was an integrated defense, with forces of both countries operating under a single command, responsible to both governments. Following the completion of another study 2 years later which had the same conclusions, integration of operational control of the two forces was recommended.

In the meantime, the two countries had gone ahead with the development of a joint radar warning network. Together, they built the Pine Tree line of radars across southern Canada. Canada started constructing the mid-Canada line, and the United States began the distant early warning (DEW) line across the northern rim of the continent. Conditions for operating and manning these lines were mutually agreed upon.

Thus, by 1957, there had been a considerable history of joint planning, coordinating, and sharing, and the need for further integration had been recognized. In August of that year, the United States Secretary of Defense and the Canadian Minister of National Defence announced that the two governments had agreed to establish a system of integrated operational control of air defense forces for North America and an integrated headquarters. On 12 September 1957, NORAD was established, followed by the signing of an official agreement by both countries on 12 May 1958.

The Commander in Chief, North American Air Defense Command (CINCNORAD), was to be responsible to the Chief, Defence Staff of Canada, and the Joint Chiefs of Staff of the United States. The agreement further stipulated that the appointment of CINCNORAD and his deputy had to be approved by both governments and that both would not be from the same country.

NORAD FORCES

NORAD has no organic fighting elements of its own, but is furnished combat-ready forces, including Reserve and National Guard forces, by three component commands (fig 1): US Army Air Defense Command (ARADCOM), US Air Force Aerospace Defense Command (USAF ADC), and Canadian Forces Air Defence Command (CF ADC), plus the air defense forces of the Alaskan Command. CINCNORAD exercises operational control over all forces attached or otherwise made available by component commanders and the Alaskan Command.

ARADCOM furnishes Nike Hercules missiles (high-altitude, surface-to-air) and Hawk missiles (low- and medium-altitude, surface-to-air). Under this command are the US Army missile units protecting the key population and industrial centers of the United States.

Most of NORAD's fighter-interceptor squadrons are provided by the USAF ADC. This component also contributes Bomarc surface-to-air missiles and a large number of radar squadrons and early warning airborne radars. USAF ADC is responsible for the ballistic missile early warning system (BMEWS) and SPACETRACK (a part of the space defense system), providing NORAD important information about ballistic missiles and orbiting space objects. The Air National Guard provides interceptor squadrons and aircraft control and warning squadrons on full-time assignment to NORAD through USAF ADC.

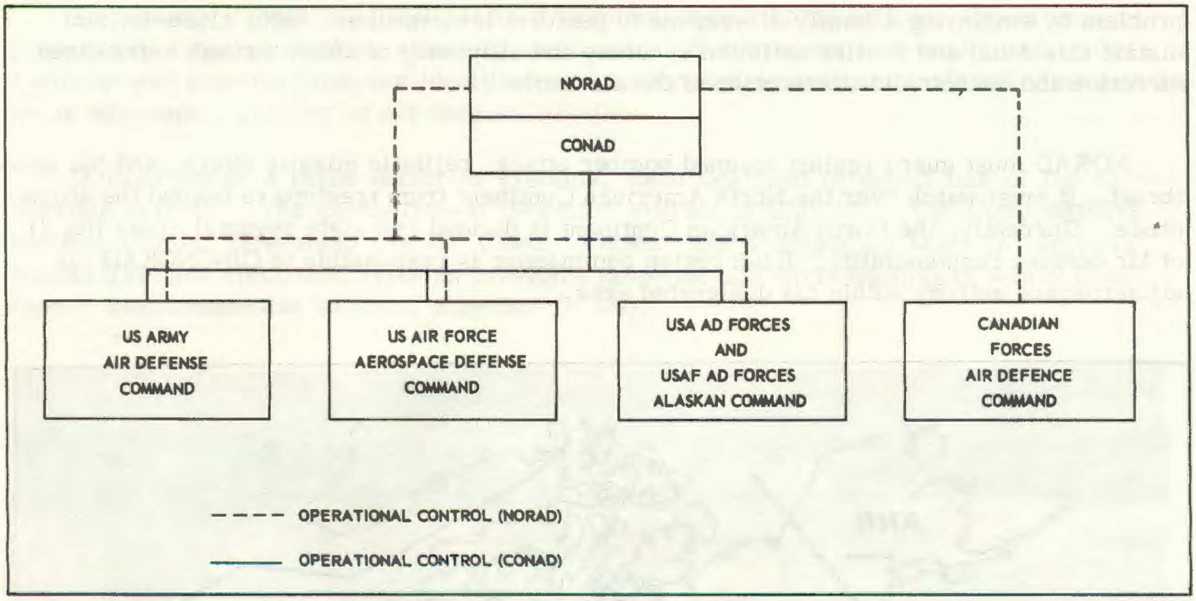


Figure 1. NORAD/CONAD operational control structure.

The CF ADC provides fighter-interceptor squadrons and two surface-to-air Bomarc missile squadrons. It also contributes heavily to performance of surveillance, detection, and identification functions.

Alaskan air defense forces are made available to CINCNORAD for operational control. This force is not a component of NORAD. The force, consisting of Army and Air Force AD weapons, are part of the Alaskan Command (a unified command). Commander in Chief, Alaska (CINCAL), has a dual role. He is the commander of the Alaskan Command and also the commander of the Alaskan NORAD region. The geographical boundaries of the Alaskan Command and Alaskan NORAD region are the same.

US Naval Forces operate the US Navy's space surveillance system (NAVSPASUR), which furnishes information to NORAD through the space defense system. The US Navy would also provide augmentation forces upon direction of the Joint Chiefs of Staff.

The Continental Air Defense Command (CONAD) is a unified command formed from the US personnel within the NORAD structure. This organization gives the US a capability of unilateral action where strictly United States interests are involved. Accordingly, the mission of CONAD is aerospace defense of Alaska, Greenland, and the continental United States (CONUS), and Mexico if requested by the Mexican Government. The senior American officer in NORAD is the Commander in Chief, Continental Air Defense (CINCONAD). If CINCNORAD is an American, he also is CINCONAD. If CINCNORAD is a Canadian, then the Deputy CINCNORAD is CINCONAD.

OPERATIONAL PROCEDURES

To accomplish its mission, NORAD is guided by these air defense principles: hit the enemy as far out as possible; increase the pressure as he continues; complicate his tactical problem by employing a family of weapons to perform low, medium, high, close-in, and distant missions; and realize optimum economy and efficiency of effort through centralized direction and decentralized execution of the air battle.

NORAD must guard against manned bomber attack, ballistic missile attack, and the space threat. It must watch over the North American Continent from treetops to beyond the atmosphere. Currently, the North American Continent is divided into eight regional areas (fig 2) of air defense responsibility. Each region commander is responsible to CINCNORAD for all aerospace activity within his designated area.

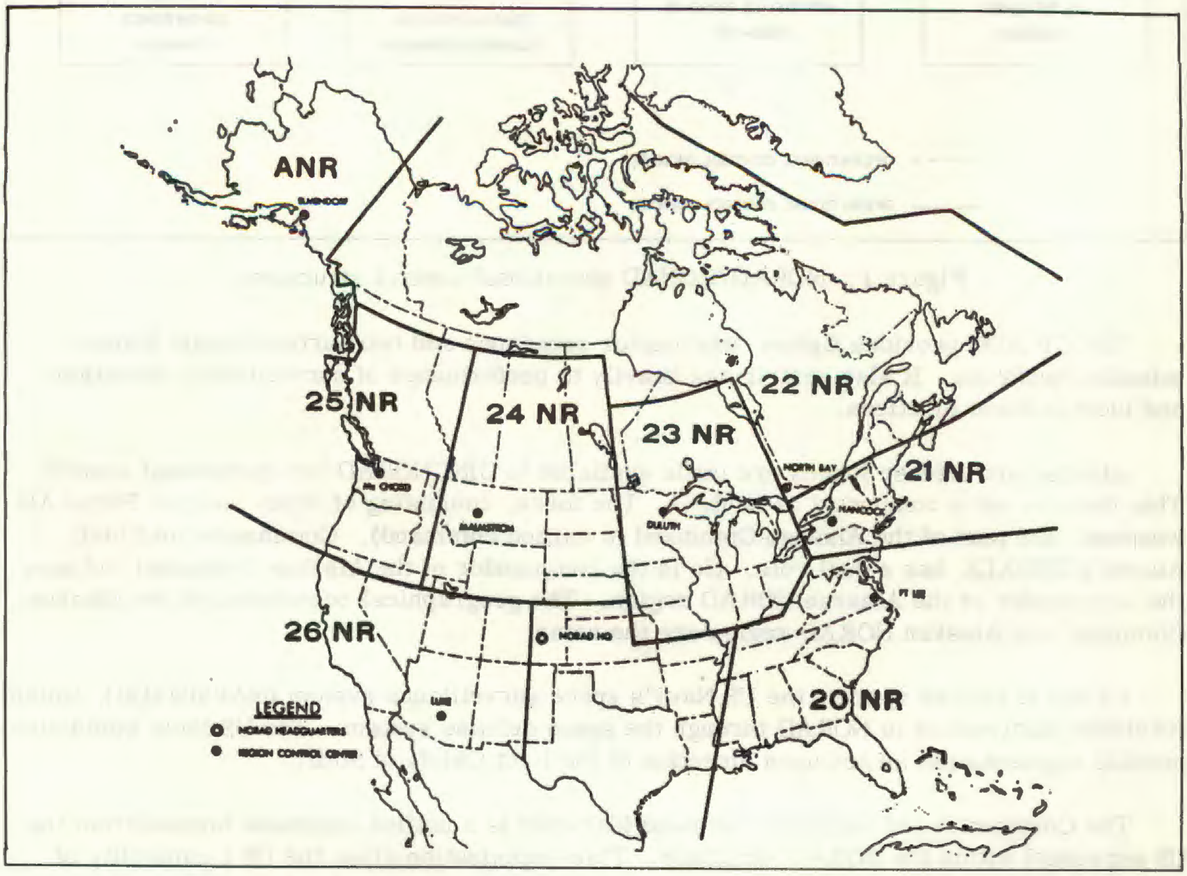


Figure 2. NORAD operational boundaries.

Each NORAD region is the basic unit for decentralized fighting of the air battle. Regions that cross the international boundary are manned jointly by United States and Canadian personnel. The sizes of regions vary depending generally on the amount of air traffic and number of vital target areas located within each region.

To perform its mission, NORAD must accomplish four basic actions: detect the presence of airborne objects, aircraft, or missiles; identify them as friendly or hostile; intercept and examine those not identified as friendly; and destroy those identified as hostile, using interceptor aircraft or air defense missiles.

NORAD employs three detection systems, each designed to detect one of the three possible threats. The northernmost detection system is BMEWS. The three BMEWS stations (Thule, Greenland (fig 3), Clear, Alaska, and Fylingdales Moor in Northern England) employ electronic systems providing detection and early warning of attack from enemy intercontinental ballistic missiles (ICBM).

Figure 3. NORAD BMEWS site at Thule, Greenland.

BMEWS was made possible by recent scientific developments in the electronics field. The system uses huge radars, approximately the size of a football field, which can detect a missile at a distance of 3,000 miles. The power required for a single station would meet the electrical needs of a small city.

The heart of the BMEWS detection system is a combination transmitter-receiver which transmits an extremely brief burst of energy many times each second in narrow fans of radiofrequency energy at two different degrees of elevation. As a missile passes through these fans, it reflects energy to the station, enabling the coordinates of flight to be recorded. From a set of coordinates, the trajectory can be plotted and the impact point, time, and point of launch calculated. Data processing equipment at the site rapidly computes the data and flashes a warning to NORAD.

A second detection system is the manned bomber surveillance network, composed of land-based radar networks (fig 4) and Air Force planes. The first line of radars begins in the far north with the distant early warning (DEW) line (fig 5). This radar fence, which stretches from the eastern shores of Greenland across the Canadian Arctic to the Aleutian chain, provides initial warning of attack by manned bombers. A ground-based radar system, called contiguous coverage, is extended out to sea off the west and southeast coasts by Air Force radar planes (fig 6). All of these systems are joined together by a communications network terminating in the NORAD combat operations center at Colorado Springs, Colorado.

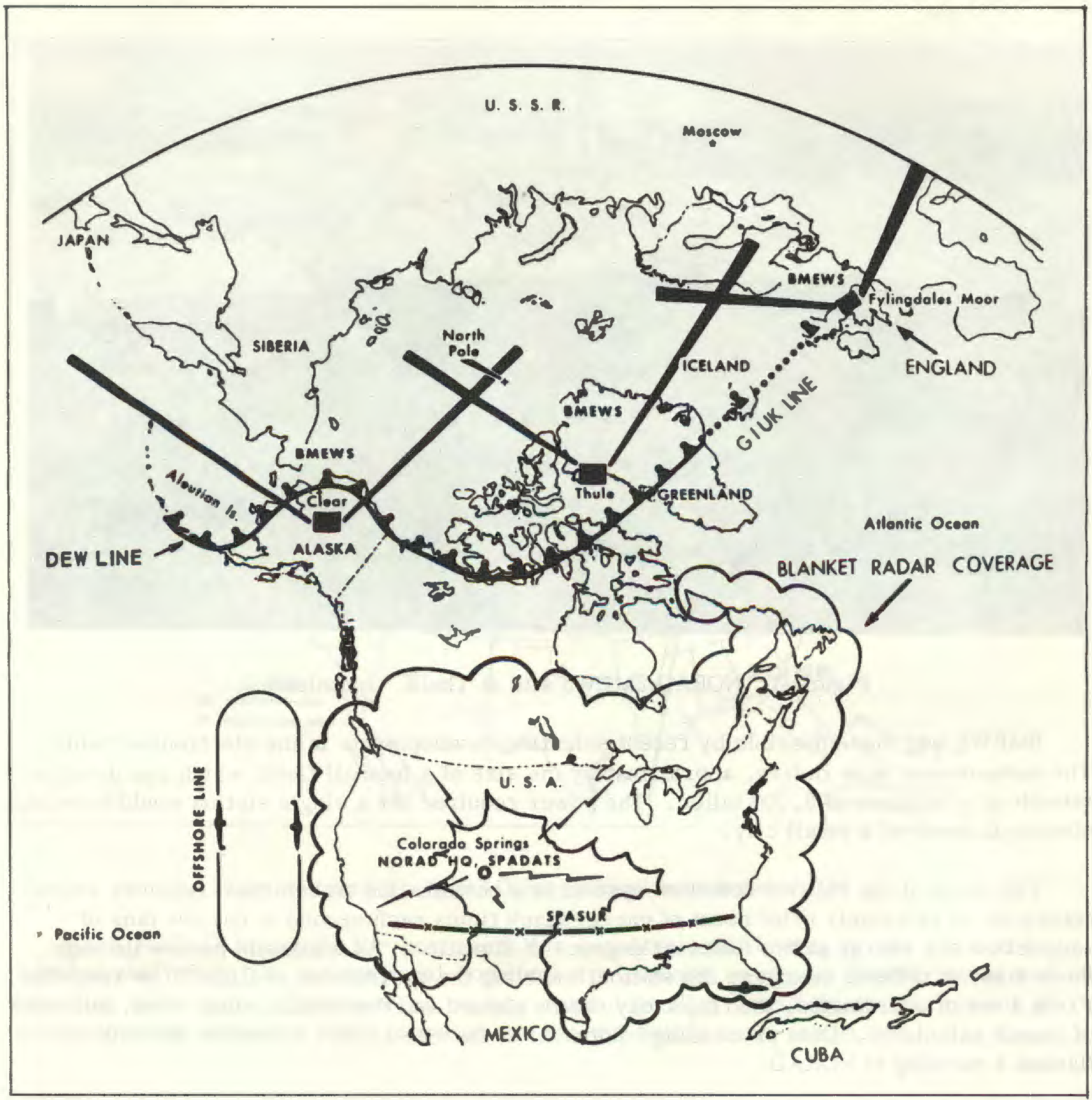


Figure 4. NORAD radar detection system.

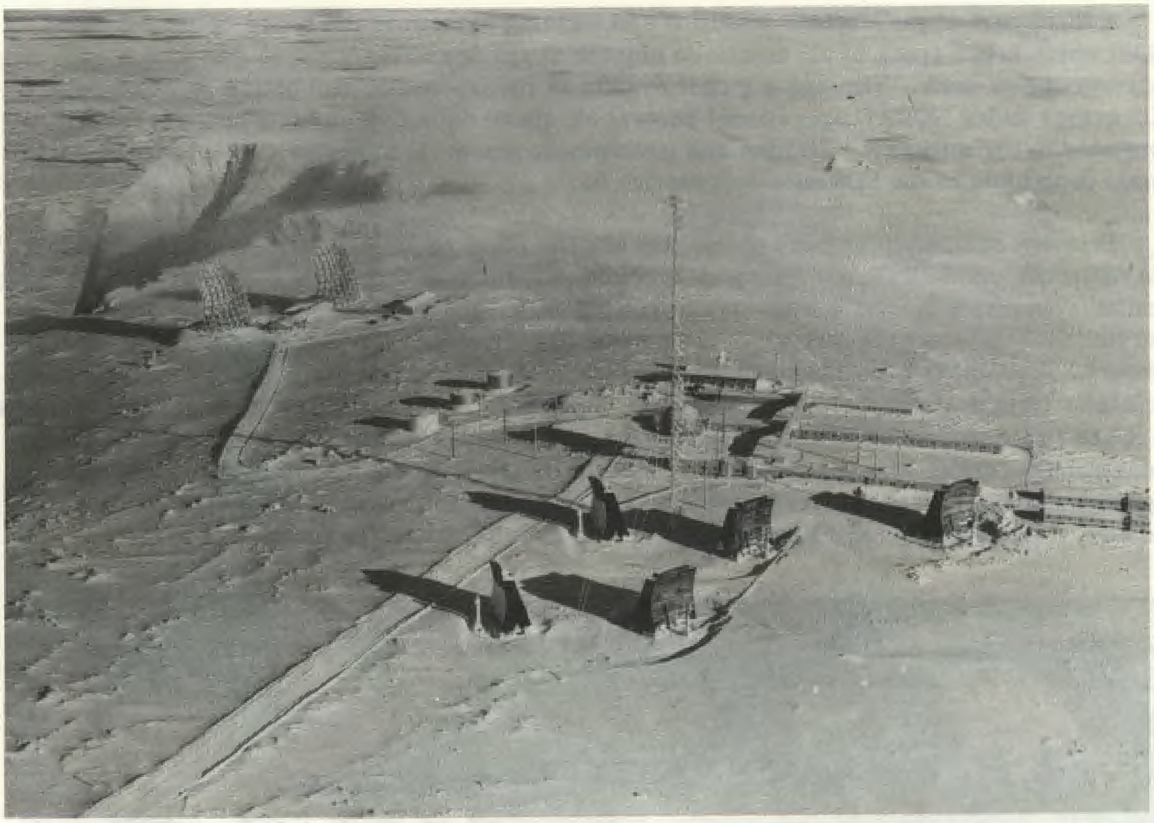


Figure 5. DEW line radar site.

Figure 6. USAF EC-121-H Super-Constellation radar plane.

A third part of the NORAD detection and warning system is the space defense system (SDS) which keeps track of all manmade objects in space and determines entry time and location of new ones. Through a global system of radar, radio, and optical sensors, the SDS brings under NORAD operational control all space detection and tracking resources available to the military. Civilian and government scientific agencies throughout the free world contribute to the SDS on a cooperative basis.

Primary military members of the SDS are the USAF SPACETRACK system and US Navy's NAVSPASUR. SPACETRACK provides tracking information through a series of USAF sensors (radar, operational, and electronic). The CF ADC provides inputs from an optical surveillance device, the Baker-Nunn camera (fig 7). NAVSPASUR is composed of three powerful transmitter stations and five receiver stations alternately spaced across the southern United States from California to Georgia. Data from this network are furnished to Space Defense Center (SDC) computers through the system's headquarters and operations center at Dahlgren, Virginia. The third type of information comes from other cooperating agencies, such as National Aeronautics and Space Administration (NASA), the National Security Agency (NSA), and Pacific and Atlantic missile ranges on an on-call basis.

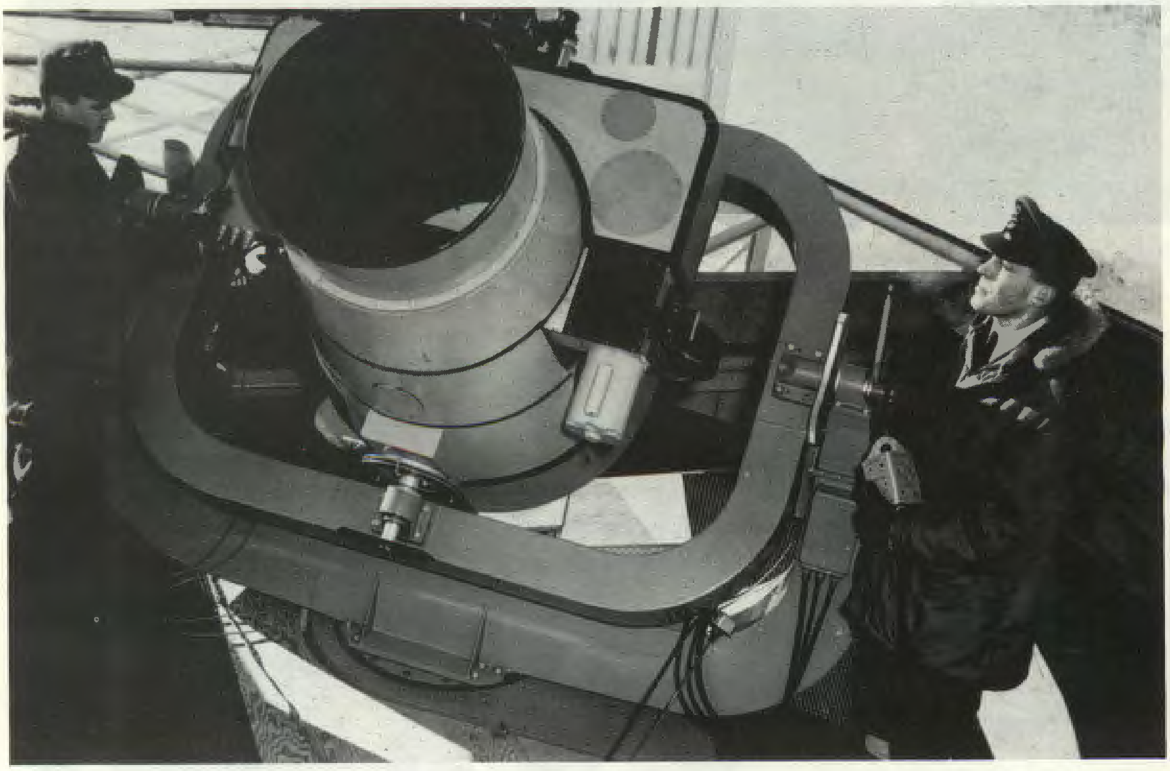


Figure 7. Baker-Nunn camera.

Space tracking information from this widespread system flows into the SDC (fig 8) at Colorado Springs where giant digital computers digest reams of complex orbital data on space objects.

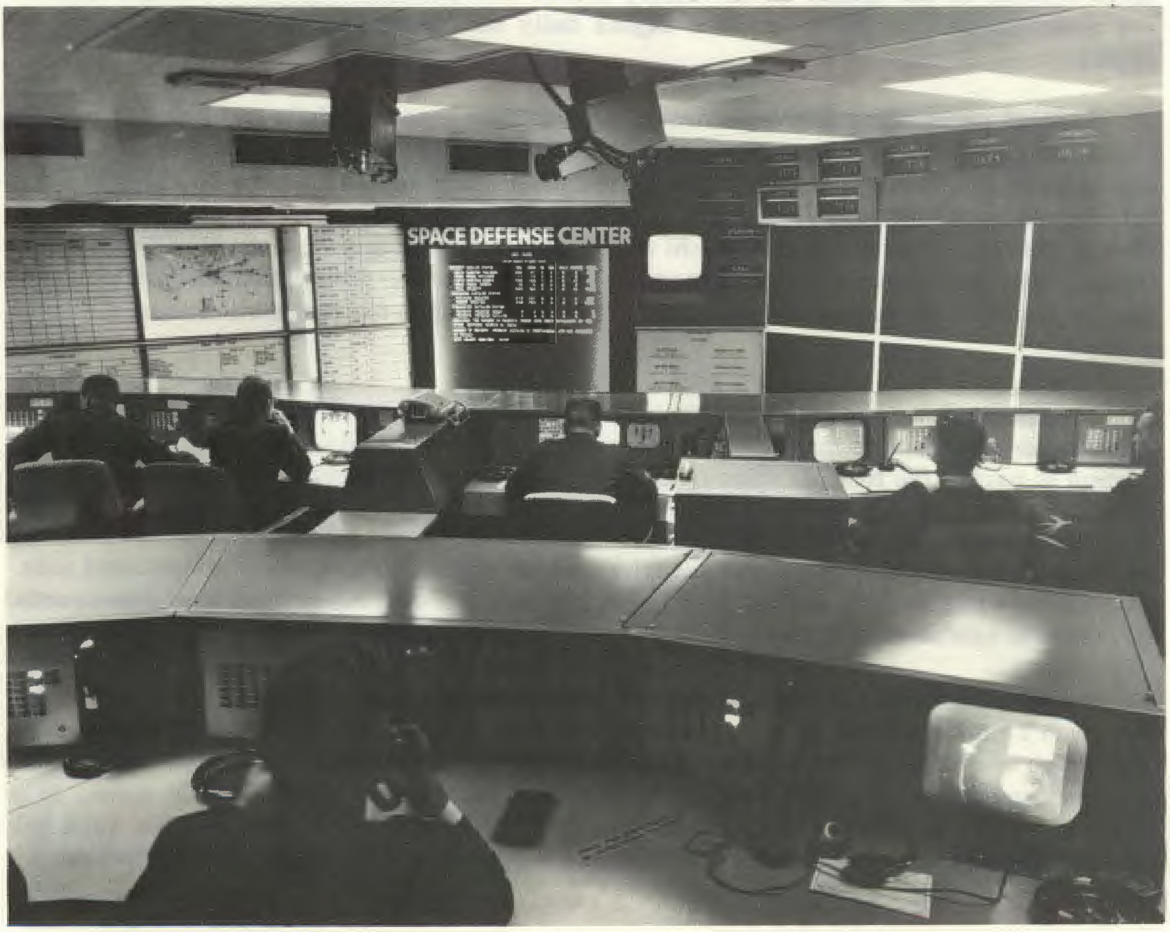


Figure 8. Space Defense Center at NORAD Headquarters.

The wide variety of data received from the numerous sources enables the SDC to provide complete and timely tracking information on all manmade objects in space. SDC also maintains a running catalog, constantly revised and updated, on all space traffic. Thousands of observations are received daily and are used to refine existing orbital characteristics of more than 1,300 objects. This includes not only payloads but space junk, such as burned-out boosters and wires the size of a lead pencil.

Once the computers have digested all the tracking data and produced their findings, the information is displayed on large status boards (fig 8) in the SDC. From here it is transmitted to the battle staff area in the adjacent NORAD combat operations center by closed-circuit television.

It is expected that at some future date the SDS must be equipped to determine the purpose and threat potential of unfriendly space objects, to warn of hostile activity in space, and to provide space traffic control, operational support to antisatellite weapons when and if developed, and support to United States space and weapon activities.

Identification is one of NORAD's most difficult problems, caused chiefly by the large amount of air traffic in the United States and Canada. On the average, there are approximately 1,200 overwater flights daily and an estimated 200,000 internal flights.

Aircraft penetrating the North American Continent enter air defense identification zones (ADIZ) established around and throughout the continent to assist in identification processing. Any aircraft originating from an oversea area must enter an ADIZ within 20 miles of a predetermined point and within 5 minutes of an estimated time, based on the pilot's flight plan filed at his takeoff point and sent ahead to the Federal Aviation Administration (FAA) in the United States and Department of Transport (DOT) in Canada. This information is relayed to appropriate NORAD region control centers (NRCC) and used for correlation when the track is acquired.

If an aircraft enters an ADIZ, but is not within prescribed limits, it is declared an unknown and interceptors may be scrambled to make positive visual identification. The ADIZ system is part of the NORAD identification process known as flight plan correlation.

Under combat conditions, the identification process would be somewhat simplified when provisions of emergency plans and security control of air traffic and air navigational aids (SCATANA) are placed in effect. SCATANA provides for orderly grounding of nonessential aircraft and establishing military control over radio navigational aids.

In view of the large number of aircraft flights taking place within NORAD airspace in any given 24-hour period, it is a rare day when none of these appear at the NORAD combat operations center as unknown. The average number of unknowns in the system has steadily declined over the years until now the number is less than 10 per day. Of these, it is common to find two or three instances where interceptors are scrambled but recalled before intercept because of the identity being established by further communication checks.

In all, there are more than 20 regular fighter-interceptor squadrons (fig 9) in the NORAD system. In an emergency, these forces would be augmented by available fighter aircraft of the US Navy, US Marine Corps, US Air Forces, Air National Guard, and interceptor training units of the CF ADC. All of these forces are highly mobile and constantly practice dispersal and forward base deployment.

NORAD COMBAT OPERATIONS CENTER

Nerve center of the North American Air Defense Command is the combat operations center (COC) situated in Cheyenne Mountain, south of Colorado Springs (fig 10). The COC is housed in steel buildings beneath more than a thousand feet of solid granite. The main part of the COC is a three-story building constructed within the intersecting chambers. It includes 200,000 square feet of floorspace to accommodate a maximum of 900 people. The COC is virtually safe from thermonuclear attack. It is from the COC that the first warning of an attack on North America would come; if such an attack should come, the air battle for survival of the United States and Canada would be directed from the COC.

Figure 9. USAF ADC fighter-interceptors go into action.

Figure 10. Cheyenne Mountain in which NORAD COC is located.

Data are received in the COC from the huge complex of radar stations, interceptor squadrons, missile sites, space tracking and ballistic missile warning units, and NORAD regions and are stored in a large digital computer. Here, too, information is received from other sources, such as the Strategic Air Command (SAC), naval forces off both coasts, the Pentagon, and the Department of National Defence in Canada.

This information is displayed on an electronic wall display system (fig 11). The system permits almost instantaneous observation of the positions of aerospace and seaborne objects thousands of miles away and over any part of the continent covered by radar networks. It flashes surveillance information on large, theater-like screens for easy observation.

Figure 11. Underground COC showing battle staff and main display boards during a test exercise.

Included is a map of North America, the surrounding oceans, Greenland, Iceland, parts of Siberia, and the Caribbean islands. Symbols show the location and direction of travel of all aircraft of special interest to NORAD. These may be strategic friendly elements or a commercial or military aircraft that for one reason or another is classed as an unknown until positive identification is made. NORAD is interested in unidentified submarines, friendly aircraft carriers, Soviet fishing trawlers, and air activity over Cuba and Siberia. All this is presented on the main display with special coded symbols that provide a variety of information about the subject.

To the right of the main display is the weapon status board. This is associated with the main display, and information on the board is received, processed, and displayed automatically. The top part of this board, referred to as the "commander's box score," shows at a glance the number of hostile aircraft in the NORAD system, the number of unknowns, the weapons committed to these tracks, the kills made, and NORAD losses. Below is a listing of worldwide major military commands and their defense readiness conditions. The bottom part of the status board shows the number of weapons available to NORAD on a 5-minute alert, including fighter-interceptors and surface-to-air missiles.

There are other types and sources of information available on call. The weather forecast office in the COC is manned with trained meteorologists, always on duty and ready to provide the latest weather information, either in person or through the closed-circuit television network, to monitors in front of each member of the battle staff. SDC also has its headquarters in the COC and can provide information to the battle staff either by a personal briefing or through the television system.

SEMIAUTOMATIC GROUND ENVIRONMENT

Conduct of an area air defense battle requires a vast amount of information, dependable communications, and coordination among many organizations. Receiving this information, processing it, and using the necessary instructions in the limited time available proved impossible for unaided human beings, and an electronic air surveillance and weapon control system was devised to do the job. This system, called semiautomatic ground environment (SAGE), receives information, processes it, and communicates instructions to those concerned.

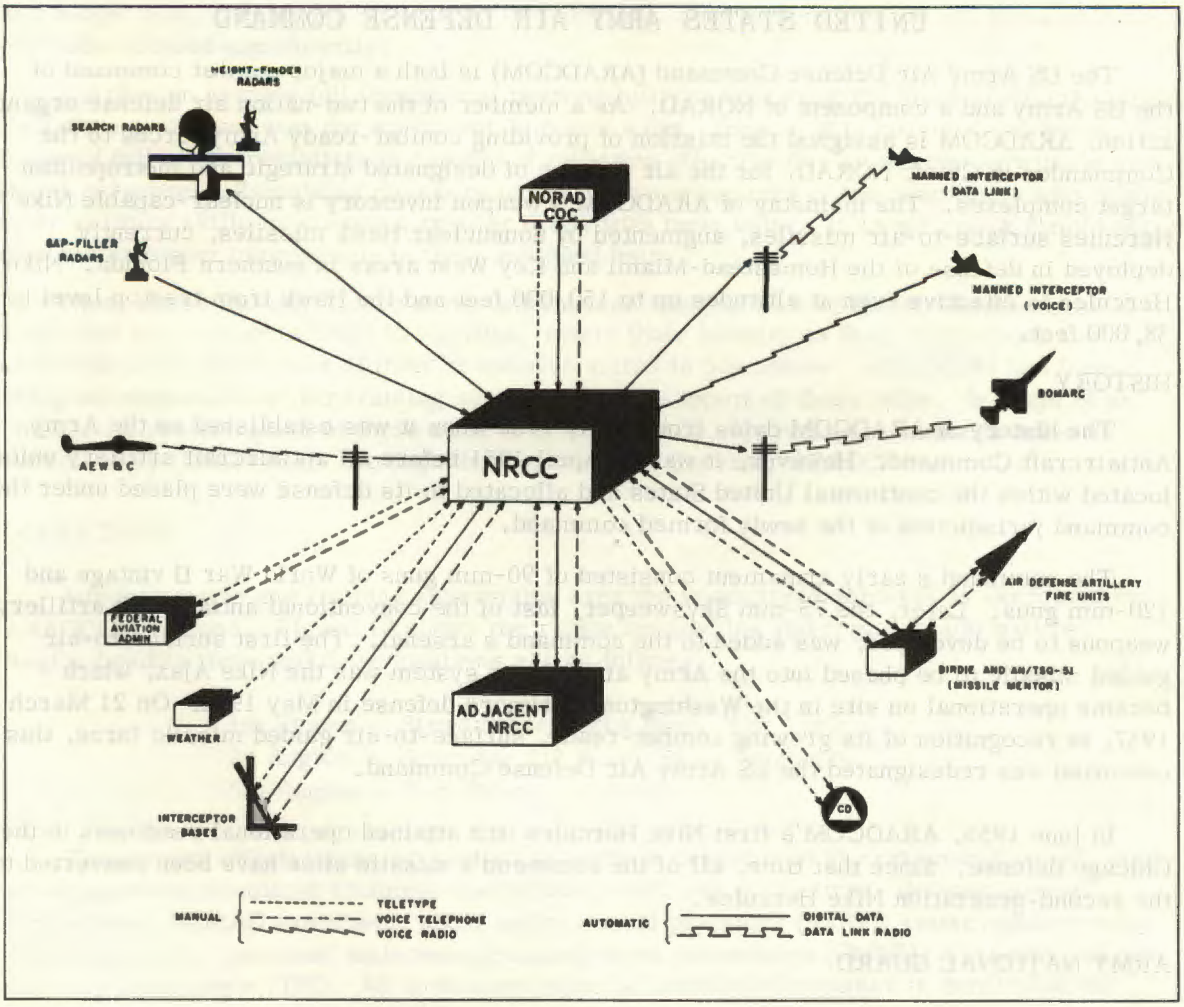


Figure 12. SAGE data flow.

Figure 12 shows the flow of data to and from the NORAD region control center (NRCC) in the air defense organization. Data are transmitted automatically to the NRCC from ground-based search radars and, on demand, from height-finder radars. Information on weapon status, weather, and airborne early warning is received by telephone, radio, and teletype and is programed into the computer. Similarly, data from the NRCC are transmitted automatically to direct Bomarc missiles and aircraft equipped with data link receivers to hostile aircraft. Digital data transmission is used to pass hostile track information to Missile Mentor (AN/TSQ-51) or battery integration and radar display equipment (BIRDIE) fire distribution systems for action by Nike Hercules and Hawk fire units. Selected data are automatically sent to adjacent NRCC's. Manned interceptors, not equipped with data link, are directed to the hostile aircraft by voice (ultrahigh frequency (UHF) radio). Telephone, teletype, and radio are used to pass information to civil defense agencies, SAC, and other headquarters.

UNITED STATES ARMY AIR DEFENSE COMMAND

The US Army Air Defense Command (ARADCOM) is both a major combat command of the US Army and a component of NORAD. As a member of the two-nation air defense organization, ARADCOM is assigned the mission of providing combat-ready Army forces to the Commander in Chief, NORAD, for the air defense of designated strategic and metropolitan target complexes. The mainstay of ARADCOM's weapon inventory is nuclear-capable Nike Hercules surface-to-air missiles, augmented by nonnuclear Hawk missiles, currently deployed in defense of the Homestead-Miami and Key West areas in southern Florida. Nike Hercules is effective even at altitudes up to 150,000 feet and the Hawk from treetop level to 38,000 feet.

HISTORY

The history of ARADCOM dates from 1 July 1950 when it was established as the Army Antiaircraft Command. However, it was 10 April 1951 before all antiaircraft artillery units located within the continental United States and allocated to its defense were placed under the command jurisdiction of the newly formed command.

The command's early armament consisted of 90-mm guns of World War II vintage and 120-mm guns. Later, the 75-mm Skysweeper, last of the conventional antiaircraft artillery weapons to be developed, was added to the command's arsenal. The first surface-to-air guided missile to be phased into the Army air defense system was the Nike Ajax, which became operational on site in the Washington-Baltimore defense in May 1954. On 21 March 1957, in recognition of its growing combat-ready, surface-to-air guided missile force, this command was redesignated the US Army Air Defense Command.

In June 1958, ARADCOM's first Nike Hercules unit attained operational readiness in the Chicago defense. Since that time, all of the command's missile sites have been converted to the second-generation Nike Hercules.

ARMY NATIONAL GUARD

The Department of the Army authorized the Army National Guard to convert 32 antiaircraft artillery battalions, then equipped with conventional guns, to Nike Ajax missile battalions in 1957. The 4th Missile Battalion (Nike Ajax), 251st Artillery, California Army

National Guard, was the first National Guard surface-to-air guided missile battalion integrated into the active continental United States defense mission. This unit assumed around-the-clock operations at four battery sites in the Los Angeles area on 14 September 1958. At the completion of the phased training program, the Army National Guard was furnishing 76 batteries in 14 states, defending 15 areas. These were the first US Reserve Forces with modern surface-to-air missiles.

In may 1962, the first of the Army National Guard Nike Ajax units were phased out and started retraining to operate and maintain the second-generation Nike missile, the nuclear-capable Nike Hercules. Four units of the Maryland National Guard were selected for the initial conversion to Nike Hercules, becoming operational on 11 December 1962.

The last four Nike Ajax sites manned by the National Guard were phased out in May 1964 at Norfolk, Virginia. The final stages of the Nike Hercules conversion program were completed in 1965 with 48 Army National Guard batteries, representing 16 states and defending 18 areas, participating in the on-site program. Since that time, due to threat reassessments and budget cuts, the number of ARADCOM batteries, both National Guard and Regular Army, has been reduced significantly.

Guardsmen assume full operational responsibility for manning the sites around the clock. Full-time personnel man the equipment 24 hours a day, keeping it in constant readiness. This cadre of full-time specialists is capable of initiating effective fire on the enemy without additional personnel. Remaining members of the units are citizens of the community who retain their military skills by attending regular drills with their units. If an air attack should occur, they would report immediately to their assigned units.

These Army National Guard units, although an integral part of the air defense system when they become operational in wartime, retain their identity as State units under the command of the governors of their respective states in peacetime. ARADCOM has been assigned responsibility for training supervision and support of these units. In event of an emergency requiring use of these units in a combat role, operational command would be exercised by CINCNORAD through the Commanding General, ARADCOM.

OPERATIONS

Administrative and training supervision over the widespread defenses is exercised by ARADCOM regions. Figure 13 shows the region boundaries and region headquarters. Region headquarters and their locations are as follows:

1st Region - Stewart Air Force Base, New York
2d Region - Selfridge Air Force Base, Michigan
6th Region - Fort Baker, California

The combat effectiveness of ARADCOM units is determined by certain indicators, such as engagement simulator training, operational readiness evaluations, defense combat evaluations, NORAD exercises, short notice annual practices (SNAP), radar bomb scoring (RBS) missions, command maintenance management inspections (CMMI), and technical proficiency inspections (TPI). All indicators must be considered together to determine the effectiveness of units. ARADCOM materiel readiness evaluation teams aid the units in maintaining a combat-ready posture.

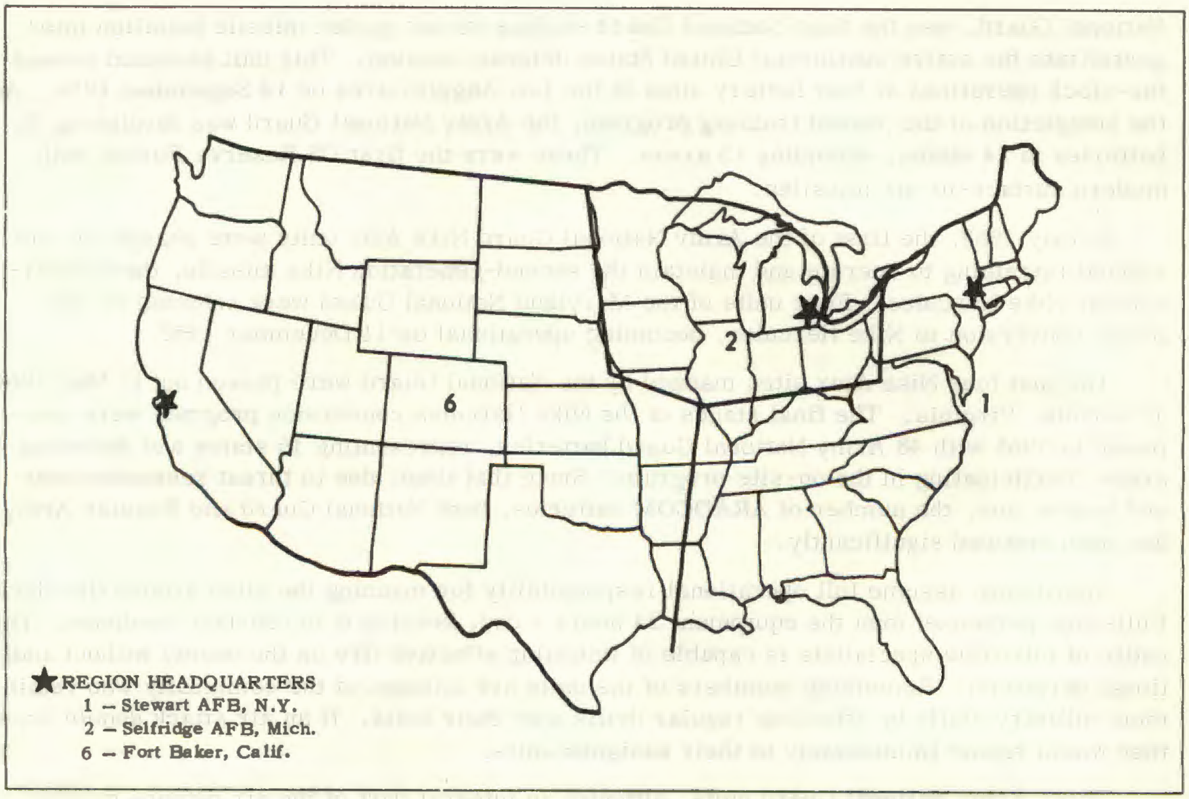


Figure 13. ARADCOM region boundaries and region headquarters.

ARMY AIR DEFENSE COMMAND POST IN NORAD OPERATIONS

The wide dispersion of ARADCOM sites poses a unique problem that requires a specific control and communications system. At the heart of this control and communications system are the Army air defense command posts (AADCP). Tactical supervision of Nike Hercules and Hawk fire units is exercised from AADCP's. An AADCP can use a semiautomatic electronic fire distribution system or be manually operated. The fire distribution system used is either of two transportable systems, the BIRDIE (AN/GSG-5) or Missile Mentor (AN/TSQ-51).

Most AADCP's are linked to an NRCC by digital data and voice and to their associated fire units by data links, voice lines, and radio. In addition, some AADCP's are linked to the NRCC by teletypewriter lines. Normal operation calls for semiautomatic data processing from NRCC to fire units through the AADCP's, with backup facilities available for emergency and supplemental operations. Fire distribution systems provide for complete semiautomatic operation with fire units when SAGE data are cut off. Facilities are also available for manual plotting and voice telling if needed.

Those AADCP's tied to an NRCC automatically receive early warning, aircraft identification, and other data. These data are collected by the AADCP's, improved when possible, and transmitted to fire units. In NORAD regions equipped with SAGE where Missile Mentor or BIRDIE fire distribution systems are in operation, NORAD has prescribed five levels of operations for weapon control for SAGE air defense artillery operations.

In level 1 operations, the primary NRCC supervises the air battle for combat elements; i.e., vectoring fighter-interceptors, programing and firing Bomarc missiles automatically through the SAGE computer, and supervising and monitoring SAM engagements through the AADCP. Reference data (symbology) is furnished over the automatic data link (ADL). Level 1 also indicates to the commander that all backup facilities are fully operational (i.e., the NORAD control center (NCC).

Level 2 indicates that the primary NRCC is still controlling the air battle, but that the backup facilities are degraded to some extent.

Level 3 indicates that the primary NRCC is still controlling the air battle, but that the backup facilities are not operational or are not available.

Level 4 indicates that the NRCC is no longer controlling the air battle and that the combat elements are being controlled by the backup facility (NCC). In each region there are at least two NCC's which can furnish limited early warning and identification to the AADCP as well as vector interceptors and program and launch Bomarcs.

Level 5 indicates that the air battle is being conducted autonomously by the AADCP's (or fire units) and manually directed fighter-interceptors. Level 5 indicates that the SAGE and BUIC control systems are ineffective; therefore, Bomarc can no longer be employed because Bomarc must be programed and directed by a computer. Autonomous operations are predicated on the complete loss of communications between the AADCP and all higher headquarters in the NORAD chain or between the fire unit and its AADCP. It must be emphasized that this loss is a total loss of communications and not a temporary outage due to natural causes (floods, hurricanes, etc.). In autonomous operations, the Army air defense commander (AADC), or the battery commander, assumes full responsibility for the air battle, using the very limited identification means available to him.

US AIR DEFENSE IN NORTH ATLANTIC TREATY ORGANIZATION

Specified United States air defense artillery units in Europe are part of the North Atlantic Treaty Organization (NATO) integrated air defense system of Allied Command Europe (ACE), one of the military commands of NATO. The senior military authority in NATO is a military committee composed of a chief of staff or special delegate of each member nation.

The standing group, composed of representatives of the Chiefs of Staff of the United Kingdom and the United States, is the executive agency of the military committee.

NATO is divided into three military commands and a regional planning group. The command that concerns air defense is ACE, which covers the land area extending from the North Cape of Norway to North Africa and from the Atlantic to the eastern border of Turkey.

Of particular interest in ACE is Allied Forces, Central Europe, extending from the southern boundary of Denmark to the northern boundary of Italy. Allied Forces, Central Europe, has responsibility for air defense of this area and has divided the area by a line running southwest-northeast through the approximate center. The responsibility for air defense of the northern portion is assigned to the 2d Allied Tactical Air Force (2 ATAF), while responsibility for air defense of the southern portion is assigned to the 4th Allied Tactical Air Force (4 ATAF).

The commander of 4 ATAF exercises operational control of all assigned air defense artillery forces through the sector operations center (SOC). Tactical control of surface-to-air guided missile units in the US area of responsibility is exercised by the SOC sector controller. The SOC is a NATO installation, combining facilities of the battle staff, an Air Force control and reporting center, and an Army missile control center (i.e., Army air defense command post). Missile control centers, tactical headquarters of the Army air defense commanders, supervise the operations of subordinate air defense artillery units. The battle staff, supervised by the sector controller, supervises overall air defense operations. The master controller coordinates activities between the missile control center and the control and reporting center. Operational procedures of US Army air defense artillery units in NATO are similar to those of air defense artillery units in the United States.

AIR DEFENSE IN PACIFIC AREA

In the Pacific area, US Army air defense artillery units are deployed in Korea, Okinawa, Vietnam, and Hawaii (National Guard). The Commanding General, US Army, Pacific (USARPAC), commands, trains, and administers the Army units. Operational control of all Pacific area air defense forces is vested in Pacific Air Forces (PACAF) (fig 14).

As an example of how a PACAF air defense sector operates when forces are deployed, the Korean sector is typical (fig 15).

Air defense artillery units in Korea are integrated for operational control into the overall air defense system of the West Pacific North Air Defense Region, a subordinate command of PACAF. The Commanding General, 5th US Air Force, is the West Pacific North Air Defense Region commander. The region is divided into four specific actively manned air defense sectors, one of which is the Korea air defense sector. The 314th Air Division is responsible for air defense of the Korea air defense sector and operates a tactical air control center (TACC) that coordinates the activities of two control and reporting centers/Army air defense command posts (fig 16). The control and reporting center (CRC) in each subsector coordinates the activities of air defense means in its area of responsibility. Operational procedures of air defense artillery units in Korea are similar to those of units in the United States.

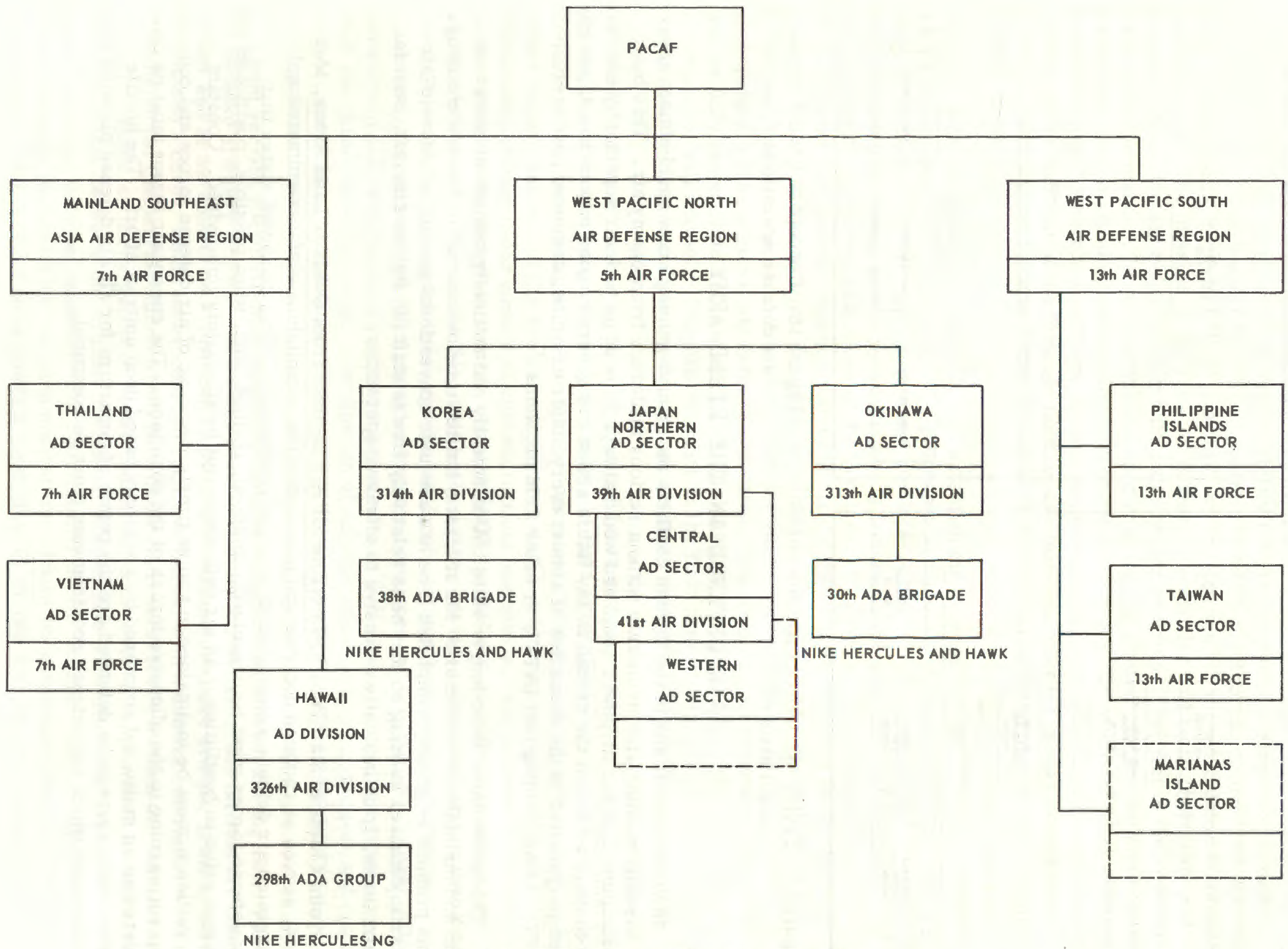


Figure 14. Pacific air defense organization.

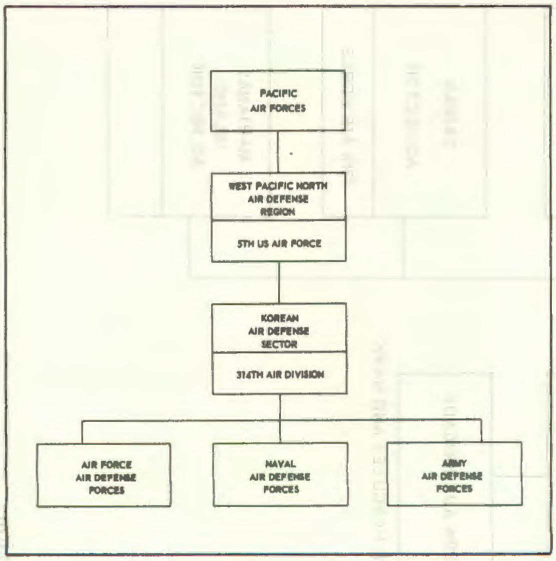


Figure 15. Pacific Air Forces operational control structure.

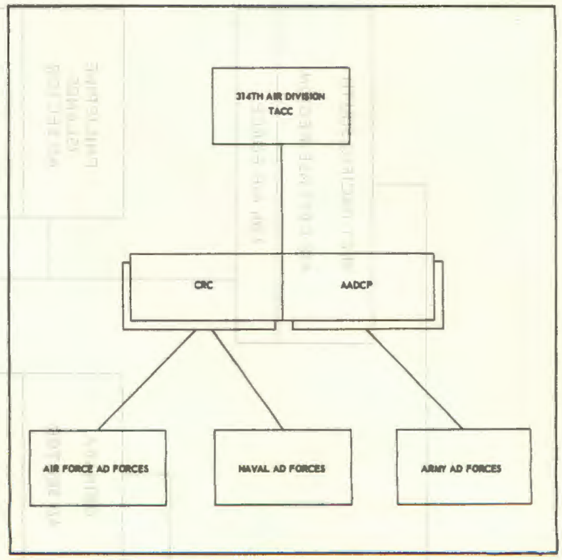


Figure 16. Concept of PACAF air defense operations.

AIR DEFENSE IN THE FIELD ARMY

In World War II and in the Korean conflict, the ground-gaining arms could almost always be assured of being able to operate without serious hindrance from enemy air. This basic assumption that our airpower could and would always provide us with air superiority and hence freedom of action on the ground in any future action has generally gone unquestioned, and has been perpetuated in the scenarios of almost every major exercise, command post exercise (CPX), Army training test (ATT), or other field problems.

This assumption is no longer valid. A technically and tactically competent enemy can gain and maintain air superiority for at least a limited time over areas of his own choosing. This problem is greatly simplified if he has adequate conventional gun and surface-to-air missile defenses in being so that he is relatively free to shift his fighter aircraft, even for short times, from basically defensive to offensive operations.

Joint Chiefs of Staff Pub. 8, Doctrine for Air Defense from Oversea Land Areas, May 1964, serves as common doctrine and prescribes the establishment of a coordinated and integrated air defense system under a single commander. This document states that air defense forces must be organized, equipped, trained, and, when possible, positioned and alerted prior to hostilities. An air defense cannot be adequately improvised. Constant surveillance must be maintained to insure timely response of air defense forces and concurrent warning to the offensive forces of the command. The enemy air threat must be considered as an entity and countered by a strategy based upon unity of effort. The hostile threat and targets to be defended are the points of departure for all air defense planning and the basis on which air defense requirements must be computed.

Within an oversea unified command, subordinate unified command, or joint task force, the commander will assign overall responsibility for air defense to a single commander. Normally, this will be the Air Force component commander. Representation from the other service components involved will be provided, as appropriate, to the air defense commander's headquarters. The mission of the area air defense commander will be to coordinate and integrate the entire air defense effort within the unified command. Subject to the authority of the unified commander, he will establish broad policies and procedures for the employment of air defense means and the coordination of such means with the operations of other elements within the area. Where a significant portion of the means for air defense is contributed by a service other than that of the area air defense commander, a senior officer should be appointed from that service to serve as deputy to the area air defense commander in air defense matters.

The area air defense commander will establish air defense regions. The number of such regions may vary, depending upon geographical factors and the complexities of the air defense problem. He will appoint regional air defense commanders and designate their areas of responsibility, taking into consideration such factors as the geography of the area, the hostile threat, and the contributions of the services. In a region where a significant portion of the regional air defense means consists of air defense weapon systems of another service, a senior officer of that service should be appointed to serve as deputy in air defense matters to the regional air defense commander. Service staff representation will be assigned, as appropriate, to the regional air defense activities. The regional air defense commander will be fully responsible for, and will have full authority in, the air defense of his region. However, he will normally delegate authority to the field army commander(s) for control and operational employment of Army air defense artillery means within the field army area.

Coordination of the employment of all air defense means within the field army is normally accomplished in the tactical operations centers at field army (FATOC), corps (CTOC), and division (DTOC) levels (fig 17). The tactical operations center is an integrated staff facility where representatives of the special and general staff sections are grouped to assist the commander in exercising control of current tactical operations. Air defense is represented in the TOC by the airspace control element (ACE) composed of both ADA and Army aviation personnel. The senior ADA unit headquarters provides personnel and equipment to the ACE of the force to which it is organic, assigned, or attached. Only the divisional Chaparral/Vulcan battalion TOE provides organic resources for this purpose. Other ADA units obtain ACE personnel and equipment as provided in TOE 44-510 or from unit resources. The ACE has three basic functions: coordination of AD operations with other tactical and tactical support operations, coordination of airspace utilization by Army forces, and coordination of Army aviation operations.

Joint service coordination is accomplished by means of liaison sections (fig 18). The air defense artillery brigade establishes liaison with the Air Force at the tactical air control center and at the control and reporting center. Air defense artillery groups, if assigned or attached to a corps, would be expected to establish liaison with a control and reporting post. The divisional Chaparral/Vulcan (C/V) battalion liaison section is provided for liaison with the air defense artillery group or Hawk battalion, whichever is appropriate. This team is a link between the organic divisional air defense capability and the corps of Army area air defense capability for coordination of air defense plans. Liaison either through personnel or via communications <u>should</u> be established between the C/V battalion and the forward area control post (FACP) of the Air Force <u>whenever possible</u>.

Coordination may be accomplished by collocation of the AADCP's with the appropriate Air Force installation or by utilizing established communications networks used by liaison teams. In theaters where Air Force and Army air defense organizations are equipped with compatible electronic command and control systems, coordination will be further improved by having the systems operationally connected.

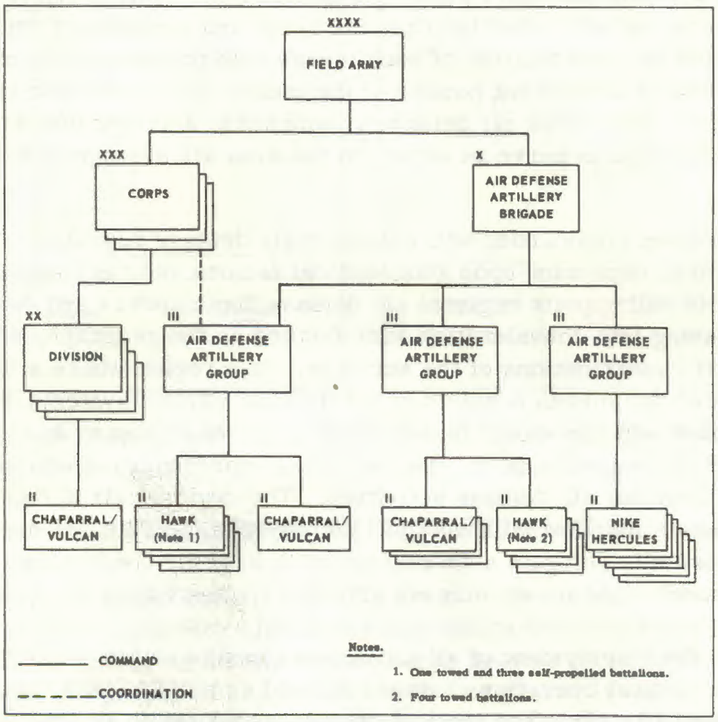


Figure 17. Organization of type field army.

Current oversea deployments vary from area to area. The principal differences are generated by the need to tailor the defense to the local conditions. The local conditions are included in a consideration of the threat and geographical factors.

To meet the requirement for rapid response to hostile air activity, communications are paramount. The Army, realizing this need for faster, more positive fire distribution of surface-to-air missiles in the field army, developed the AN/MSG-4 (Missile Monitor) fire distribution system. This system may be employed for centralized or decentralized control as directed by the Army air defense commander.

Coordinated air defense effort is a requirement, not only within a field army but between the field army and tactical air force. To fulfill this responsibility, the Army air defense commander normally establishes liaison with the tactical air force. This liaison may be accomplished by collocating the AADCP of various air defense artillery commands with the functional counterpart of the tactical air force or by liaison between these elements. Figure 18 graphically depicts a typical solution of the liaison requirement. Liaison expedites the flow of early warning and identification information, two vital elements of data for any air defense. Both the control and reporting center and control and reporting post can provide early warning information to air defense artillery units, and the control and reporting center can provide target identification information.

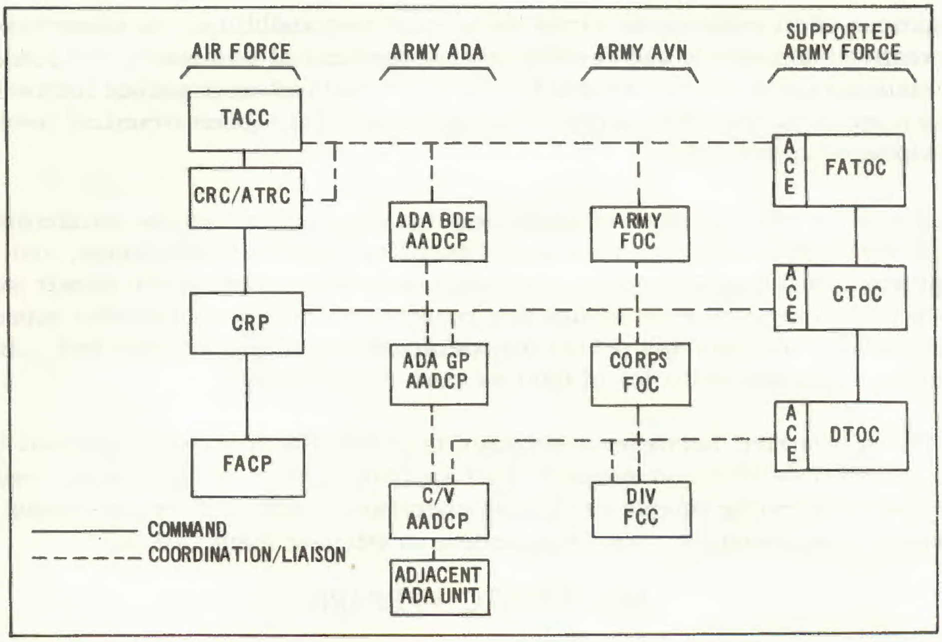


Figure 18. Field army ADA command, coordination, and liaison.

AIR DEFENSE ARTILLERY MAINTENANCE

The tactical and operational requirements of current and future air defense artillery systems demand employment of skilled technicians and adequate test equipment to provide responsive maintenance support to the Army air defense commander. Preventive maintenance must be efficiently scheduled and malfunctions rapidly corrected. Maintenance management is the responsibility of every commander and includes motivation, organization, accurate records and reports, and training.

The commander of an air defense artillery unit must have the capability of maintaining a high degree of operational readiness around the clock, in peacetime as well as in combat, and in the United States as well as overseas. He requires technicians who are system diagnosticians, supported by repairmen with a capability for repair of defective assemblies and subassemblies. Emphasis must be in the direction of performing tests, maintenance, and repairs as close to the point of failure as practical. Support personnel organic to air defense artillery units and organizations provide the commander a maintenance capability commensurate with his responsibility. In this light, the principal maintenance functions (organizational and direct support) are immediately responsive to the operational requirements of the system.

The organizational maintenance technician is concerned primarily with system analysis. He has a thorough understanding of electronic theory, the practical application of this theory, and the functions of all components within his area of responsibility. He supervises or performs preventive maintenance and verifies system operational readiness. To reduce repair time and minimize travel on the battlefield, the organizational maintenance technician is trained and must be permitted to perform maintenance to the highest practical level under combat operational conditions.

Timely reports must be made of conditions that adversely affect the maintenance effort. Examples of these conditions are shortages of qualified personnel, equipment, and repair parts; improper scheduling of training; and assignment of missions which impair maintenance of equipment. Commanders must insure that reports concerning maintenance support of their equipment are accurate and reflect the operational readiness of their unit. Analysis of these reports aids in determination of total support requirements.

In short, an effective maintenance program is of the utmost importance in air defense artillery units. Air defense commanders must apply techniques of maintenance management which will insure operating equipment to meet operational readiness requirements. The best in air defense, in peacetime or war, is dependent on efficient maintenance.

ELECTRONIC WARFARE

The ability to interfere with the enemy's electronically controlled equipment while operating our own without interference is included in an area of military activity known as electronic warfare.

Electronic countermeasures (ECM) is that major subdivision of electronic warfare involving actions taken to prevent or reduce the effectiveness of enemy equipment and tactics that employ or are affected by electromagnetic radiations.

The US Air Force has equipped its aircraft with varying types of intercept receivers, transmitting electronic jammers, and chaff dispensers contingent upon the tactics to be employed. Intelligence reports indicate that potential enemies of the United States have spent vast amounts of money in the development of ECM equipment.

Generally speaking, ECM is introduced into a radar receiver to impair the use of the reflected radar signal. If a jamming signal enters the receiver and prevents the radar operator from seeing the target or causes him to lose the target, the jamming has reduced the effectiveness of the air defense.

Electronic countermeasures may range from relatively simple measures, such as chaff, to complex devices known as spoofers, whereby false targets are electronically displayed in addition to the actual target echo.

This susceptibility of radar equipment to jamming, both reflective and transmitted, once again forced military planners to the drawing board. This time the criteria for research was to counter the advantage gained by an attacking force employing ECM. These studies resulted in extensive improvements to radar systems which allow effective operation despite heavy jamming. Since we are countering the use of electronic countermeasures, the term, electronic counter-countermeasures (ECCM), came into existence.

To counter an ECM attack, many ECCM devices and techniques have been evolved. The salient factors concern frequency diversity and frequency change, increased power, increased receiver sensitivity, greater antenna gain, and special ECCM circuits. Some devices employed are special ECCM receivers to allow selection of the best (least jammed) video presentation, parametric amplifiers to reduce receiver noise level, amplitrons to increase power, coincidence circuits to counter random pulses, and other special ECCM circuits, such as antijam displays, track-on-jamming, and side-lobe blanking circuits. Frequency diversity, involving the use of several radars in different frequency bands, imposes a great problem to any attacking force.

During any future conflict, ECM will be the normal operational environment; therefore, operators must expect ECM, recognize ECM, report ECM, and take appropriate action to counter its effects. Trained operators must use the ECCM devices only as absolutely necessary. The purpose of ECCM operation is to obtain a screen presentation that is free of interference and retains the greatest possible amount of information useful for accomplishing the mission.

To survive in an ECM environment, air defense artillery units must have their radar equipment operating at peak efficiency, the latest ECCM equipment, well-trained operators, and skilled maintenance personnel.

IDENTIFICATION, FRIEND OR FOE

Identification of airborne objects presents a major problem to all air defense units. To prevent destruction of friendly aircraft, a positive means of identification must be provided. This need was initially met by development of the Mark III identification, friend or foe (IFF), system. This system, used with ground station radars during World War II, assisted in the identification of aircraft, but limitations of the system caused its use to be discontinued at the end of the war. Research was started to develop an identification system to satisfy the needs of all services. The Mark X IFF system was the result.

The Mark X IFF system is composed of two groups of equipment. One, the interrogator-responder, is located with ground radars and the other, the transponder, is located aboard friendly aircraft. The interrogator-responder is installed at the ground station and depends on a parent radar for a synchronizing trigger, an ac power input, and a plan position indicator (PPI) to display IFF video. Its major components include a coder control (modes 1, 2, and 3), receiver-transmitter, and antenna. The interrogator-responder antenna is unidirectional. Because the radar antenna is also unidirectional, the two antennas must be synchronized for azimuth resolution. (This causes IFF video to be portrayed on the PPI at the same azimuth as the radar video of the interrogated target.) The airborne transponder is independent of any radar that might be located in the aircraft; however, it requires power from a source in the aircraft. The unit consists of a receiver-transmitter and antenna. The antenna is omnidirectional; thus, it can receive and transmit in any direction.

The sequence of operation (fig 19) for Mark X equipment is the same for Nike Hercules and Hawk batteries, battalion operation centrals, fire distribution systems, and AADCP's. When target video appears on the PPI, the acquisition radar operator or tactical control assistant (Hawk battery) places the interrogator-responder in operation by turning on the challenge switch. (The acquisition radar operator or tactical control assistant will determine which IFF mode is to be interrogated.) This causes a pair of radiofrequency (RF) pulses to be transmitted from the IFF antenna at the same azimuth as the radar pulse. These RF pulses will have an interpulse spacing, from leading edge to leading edge, of 3, 5, or 8 microseconds, depending on which mode is being interrogated (mode 1, 3 microseconds; mode 2, 5 microseconds; and mode 3, 8 microseconds). The transponder receives the RF pulse-pairs and amplifies the challenge signal (both RF pulses must be present because one pulse does not constitute a valid challenge). Upon receiving a valid challenge, the transponder will then transmit its identification signal. The reply is received and amplified in the interrogator-responder receiver. The output of the receiver through the decoder is sent to the PPI where it will be displayed as one, two, or four arcs at a range greater than the interrogated aircraft but at the same azimuth (one arc is the valid response for a mode 1, 2, or 3 challenge, two arcs constitute a valid response in modes 1 and 3 for an identification of position (IP) reply, and four arcs indicate that the aircraft has declared an emergency).

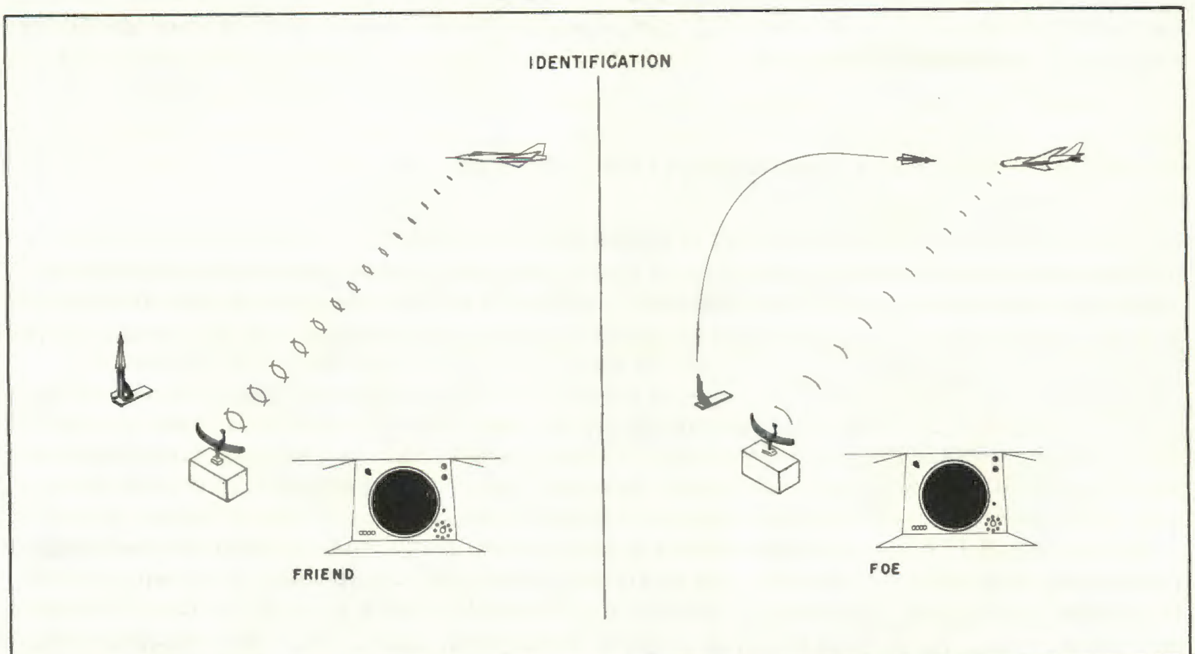


Figure 19. Identification, friend or foe (IFF).

The Mark X IFF equipment used in conjunction with air defense artillery radars includes a selective identification feature (SIF) which enables the IFF equipment to receive 32 codes in mode 1 responses and 64 codes each in mode 2 and mode 3 responses. The 160 possible codes of the Mark X IFF/SIF system enabled the establishment of a more positive identification system. When the selective identification feature of the Mark X IFF system is used, correct responses by the interrogated aircraft will be displayed as one arc, except for IP, at a range greater than the interrogated aircraft but at the same azimuth. Should the aircraft declare an emergency, the SIF reply would appear on the PPI as four arcs.

Currently under development is a new family of IFF equipment known as the Mark XII system. The Mark XII IFF includes AN/TPX-46 and AN/TPX-50 interrogator sets which incorporate the features of Mark X with two additional modes, C and 4. The AN/TPX-46 with Mark X modes 1, 2, and 3/A, and Mark XII IFF capability in mode 4, will replace the AN/TPX-26 and AN/TPX-27 Mark X IFF/SIF now in use in US Army air defense installations. The AN/TPX-50 with Mark X modes 1, 2, and 3/A and Mark XII mode 4 capability will be mounted on the forward area alerting radar associated with Chaparral/Vulcan weapon systems.

At present, four modes of interrogation between military aircraft and military and civil ground stations are used. Modes 1 and 2 are assigned to and used by the military. Mode 3/A is assigned to both military and civilian aviation for common air traffic control. Modes 2 and 3/A are currently limited in application due to the relatively few codes provided. In the new sets, modes 2 and 3/A will be expanded to 4, 096 code selections and, under the Mark XII concept, an additional mode 4 will be provided. Mode C (altitude reporting) is provided for Air Force and civil aviation but is not currently planned for Army aircraft.

The operational concept of the Mark XII identification, friend or foe, system is similar to and compatible with the Mark X IFF/SIF. Both are really identification-of-friend systems. An aircraft not identified as a friend is an unknown, possibly a foe. The Mark XII mode 4 crypto-secure feature provides the most positive and reliable identification of friendly aircraft to date.

AIR DEFENSE ARTILLERY COMMUNICATIONS

The vital link between weapon systems and command/control facilities of air defense artillery is communications. The supersonic nature of the aerospace threat dictates that air defense artillery communications be rapid, reliable, and redundant to insure maximum effectiveness on a continuous basis.

Within NORAD, air defense artillery communications in a fixed environment is adequately provided by a combination of means to include both commercial and sophisticated military facilities of the Defense Communications Agency (DCA). The extension of the DCA system automatic voice net (AUTOVON) throughout the NORAD organization combined with leased cable, microwave radio, and other means have provided redundancy so as to enhance communications survivability while insuring reliability under a host of adverse conditions. Presently, the only organic radios provided for NORAD air defense artillery units are the AN/TRC-47, used to furnish backup intra-area communications for the cable connecting the battery control and launching areas in Nike Hercules on-site units, and TOE radios for Hawk units.

Communications for air defense artillery units (Hawk and Nike Hercules) in an oversea or mobile air defense environment is furnished by organic equipment. The primary means of communication for Hawk and Nike Hercules units is a very high frequency/ultrahigh frequency (VHF/UHF) radio relay system. This primary system of VHF/UHF multichannel equipment supports the electronic fire distribution system deployed with these field units. It is capable of transmitting digital data as well as voice information. Should this primary communications system fail, backup communication would be needed that could reliably pass digital data in order to remain in automatic operation. If this backup equipment is limited to the present

AM and/or FM tactical radio equipment, this reliability is not available. In this case, failure of the primary system would necessitate going to manual AADCP operation.

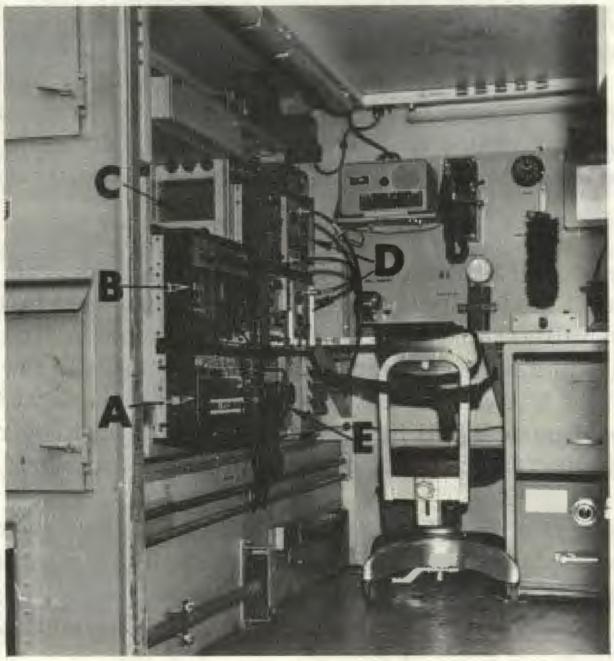


Figure 20. Radio terminal set AN/TRC-145.

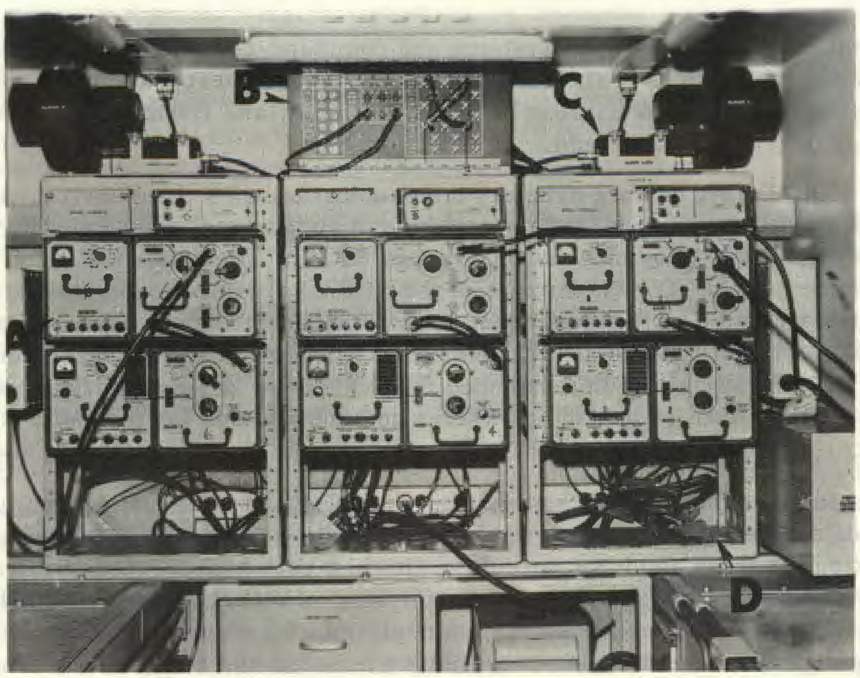


Figure 21. Radio relay set AN/TRC-113.

The basic equipment used to establish primary communications is the radio terminal set AN/TRC-145 (fig 20). This set is a package consisting of two AN/GRC-103 radio receiver-transmitters and two TD-660 telephone multiplex terminals. It provides a dual 6/12-channel duplex capability with a rated range of 40-48 kilometers between stations, provided electrical line of sight is maintained. The AN/TRC-145 can be used as a dual terminal or relay set, or as both simultaneously.

Should it be necessary to provide communications beyond the line of sight capability or range of the AN/TRC-145, radio relay set AN/TRC-113 (fig 21) could be used to extend the circuit. The AN/TRC-113 consists of three AN/GRC-103 radio receiver-transmitters, two of which are necessary for providing relay operation and the third being used solely as a standby component for increased reliability.

This equipment is a recent addition to ADA TOE and will be fielded as they become available. Older equipment, consisting of the AN/TRC-24 radio receiver-transmitter and the AN/TCC-7 telephone multiplex terminal, will continue to be used until the new equipment is issued.

Nike Hercules and Hawk units are issued the following organic radios to provide backup to the primary communications system.

The AN/GRC-106 (fig 22), an amplitude-modulated (AM), single sideband (SSB) radio set, is used in tactical nets. Designed for mobile use, it can be used for both fixed and portable service and is capable of providing communication over a distance of 50 miles when using the organic whip antenna.

Figure 22. Radio set AN/GRC-106.

The AN/GRC-122 is a shelter-housed transportable radioteletypewriter set which uses the AN/GRC-106 as its major basic component. The AN/GRC-122 is authorized for air defense artillery battalions primarily to provide teletypewriter communication with higher headquarters.

The AN/GRC-26 is a long-range AM radio used at group and brigade levels.

The TOE for all air defense artillery echelons, brigade to battery, include new type communications equipment. In voice command nets, the new AN/VRC-12 family of frequency-modulated (FM) radios has been issued. The basic receiver-transmitter of the AN/VRC-12 family issued to air defense artillery units is the AN/VRC-46 (fig 23). The AN/VRC-47 (fig 24) is a basic receiver-transmitter with an auxiliary receiver, and the AN/VRC-49

Figure 23. Radio set AN/VRC-46.

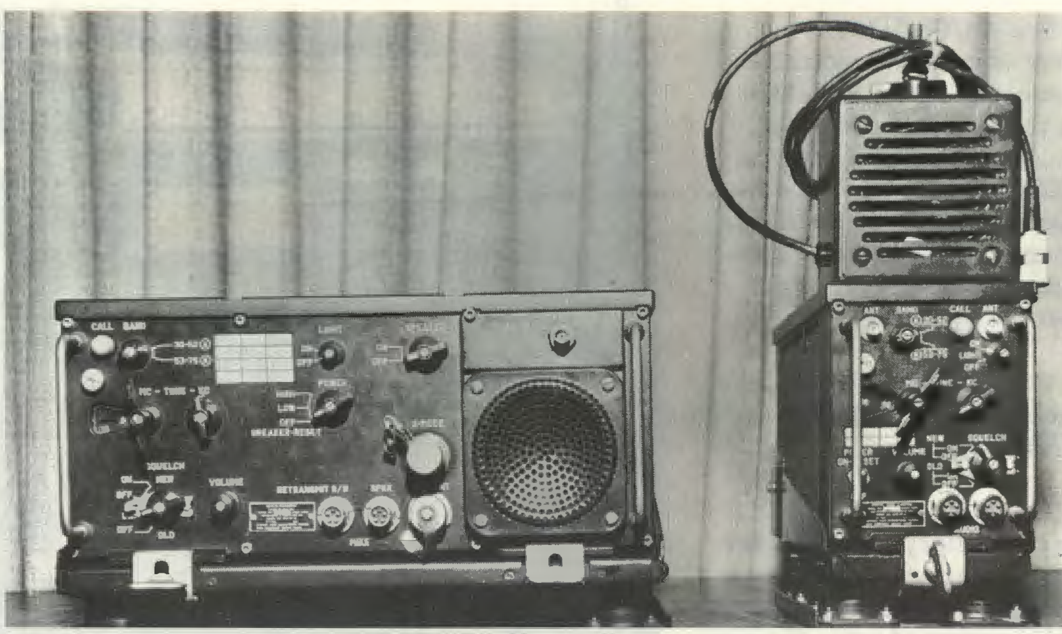


Figure 24. Radio set AN/VRC-47.

consists of two of the basic receiver-transmitters on a single mounting. These small, rugged radio sets possess a range capability of 20 miles, using a whip antenna. Channel capacity is increased to 920 channels, making it capable of netting with infantry, armor, or field artillery units.

Technical advances in weapon systems and advanced concepts of deployment result in ever-increasing demands within the field of communications. Fortunately, improvements in communications equipment design have met this challenge, and the end product is a new series of radios with improved capabilities as well as reduced size, weight, and power requirements.

The man-packed AN/PRC-25 radio, another of the improved radios, is a forward area radio set to replace the AN/PRC-8, -9, and -10 radios. Its use by Nike Hercules batteries will improve unit security control. This basic set is also to be built as a vehicle-mounted version (AN/VRC-53) (fig 25) or as a convertible man-packed/vehicle-mounted version (AN/GRC-125). The normal range of 3 to 5 miles may be increased to 15 to 20 miles by use of an amplifier.

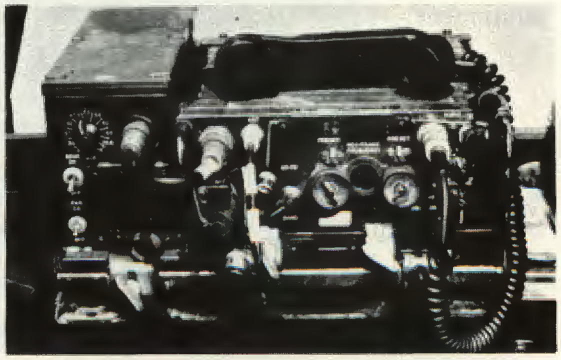


Figure 25. Vehicle-mounted radio set AN/VRC-53.

Communications provided for air defense artillery automatic weapons (ADA AW) (self-propelled (SP)) units (40-mm M42) include all means necessary to transmit information, intelligence, commands, and means to establish liaison with other units. Because of the nature of operations and equipment found in these units, there is no requirement for automatic data link. Therefore, no VHF/UHF communications are required for effective operations. Communications means available to these units include radio, wire, and messenger. TOE radios (AN/GRR-5, AN/GRC-106, AN/GRC-46, and the VRC-12 family) discussed above are the primary means of communications in the AW SP units. Wire and messenger are used as a backup to these organic radios.

The challenge presented to air defense artillery communications as a result of technical advances in fire distribution systems and modern weapons has been more than adequately satisfied by aggressive research and development within the field of communications equipment. The new, compact, longer range communications equipment is being issued to all echelons of air defense artillery to provide an even greater capability to accomplish the latter portion of the artillery axiom—move, shoot, and communicate.

Chapter 2

Air Defense Artillery Control Systems

The exchange of information between missile fire units and command posts must be instantaneous. Army air defense artillery units require timely and continuous information on the location of friendly and hostile aircraft. Immediate collection and dissemination of target data are required to insure rapid fire unit response and concentration of effort directed toward the enemy threat. To provide air defense artillery commanders with this required capability, the Army employs electronic fire distribution systems and associated equipment.

Modern fire distribution systems are essentially specialized automatic data processing systems and, as such, have shared in major state-of-the-art advances over the past few years. As the vacuum tube gave way to the transistor, with its reduced size, weight, and power requirements, so the transistor circuits of today have been replaced by microminiaturized integrated circuits in new fire distribution systems. Thus, the challenge of the ever-increasing air threat is being countered by the most reliable and effective fire distribution equipment possible.

BIRDIE (AN/GSG-5)

The battery integration and radar display equipment (BIRDIE) system AN/GSG-5 (figs 26 and 27) was developed to provide a compact, reliable, and transportable system to economically integrate Nike Hercules batteries. Through semiautomatic ground environment (SAGE) direction centers, and backup interceptor control (BUIC) stations in certain operational modes, BIRDIE systems are integrated into the overall air defense of CONUS.

Radars used with the AN/GSG-5 system include defense acquisition radars AN/FPS-36, AN/FPS-69, or any acquisition radar with a pulse rate of 200 to 400 pulses per second. The radar furnishes target slant range and azimuth, but no height data, to the AADCP. The radar has IFF equipment which is used as an aid to identification.

The AADCP contains display equipment, computer and data storage facilities, voice communications, and power and testing equipment. The situation display console has controls and indicators that enable the controller to enter target identity, position, and velocity into the memory system. The controls and indicators also enable the controller to make or erase target assignments to batteries and to dump data from the memory system. The plan position indicator (PPI) displays video from the radar, local track symbols, SAGE/BUIC track symbols, battery return symbols, and other symbols as selected by the controller.

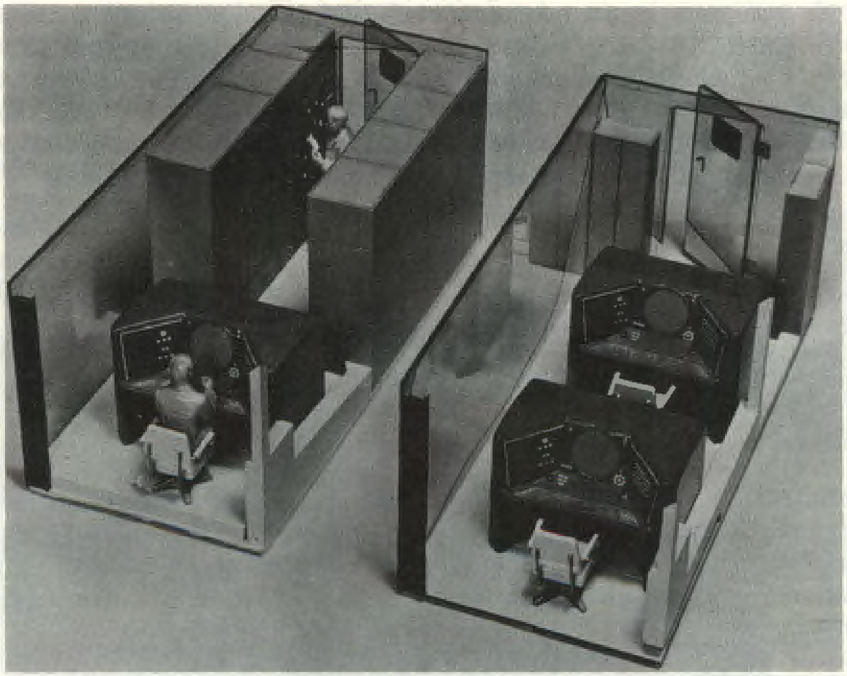


Figure 26. Battery integration and radar display equipment (BIRDIE) system AN/GSG-5.

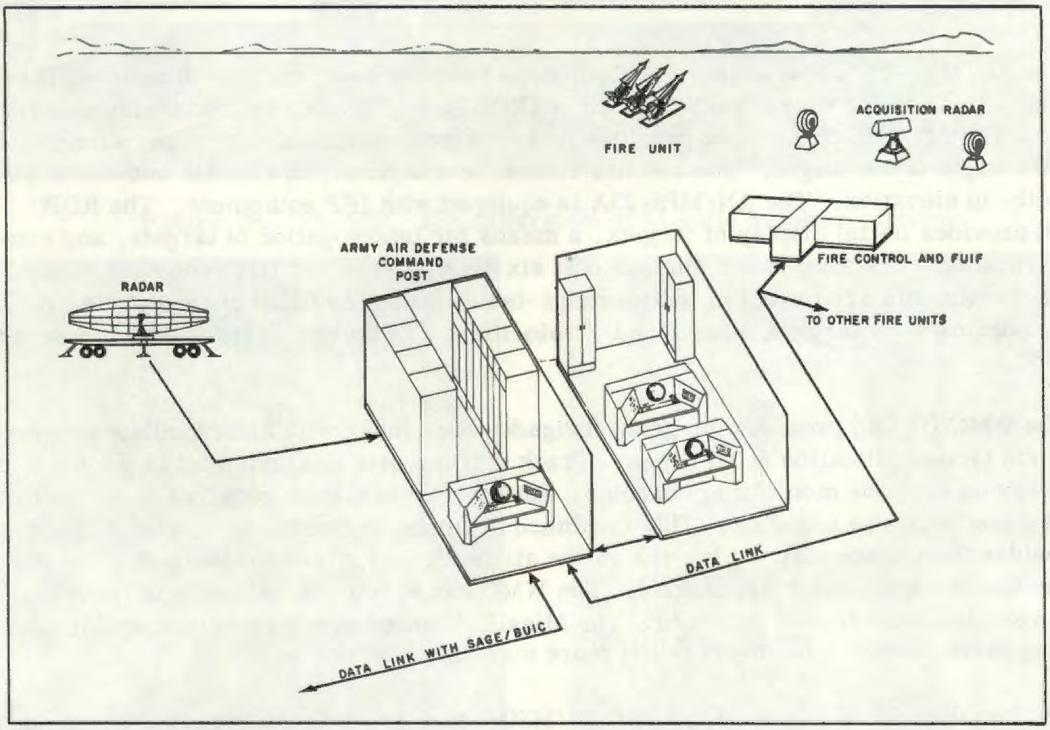


Figure 27. AN/GSG-5 (BIRDIE) system.

The AN/GSG-5 can integrate a maximum of 16 Nike Hercules batteries and display approximately 30 SAGE/BUIC and local tracks plus 16 battery returns. The automatic data link (ADL) permits automatic transmission of digital data between BIRDIE and SAGE/BUIC. The battery data link (BDL) transmits data from BIRDIE to the batteries. The batteries transmit data back to BIRDIE and all other integrated batteries. The computer and storage system allows semiautomatic tracking of targets up to a speed of 2, 250 knots.

The data converter AN/GSA-77, described in detail later in this chapter, which has replaced older battery terminal equipment in all ADA fire distribution systems, links the missile battery with the BIRDIE system.

MISSILE MONITOR (AN/MSG-4)

The Missile Monitor (AN/MSG-4) fire distribution system was developed by the US Army to coordinate the fire of Nike Hercules and Hawk missile batteries with the army in the field. These systems make it possible to observe and influence the entire air battle from the widest viewpoint so separate actions of numerous batteries can be supervised and unified into an integrated defense.

The AN/MSG-4 system is composed of two basic subsystems: the AN/MSQ-28, AN/MSQ-28B, or AN/MSQ-56 subsystem located at group/brigade level and the AN/MSQ-18 (or AN/TSQ-38 which is helicopter-transportable) subsystem located at battalion and battery levels.

The AN/MSQ-28B subsystem (fig 28) includes a frequency-scan, three-dimensional radar AN/MPS-23A, a radar data processing center (RDPC), and a weapons monitoring center (WMC). The AN/MPS-23A radar provides target detection, furnishing range, azimuth, and elevation angle of the target. The antenna rotates mechanically in azimuth and scans electronically in elevation. The AN/MPS-23A is equipped with IFF equipment. The RDPC (fig 29) provides initial display of targets, a means for interrogation of targets, and automatic tracking. Tracking is accomplished at six detector-tracker (DT) consoles in the RDPC. Height data are observed on two range-height indicator (RHI) consoles. The H, X, and Y coordinates of targets, plus X and Y velocities, are stored as track data and sent to the WMC.

The WMC (fig 30) provides the group/brigade commander with an immediate presentation of the tactical situation at all times. Track marker data are displayed in the form of symbology on weapons monitoring consoles. Battery status also is received from the battery and displayed on these consoles. This combined symbolic and read-out display of information enables the commander to view the entire air battle and make assignments from the WMC to the batteries under his control. The WMC can accept and utilize data from Air Force agencies and adjacent defenses. The Missile Monitor system has the capability of directing more than 30 fire units against more than 150 targets.

The battalion-level component of the AN/MSQ-18 or AN/TSQ-38 is the battalion operations central (Bn OC) (fig 31). The Bn OC gives the battalion commander the capability of either monitoring reference data and the changing status, or making assignments to the firing battery, depending upon the method of control and mode of operation. It links the battalion with the group WMC and fire units and displays battery status, target video, and symbology on each of two consoles. The electronic search central AN/GSS-1 (or AN/GSS-7) of the battalion is connected to the Bn OC and can furnish radar data to the Bn OC. In turn, the Bn OC can insert these data into the data link, thus providing additional information to all fire units under WMC control in the normal mode of operation.

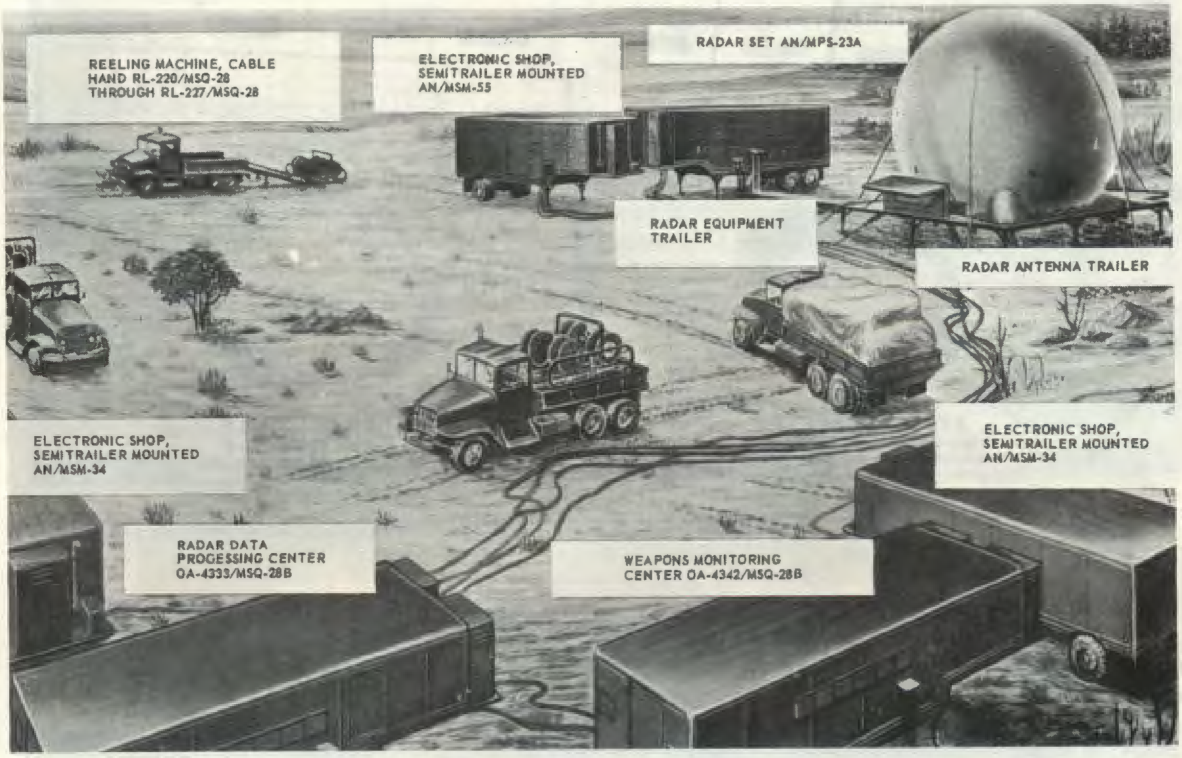


Figure 28. AN/MSQ-28B subsystem of Missile Monitor system.

Figure 29. Interior view of radar data processing center.

Figure 30. Interior view of weapons monitoring center.

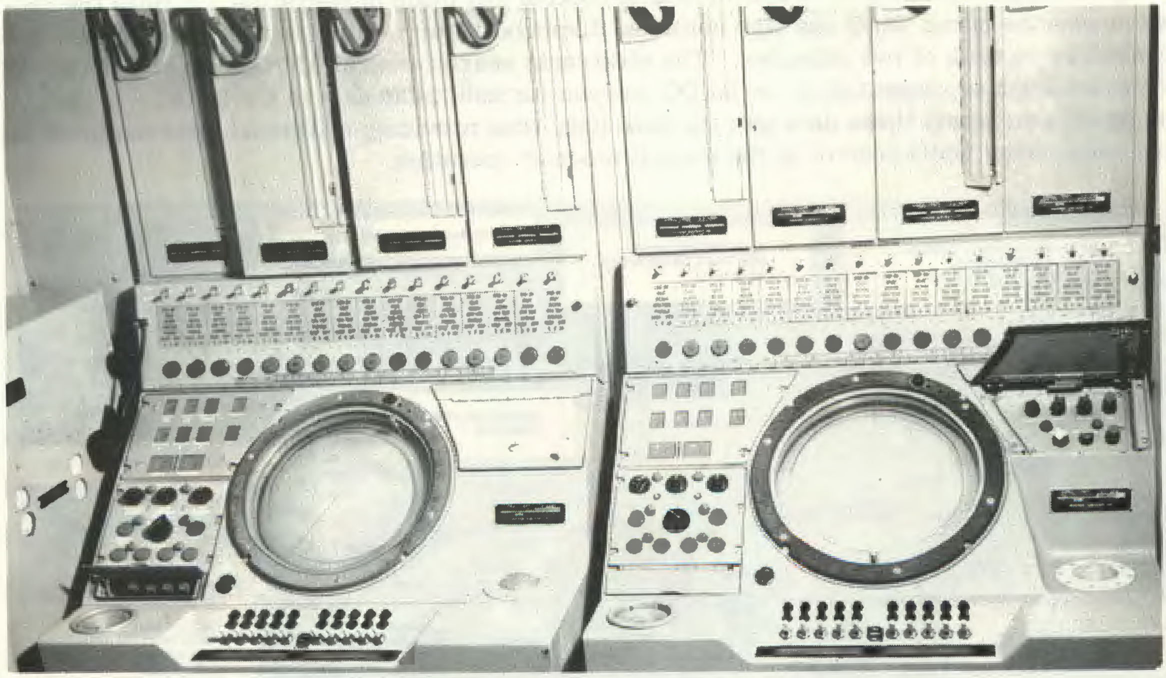


Figure 31. Battalion operations central consoles.

The battery-level component of the AN/MSQ-18 or AN/TSQ-38 is the data converter AN/GSA-77. The data converter, which functions as a link between battalion and battery, is a transmitter-receiver that permits exchange of data between the battery and other elements of the system. Information which may have originated at the WMC, Bn OC, or other fire units is received at the AN/GSA-77 in the form of binary digital data. The AN/GSA-77 converts these data for display at the battery control console. Information originating at the battery is converted to binary digital data by the AN/GSA-77 and sent to the Bn OC and WMC.

The AN/MSG-4 system has six data link switching modes of operation. Only three of these modes—normal, sector, and independent—are used in tactical operations. In the normal mode, the WMC sends reference information and commands through the Bn OC to the battery. The Bn OC monitors, but does not originate, commands to the batteries. In the sector mode, reference information is sent to the Bn OC and the batteries and the Bn OC originates commands to the batteries. In the independent mode, all reference information and commands originate at the Bn OC. The other three modes of operation are used for tests and emergencies.

The primary means of transmitting information, using binary digital data, is by automatic data link. Common carriers of ADL include spiral-4 cable or microwave, but any carrier capable of handling pulses made up of frequencies between 600 and 1875 hertz will suffice.

MISSILE MENTOR (AN/TSQ-51)

A new fire distribution system, Missile Mentor (AN/TSQ-51), has been deployed in CONUS to replace some first-generation fire distribution systems, including all Missile Master systems. This new system is designed on the modular concept, allowing addition or deletion of major functions so that requirements of various defense complexes may be met with reduced operational costs, simplified maintenance, and increased track-handling capability as compared to older systems. Data are automatically exchanged by digital data link and voice communications with all defense elements, including both Nike Hercules and Hawk fire units. This mobile AN/TSQ-51 system requires no equipment air conditioning. The system integrates the operation of surface-to-air missile ADA fire units by acquiring tracks, processing data, and making track assignments to fire units. Each deployment site has a varying number of associated fire units and remote data sources integrated into a coordinated air defense system. Effective air defense control and coordination are sustained by the AN/TSQ-51 gathering and supplying up-to-date, real-time information on the air situation, threat, and weapon availability.

Figure 32. AN/TSQ-51 operations trailer (interior view).

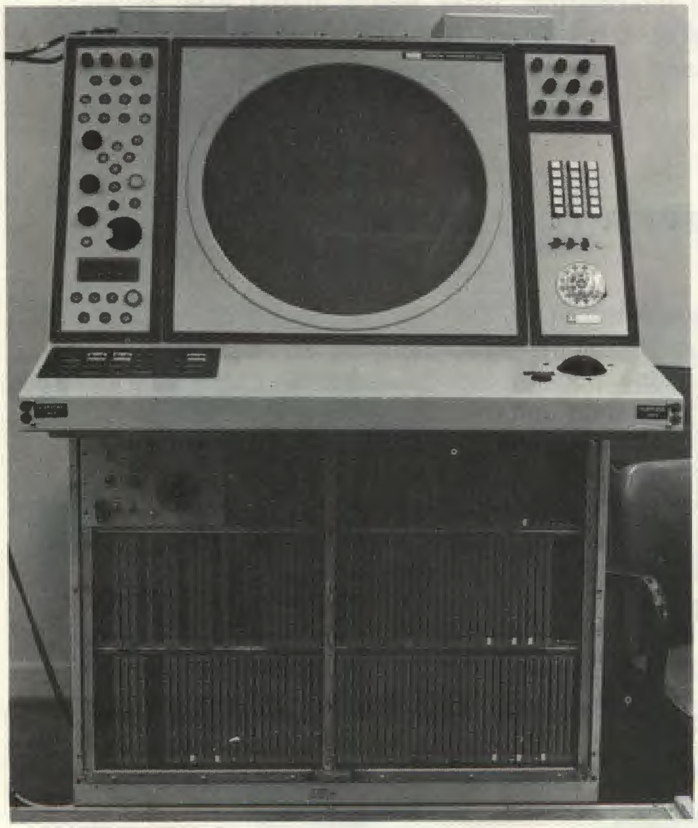


Figure 33. AN/TSQ-51 general purpose console.

The AN/TSQ-51 system is comprised of two subsystems, the operations and equipment trailers, which together serve as the Army air defense command post (AADCP), and the remote radar integration station (RRIS). The RRIS, contained in one trailer, can be used to provide radar gap-filler information as well as extend the effective radar range of the defense. The operations trailer (fig 32) contains tracking and tactical display (general purpose) consoles (fig 33) and operations boards, and the equipment trailer (fig 34) contains track processing equipment and a general purpose digital computer. The major functions performed by the system are target detection, acquisition, identity, track correlation, threat evaluation, fire unit designation, and fire unit status monitoring. The system gathers these data concerning its defense area and extends the system coverage by analysis of track data from remote sources; i.e., semiautomatic ground environment (SAGE) system, backup interceptor control (BUIC), RRIS stations, adjacent AADCP's, and surveillance radars. Actions are coordinated for fire units under its command. The system operates in conjunction with standard acquisition and height-finder radars for local zone coverage. It has automatic and rate-aided manual tracking facilities for keeping data current for local tracks. The operations trailer equipment has been remoted into permanent facilities. Operation and maintenance of remoted equipment are the same except for equipment cooling.

The RRIS (fig 35) consists of one trailer containing tracking display (general purpose) consoles, and a general purpose digital computer that differs from that in the equipment trailer chiefly in its smaller memory capability. Each RRIS nets remotely located radars, and each RRIS can compute data on tracks within its area of coverage and transmit data to the parent AADCP. It also stores and displays data on AADCP-transmitted tracks.

The data converter AN/GSA-77 serves as the battery terminal equipment for the AN/TSQ-51, performing the same functions as it does with the AN/MSG-4 system.

Figure 34. AN/TSQ-51 equipment trailer (interior view).

Figure 35. Remote radar integration station (interior view).

THREE-DIMENSIONAL RADAR

Before any commander can engage an airborne threat, he must know the location of the threat in relation to his unit. The location of the threat is expressed in terms of azimuth, elevation, and range from the unit. In most current air defense artillery fire distribution systems, two types of radars are used to provide these data: an acquisition radar to determine azimuth and range and a height-finder radar to determine elevation. Use of two radars rather than one presents obvious problems; e.g., two radars must be moved in a mobile situation, two radars must be maintained and repair parts stocked for each, and two radars must be emplaced on carefully selected terrain to prevent masking of the height-finder radar so that it can cover areas identical to those covered by the acquisition radar.

A three-dimensional (3D) radar can furnish all these data; i.e., azimuth, elevation, and range. This type of radar utilizes electronic scanning. One of the later classes of electronic scanning radars, the AN/MPS-23 (a component of the Missile Monitor FDS), provides three-dimensional search. It supplies target azimuth, elevation angle, and range data simultaneously from a single antenna (transmitter and receiver) channel. The beam scans electronically in elevation while the antenna rotates in azimuth. The antenna frequency-scan operation is similar in principle to that of a slotted waveguide with the microwave energy radiated from the slots combining to form a beam. When the frequency is matched and phased with the distance between the slots, the direction of propagation is straight ahead. If the frequency of the energy is changed, relative phase differences are set up from one slot to the next, changing the direction of propagation accordingly. Continuous phase shifting is achieved by using variable frequency exciters in the transmitter. These exciters can be programed digitally to provide various patterns of beams scanning in elevation. The AN/MPS-23 incorporates moving target indicator circuits that blank out returns from stationary objects. It is capable of azimuth sector scanning as well as 6,400-mil rotational scan. It provides variable scan rates in elevation and azimuth and uses variable pulse repetition frequencies. The changing radiation frequency gives this radar inherent resistance against electronic jamming.

Another proposed type of 3D radar incorporates many desirable characteristics, such as mobility, compactness, light weight, ease of maintenance, and ability to operate in an ECM environment. Electronic equipment is sealed from such ambient conditions as sand and dust, salt spray, rain, and humidity and is cooled by built-in, air-to-air heat exchangers. Transportable by helicopter, cargo aircraft, or standard military vehicles, the lightweight 3D radar can be put into operation quickly at remote sites. Rugged, compact design enables the entire system to be packaged in two waterproof inclosures, $6\frac{1}{2}$ feet by $6\frac{1}{2}$ feet. The antenna package has a length of 12 feet and weighs 2,300 pounds; the electric equipment shelter has a length of 9 feet and weighs 3,500 pounds.

The antenna inclosure of this radar is uniquely designed for transportability and rapid assembly. The pedestal and simplified azimuth drive system are integral parts of the lower portion of the antenna package. Packed in the upper portion of the inclosure are the reflector panels and waveguide lengths. The thin-shelled parabolic reflector is assembled from four structural modules joined with quick-disconnect fasteners. Six men can perform the entire assembly and hookup procedure.

RADAR NETTING SYSTEM

All air defense must start with a knowledge of the attacking forces. As a result, any air defense system must perform an aircraft tracking function which yields information that commanders can use to engage the attacking force. This tracking function can exist either as an integral feature of the air defense system, such as the defense acquisition radar, or by the addition of radars specifically deployed for the purpose of early warning or gap-filling.

The term, radar netting (fig 36), describes the process by which track data derived from several additional or remote radars are gathered at a single center to produce an integrated set of meaningful target information which can be distributed to all air defense elements concerned.

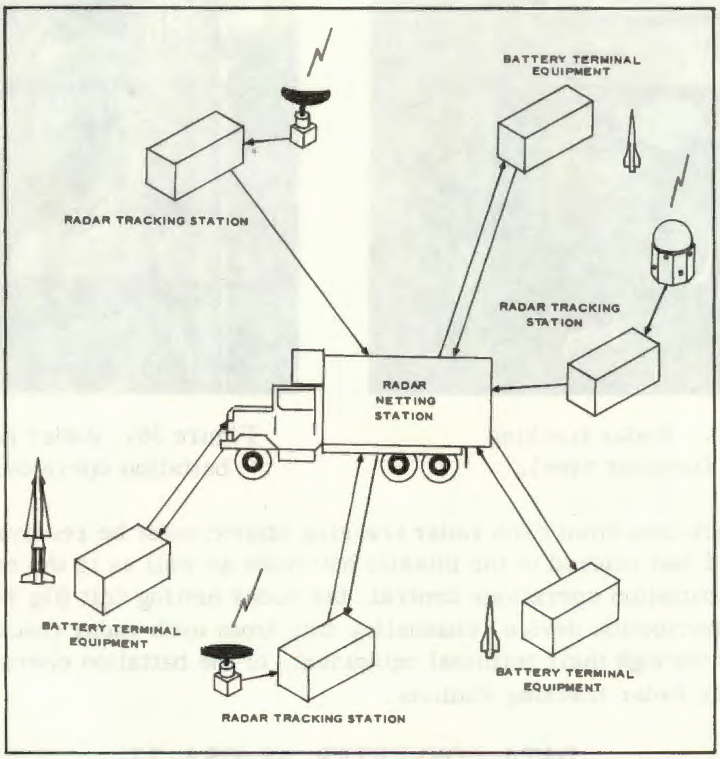


Figure 36. Radar netting concept.

Radar netting can provide concurrent coverage of a selected area by more than one radar. Each remote radar, independent of central computing facilities, can continue to furnish processed track data to another user even if its primary user is disabled. Another advantage is furnishing jam-strobe tracking or obtaining cross-bearings on a jamming target to determine its position by triangulation.

A radar netting system exchanges data among various radars, surface-to-air missile batteries, and command centers by advanced digital data transmission techniques. The standard operational system consists of the following subsystems: radar tracking station, radar netting unit, and battery terminal equipment.

The radar tracking station (fig 37) is a compact radar data processor which accepts track information from its associated acquisition radar. This track information enters the computer and is updated by manual tracking on the part of the console operator. The computer stores the track data in digital form, which are then made available by data link to any user in the netting system. The user receives position coordinates, velocity components, raid size, identification, track number, and target height.

Figure 37. Radar tracking station (interior view).

Figure 38. Radar netting unit at battalion operations central.

Incoming track data from each radar tracking station must be received at the battalion operations central and relayed to the missile batteries as well as to the other radar tracking stations. At the battalion operations central, the radar netting unit (fig 38) acts as a sequencing and distribution device, channeling data from each radar tracking station to the missile batteries through their terminal equipment, to the battalion operations central displays, and to other radar tracking stations.

DATA CONVERTER AN/GSA-77

Data converter AN/GSA-77 is an on-site data processing unit that links the missile battery to its fire distribution system (fig 39). Its function is to provide a means of integrating both Nike Hercules and Hawk units into either the BIRDIE, Missile Monitor, Missile Mentor, or Marine Tactical Data System. Digital commands and target coordinate data, received over automatic data links from the fire distribution system, are converted into suitable form for use by the weapon system. Battery status and coordinates of the tracked target are encoded into digital form and transmitted to the fire distribution system for use by the defense commander and retransmission to other batteries of the defense.

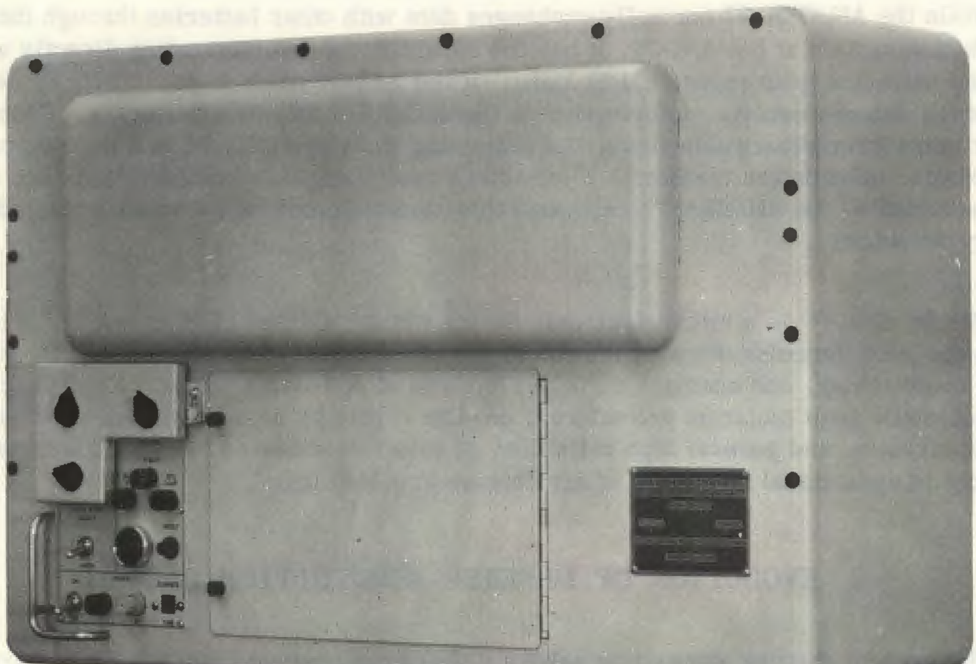


Figure 39. Data converter AN/GSA-77.

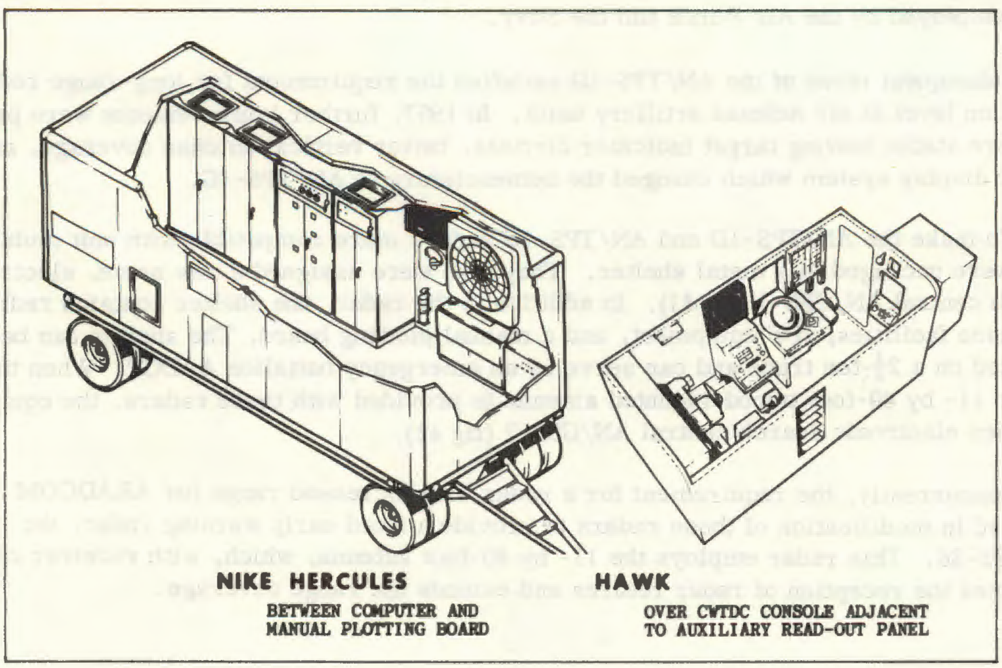


Figure 40. Location of AN/GSA-77 in Nike Hercules and Hawk systems.

While the AN/GSA-77 normally exchanges data with other batteries through the fire distribution system at the AADCP, it has the capability of communicating directly with adjacent batteries over separate data links. If the AADCP itself is out of action, each battery of the defense receives information on the actions of all other batteries. Upon loss of one or more interbattery data links, the remaining links are utilized in a manner calculated to maximize information transfer. The various communication configurations are automatically selected by the AN/GSA-77, although this selection may be manually overridden by battery personnel.

The AN/GSA-77 is a microelectronic device which replaced FUIF and CDG. It is mounted within the Nike Hercules director station or the Hawk battery control central (fig 40), requires no air conditioning, and operates on only 178 watts of 400-hertz power. Automatic self-test, semiautomatic fault isolation procedures, on-site repair by replacement of throw-away, plug-in circuits, and general high reliability of solid-state devices result in a significant increase in operational readiness of air defense artillery units.

EVOLUTION OF DEFENSE ACQUISITION RADARS

The present defense acquisition radars (DAR) have evolved from the early warning radar AN/TPS-1. This radar included only the essentials required to provide early warning information. Similar but not identical equipment, the SCR-602A, appeared in the military radar inventory during World War II. Later the AN/TPS-1B radar was designed. The addition of moving target indicator circuits to the AN/TPS-1 produced the AN/TPS-1D, a medium-power search radar designed to detect targets in excess of 290 kilometers. It was first employed by the Air Force and the Navy.

Subsequent issue of the AN/TPS-1D satisfied the requirement for long-range radars at battalion level in air defense artillery units. In 1957, further improvements were provided by more stable moving target indicator circuits, better vertical antenna coverage, and a better display system which changed the nomenclature to AN/TPS-1G.

To make the AN/TPS-1D and AN/TPS-1G radars more compatible with unit mobility, they were packaged in a metal shelter. They also were assigned a new name, electronic search central AN/GSS-1 (fig 41). In addition to the radar, the shelter contains radio and telephone facilities, IFF equipment, and a manual plotting board. The shelter can be mounted on a $2\frac{1}{2}$-ton truck and can serve as an emergency battalion AADCP. When the larger 11- by 40-foot tripod-mounted antenna is provided with these radars, the equipment becomes electronic search central AN/GSS-7 (fig 42).

Concurrently, the requirement for a radar with increased range for ARADCOM units resulted in modification of these radars to provide a fixed early warning radar, the AN/FPS-36. This radar employs the 11- by 40-foot antenna, which, with receiver changes, improves the reception of radar returns and extends the range coverage.

Figure 41. Electronic search central AN/GSS-1.

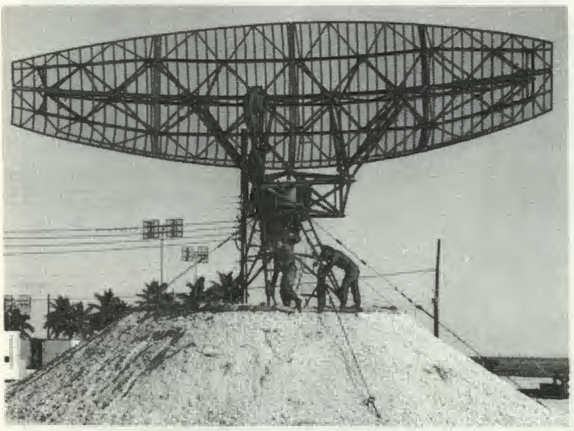


Figure 42. AN/GSS-7 antenna.

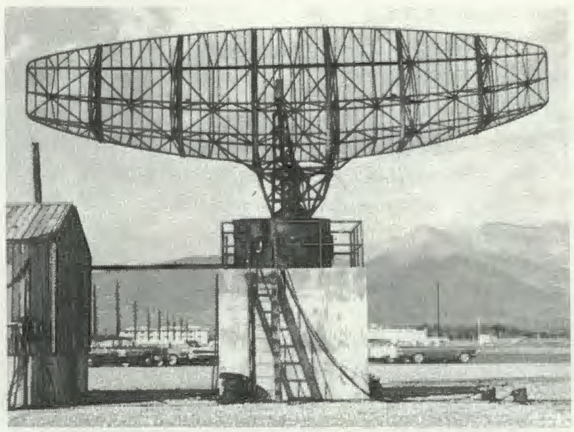


Figure 43. AN/FPS-61 radar.

Further modification of the AN/FPS-36 resulted in the AN/FPS-56 radar. This radar consists of two AN/FPS-36 radars that transmit and receive through a common antenna, thus providing two operating channels and increased reliability. The addition of ECCM capabilities converted the AN/FPS-56 radar to the AN/FPS-61 (fig 43).

The modification of the AN/TPS family of radars did not cease with the development of defense acquisition radars. These same radars are the basis for the development of the alternate acquisition radars discussed in chapter 3.

Chapter 3

Current Air Defense Artillery Weapon Systems

GENERAL

With the advent of aircraft, armies of the world began searching for weapon systems to counter this threat. World War II brought a new era to aircraft performance and tactics. To counter these threats, air defense artillery weapons were developed with increased range and rate of fire. Many weapon systems began to use advanced types of computing sights and radar. Even with these improvements, the aircraft still had an inherent advantage in that after the projectile left the gun it was unguided (followed a ballistic trajectory), resulting in a very low kill probability.

In the fall of 1944, the first US air defense artillery missile was conceived at Fort Bliss. Development of a radically new weapon system, based on the guided surface-to-air missile as a means of destroying enemy aircraft, was begun in 1945. The project was named after Nike, the Greek goddess of victory.

The first Nike Ajax battery became operational in December 1953. Because of additional requirements, the Nike Hercules and Hawk systems were developed and produced.

IMPROVED NIKE HERCULES

Improved Nike Hercules, successor to the first-generation Nike Ajax air defense artillery weapon system and the second-generation basic Nike Hercules system, has dramatically demonstrated the dynamic growth potential of the Nike family of missile systems. This system increases many of the capabilities of the basic Nike Hercules system while incorporating the most advanced and sophisticated electronic counter-countermeasures (ECCM) equipment available.

CAPABILITIES

Improved Nike Hercules, with its ability to engage high-performance aircraft at both high and low altitudes, its long ranges, and its nuclear capability, can engage and destroy an entire formation of hostile aircraft. Reliable, extremely accurate, and possessing a large kill radius, the system has demonstrated its effectiveness against airborne targets traveling at speeds in excess of 2,100 miles per hour (mach 3), at ranges greater than 75 miles, and at altitudes up to 150,000 feet. In addition, the system can effectively engage surface targets at ranges greater than its surface-to-air range capability.

Normally, this flexible system will function as part of an integrated air defense complex; however, each firing battery is capable of functioning as an autonomous fire unit when required. The Improved Nike Hercules system is emplaced in two areas normally separated by a distance of approximately 1 to 3 miles. The fire control platoon equipment is located in the battery control area (fig 44), while equipment and facilities needed to assemble, store, check out, and launch a Nike Hercules missile are located in the launching area (fig 45).

Figure 44. Improved Nike Hercules battery control area.

Figure 45. Improved Nike Hercules launching area.

SCHEME OF OPERATION—SURFACE-TO-AIR

The same basic concept of operation and command guidance is used for Nike Ajax, Nike Hercules, and Improved Nike Hercules. To understand how Nike Hercules works, only the major items of equipment need be considered: an electronic computer, three radars, a missile, and a launcher (fig 46).

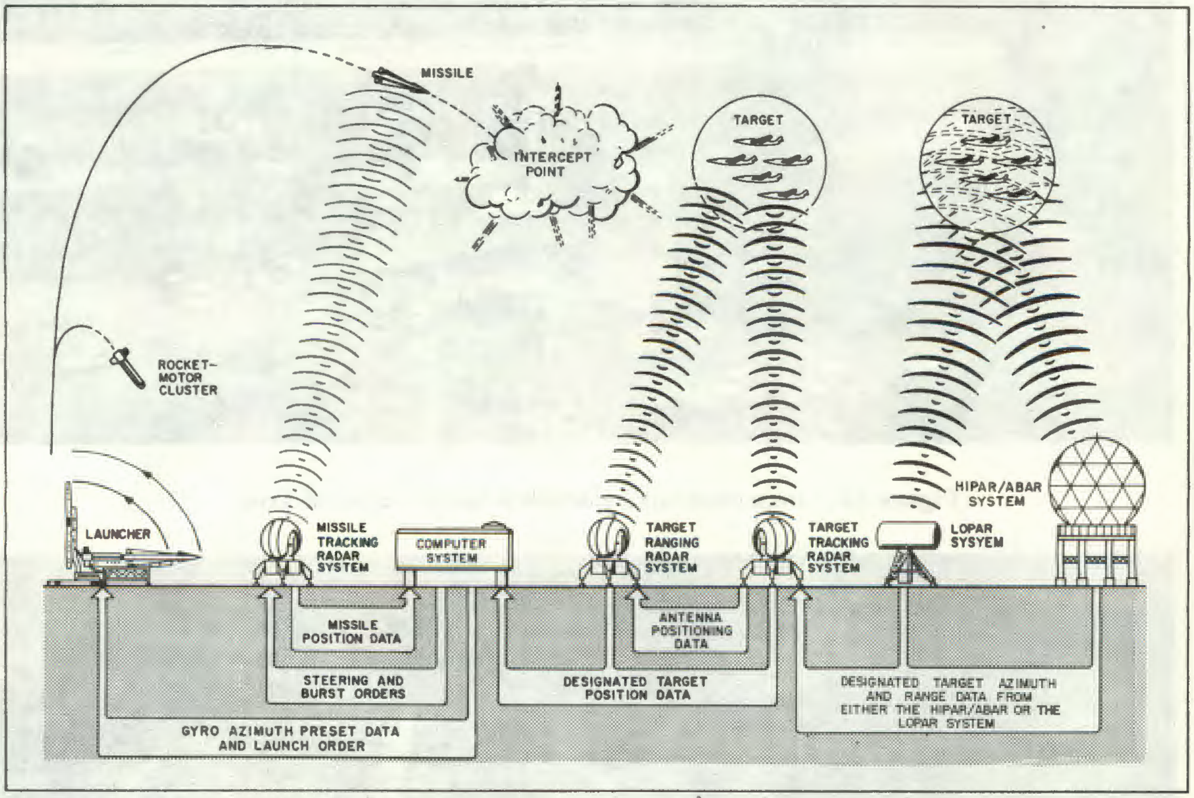


Figure 46. Scheme of operations, Nike Hercules system.

The acquisition radar detects a target which, when identified as hostile, is designated to a target tracking radar. The target tracking radar acquires and tracks the target; measures range, azimuth, and elevation to the target; and continuously sends these data to the computer. A third radar, the missile tracking radar, locks on the missile on a launcher; measures range, azimuth, and elevation of the missile in flight; and continuously sends this information to the computer. The computer, knowing the location of both target and missile, continuously computes an intercept point, directs the missile to the intercept point, and causes the burst command to be sent to the missile at the appropriate time.

FIRE CONTROL PLATOON—IMPROVED NIKE HERCULES

The major equipment items of the fire control platoon are the director station, tracking station, target tracking radar, target ranging radar, missile tracking radar, and acquisition radar. The director station houses the computer, battery control console, and communications switchboard. The computer, using target and missile present position information, computes a predicted intercept point. With this information, it formulates the commands which the missile tracking radar must send to the missile to guide it to the intercept point. The battery control console is the control center of the Improved Nike Hercules system. The acquisition radar operator, stationed at this console, operates the acquisition radar, a long-range search radar capable of detecting targets approaching the defended area. From information provided by the acquisition radar and from other information supplied to the battery control console, the battery control officer analyzes the tactical situation and directs operations of the battery during an engagement. The switchboard provides the battery control officer with communications to the necessary elements of the battery.

The tracking station houses electronic equipment and electronic controls of the missile tracking, target tracking, and target ranging radars. Separate control consoles or control panels are provided for each radar. At the target radar console, three operators, using the controls and indicators, track the target designated by the battery control officer. The target tracking radar automatically sends the required target position information to the computer. The target ranging radar, used in conjunction with the target tracking radar in an electronic countermeasures environment, provides an alternate source for obtaining target range data. The missile tracking radar, manned by a single operator, will automatically acquire and track the missile during an engagement. When the missile is being tracked, the missile tracking radar provides the computer with missile present position information, needed to determine the predicted intercept point, and transmits the commands from the computer to guide the missile to the intercept point and cause warhead detonation.

LAUNCHING PLATOON

The launching area contains facilities for assembly, storage, checkout, and launching of missiles. The launching platoon equipment is composed primarily of the launching control station, launching section equipment, and associated power generating equipment.

The launching control station contains the launching control console and a communications switchboard. Under the direction of the launching control officer, a panel operator selects the launching section from which the missiles are to be fired. Each launching section contains a section control group which distributes power to the launchers within the section and exercises control of them.

ASSEMBLY AND SERVICE AREAS

The major components of the missile are received at the assembly area in shipping containers. Here the main body of the missile is assembled and the guidance unit tested. The explosive components of the missile are received and tested at the service area. The warhead is also mated to the missile body in the service area.

NIKE HERCULES MISSILE

The Nike Hercules missile (fig 47) is a solid-propellant missile. It includes the missile body and rocket-motor cluster. When the missile is launched, it is accelerated to supersonic velocity by the rocket-motor cluster (booster). After the first few seconds of flight, the booster separates from the missile body and the missile rocket motor ignites. Guidance commands in the form of steering orders are sent from the missile tracking radar to steer the missile body to the predicted intercept point. At the optimum time, warhead detonation occurs.

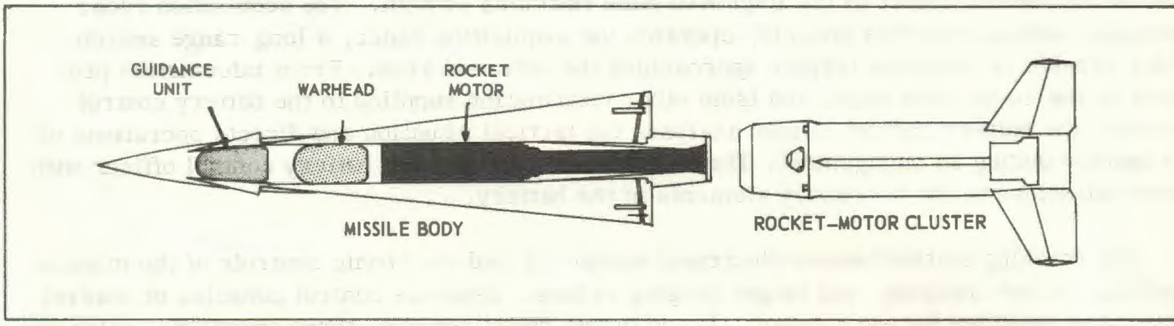


Figure 47. Nike Hercules missile.

MOBILITY

Emphasis on air defense deployed in depth in support of the army in the field prompted the Army to undertake a series of studies to determine if Nike Hercules, with a minimum of cost and new equipment, could be more effectively employed as a mobile air defense artillery system. As a result of these studies, tests were begun to explore this new potential. By modifying existing equipment and developing new equipment, a mobile Nike Hercules system was attained.

The standard launcher was converted to a mobile launcher (fig 48) by three modification kits: a transport kit consisting of an axle and kingpin suspension; a field adaption kit consisting of jacks, outriggers, and footplates; and a blast deflector kit consisting of a blast shield, emplacement linkage, and tiedown linkage. The transport and field adaption kits permit the converted mobile launcher to be towed by a prime mover and to be emplaced easily without need for a concrete pad, while the blast deflector kit helps stabilize the launcher by proper distribution of the thrust load.

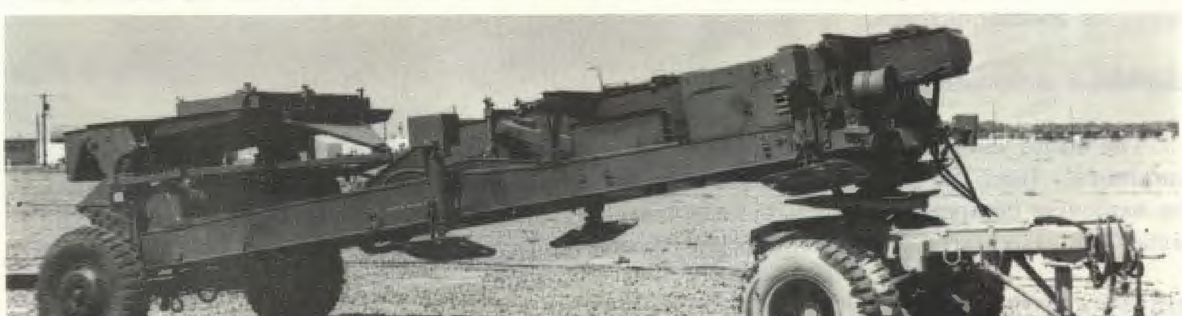


Figure 48. Nike Hercules mobile launcher.

The ready-round transporter (fig 49) was developed to carry an assembled Nike Hercules round, eliminating the necessity of missile body and rocket-motor cluster (booster) joining on the launcher. The mobile launcher receives the round directly from the ready-round transporter, thus saving time and effort.

Figure 49. Nike Hercules ready-round transporter.

In addition, other equipment was modified to increase mobility. These items include the section operating equipment trailer (fig 50) housing the section control group; the test station truck (fig 51) containing the equipment for servicing, testing, and performing organizational maintenance on the missiles; and a dolly-mounted launcher control-indicator (fig 52).

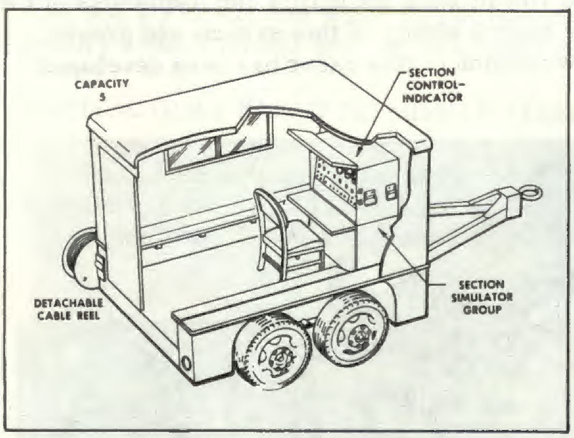


Figure 50. Nike Hercules section operating equipment trailer.

Figure 51. Nike Hercules test station truck.

Special tools and equipment are provided with the fire control platoon equipment to reduce the time required to emplace and march order the equipment. Cable reel racks (fig 53) are used to rapidly pick up and lay interarea cables. A vehicle-mounted A-frame is provided for emplacing the acquisition antenna-receiver-transmitter group. A hoisting beam is provided for removing the cable reel racks from the prime movers. Thus, the capabilities of cross-country mobility and rapid emplacement and march order with minimum manpower were achieved without sacrifice of reliability or performance.

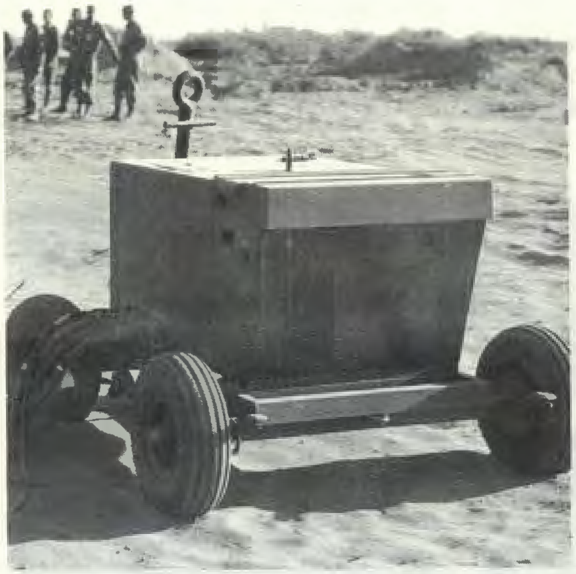


Figure 52. Nike Hercules dolly-mounted launcher control-indicator.

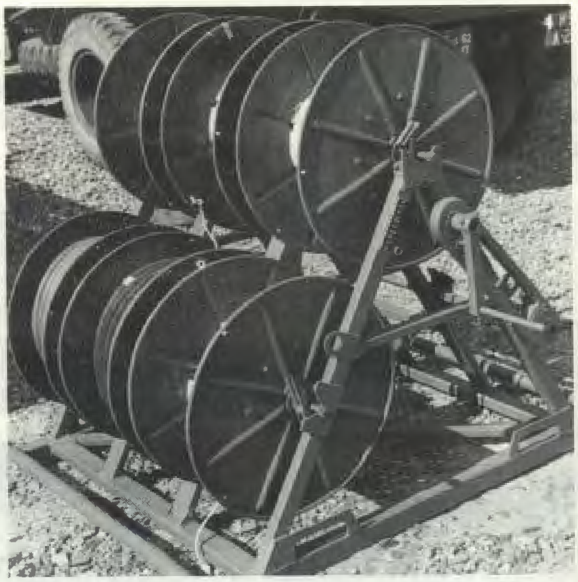


Figure 53. Cable reel racks.

HIGH-POWER ACQUISITION RADAR

With the advent of the Improved Nike Hercules system with its increased capability, it was desirable to extend the target detection range at selected sites. This was done by adding the high-power acquisition radar (HIPAR) (fig 54). The HIPAR does not nullify the usefulness of the basic acquisition radar; rather, it supplements the search ability of this system and greatly enhances the performance of the battery. A mobile version of this radar has been developed.

Figure 54. High-power acquisition radar.

Figure 55. AN/FPS-71 antenna.

ALTERNATE ACQUISITION RADAR

The growth potential of the Nike system was again demonstrated when it was decided to supplement the search, acquisition, and ECCM capabilities of Nike Hercules sites not designated to receive HIPAR. The radar selected for installation at these units was designated the alternate acquisition radar (AAR). The AAR resulted from modification of the AN/FPS-36 and AN/FPS-61 defense acquisition radars discussed in chapter 2.

The simplexed AAR AN/FPS-75 was produced by providing integration kits so that the output of the AN/FPS-36 could be viewed on the consoles of the Nike Hercules system. The addition of ECCM capabilities converted the AN/FPS-75 to the AN/FPS-71 (fig 55).

The diplexed AAR is known as the AN/FPS-69. It is derived from the AN/FPS-61 defense acquisition radar and for tactical usage was designed to be deployed on a collocated site where it serves both as an AAR and DAR.

In 1965, the operation of both the AN/FPS-71 and the AN/FPS-69 radars was further enhanced by increased power output, greater receiver sensitivity, and more efficient moving target indicator circuits; and the nomenclature was changed to Improved AN/FPS-71 or Improved AN/FPS-69.

The AN/FPA-16 and AN/FPA-15 ECCM consoles are video presentation monitor systems employed with the AN/FPS-71 and AN/FPS-69, respectively. Under control of two operators and an electronic warfare officer, these consoles provide a central control point for operation of the AAR and a comparison point where the output of the AAR and low-power acquisition radar (LOPAR) can be monitored. Using the displays available at the consoles, the operators may quickly determine which ECCM features of the two acquisition radars will provide the battery control officer with the best video presentation in complex ECM environments.

ANTITACTICAL BALLISTIC MISSILE (ATBM) TESTS

On 3 June 1960, a Nike Hercules missile destroyed a Corporal surface-to-surface missile (fig 56-), the first known kill of a ballistic missile by another missile. On 12 August 1960, a Nike Hercules missile destroyed another Nike Hercules missile that had

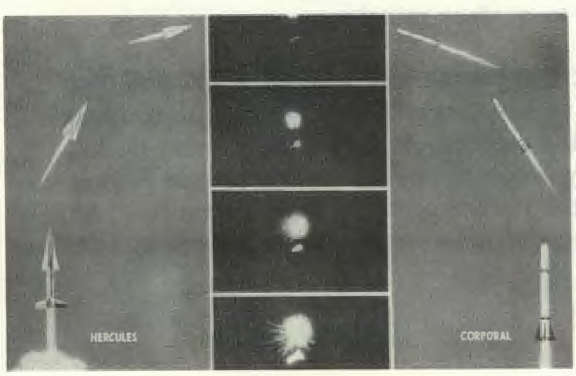


Figure 56. Nike Hercules missile destroys Corporal missile.

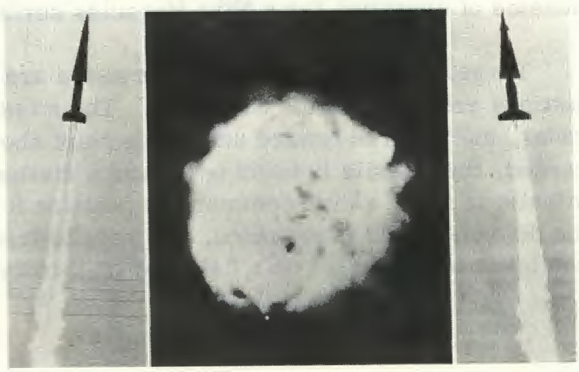


Figure 57. Nike Hercules missile destroys another Nike Hercules missile.

been launched as a target (fig 57). The Nike Hercules missile presented a far more difficult target than the Corporal missile, having a higher velocity and smaller size. Further tests have been conducted to determine the extent of ATBM capability.

IMPROVED NIKE HERCULES IN THE SURFACE-TO-SURFACE ROLE

The use of air defense artillery in a secondary role against surface targets has historical precedent in both World War II and Korea. When surface-to-air missiles replaced antiaircraft guns, it appeared that this traditional role would no longer exist. It is common knowledge that Improved Nike Hercules has a deadly capability against high-performance aerial targets. Not so well known, however, is that the pinpoint accuracy of Nike Hercules against distant surface targets permits it to effectively engage enemy ground concentrations.

Since the inception of the Nike Hercules program, the tactical advantage of developing Nike Hercules into a highly mobile weapon to support the army in the field has been recognized. In 1959, the potential of Nike Hercules as a mobile air defense artillery weapon became evident and interest in the surface-to-surface capability increased.

In 1960, the US Army Air Defense School began presenting formal instruction on Nike Hercules surface-to-surface employment and computation of firing data. During 1961, troop firings provided additional testing of Nike Hercules as a surface weapon. The US Army Air Defense School, US Army Artillery and Missile School, US Army Air Defense Board, and the prime contractor have studied numerous concepts and made subsequent recommendations regarding organization and mobility to improve the Nike Hercules system capability in the surface-to-surface role. Nike Hercules, with its quick reaction time, can be used to attack targets of opportunity with nuclear warheads in support of field army operations.

SCHEME OF OPERATION—SURFACE-TO-SURFACE

In preparing for a surface-to-surface mission, firing data are computed by an air defense artillery group operations section (or battalion operations section in a separate battalion defense). The data required by the firing battery are target range, azimuth, and elevation; fuze setting for proper height of burst; and computer dial settings. Figure 58 shows the scheme of operation for a Nike Hercules surface-to-surface mission.

Target range, azimuth, and elevation are set into the target tracking radar, and dial settings are made on the computer. The missile is fired, tracked by the missile tracking radar, and steered toward an aiming point above the target. As far as the system is concerned, the missile is heading toward a stationary target in space. At the proper instant the missile is given a dive command to position it in the proper attitude to hit the target. After the dive command is executed, the missile tracking radar ceases tracking and the missile continues to the target on a ballistic trajectory.

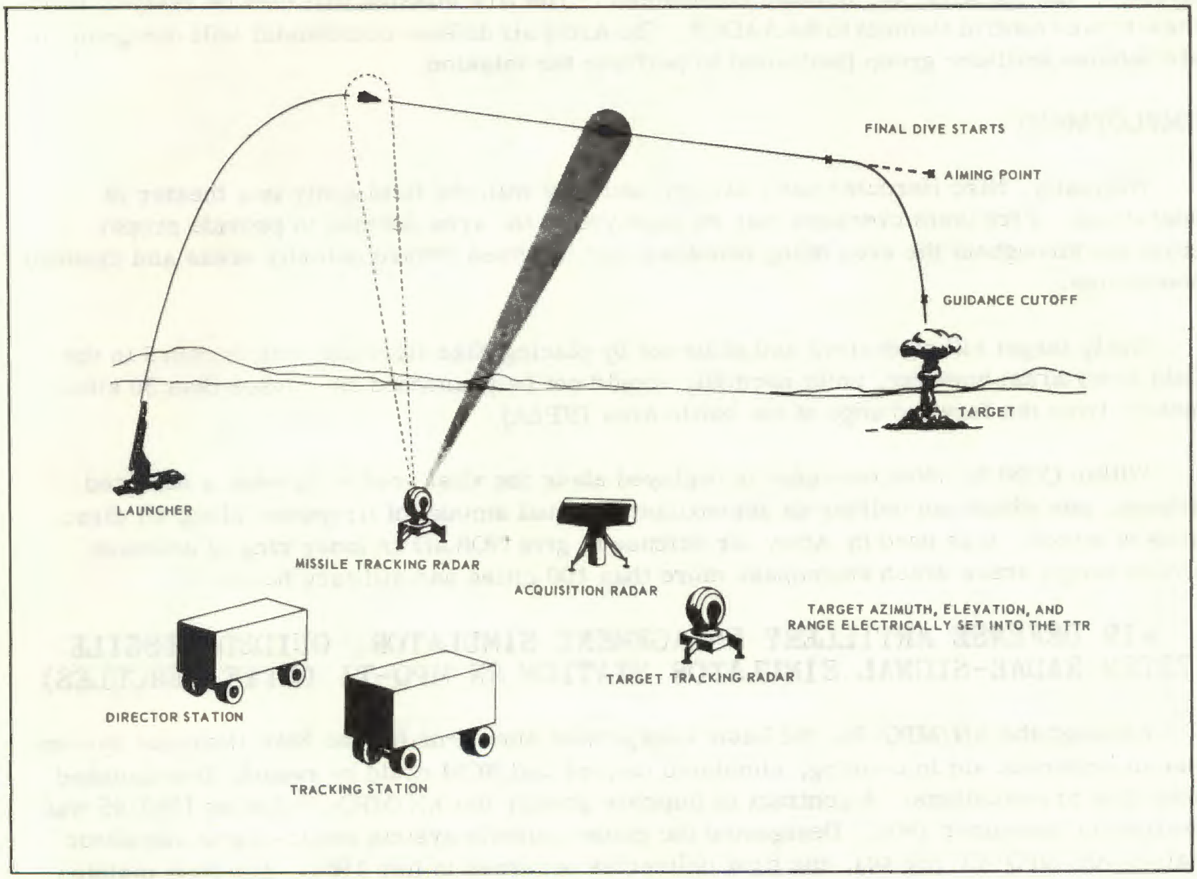


Figure 58. Nike Hercules surface-to-surface scheme of operation.

Entering the computed firing data into the Nike Hercules system is relatively easy. Tests conducted at Fort Bliss show that the time required for making the required settings does not exceed 5 minutes. During the time a battery is engaged in a surface-to-surface mission, it is still capable of searching with its acquisition radar to locate any approaching airborne object. After successfully completing the surface-to-surface mission, the battery can return to its air defense mission in a matter of seconds.

AUTHORITY

Under current concepts, Nike Hercules units are assigned to the field army in an active theater of operations. The use of Nike Hercules in a surface-to-surface mission in the field army will depend on the authority delegated to the field army commander by the regional air defense commander. Normally, the regional air defense commander will delegate authority for operational employment of organic Army air defense artillery units. The field army commander then may utilize Nike Hercules in a surface-to-surface mission. If operational employment of air defense artillery units has not been delegated to the field army commander, the regional air defense commander must approve the mission. When Nike Hercules is to be employed in a surface-to-surface role, coordination must be effected at the tactical operations center between the fire support element, airspace control element, units selected for the mission, and the Army air defense commander. The fire mission will then be relayed from the airspace control element to the AADCP. The Army air defense commander will designate an air defense artillery group (battalion) to perform the mission.

EMPLOYMENT

Normally, Nike Hercules units are utilized only with the field army in a theater of operations. Fire units overseas may be deployed in the area defense to provide proper coverage throughout the area being defended, but weighted toward priority areas and exposed boundaries.

Early target kill is desired and achieved by placing Nike Hercules well forward in the field army area; however, units normally should not be positioned any closer than 30 kilometers from the forward edge of the battle area (FEBA).

Within CONUS, Nike Hercules is deployed about the vital area to provide a balanced defense, one which can deliver an approximately equal amount of firepower along all directions of attack. It is used by Army air defense to give NORAD an inner ring of defenses around target areas which encompass more than 100 cities and military bases.

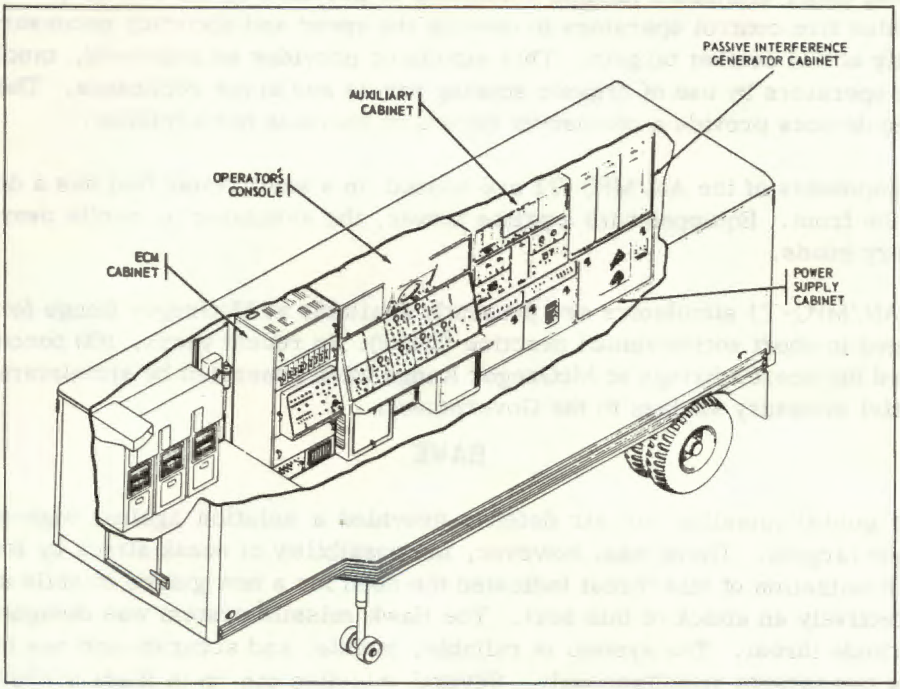
AIR DEFENSE ARTILLERY ENGAGEMENT SIMULATOR; GUIDED MISSILE SYSTEM RADAR-SIGNAL SIMULATOR STATION AN/MPQ-T1 (NIKE HERCULES)

Although the AN/MPQ-36, the basic engagement simulator for the Nike Hercules system, was an important aid in training, simulated targets and ECM could be readily distinguished from true presentations. A contract to improve greatly the AN/MPQ-36 during 1963-65 was awarded in December 1961. Designated the guided missile system radar-signal simulator station AN/MPQ-T1 (fig 59), the first deliveries occurred in July 1964. The first maintenance class started training in October 1964.

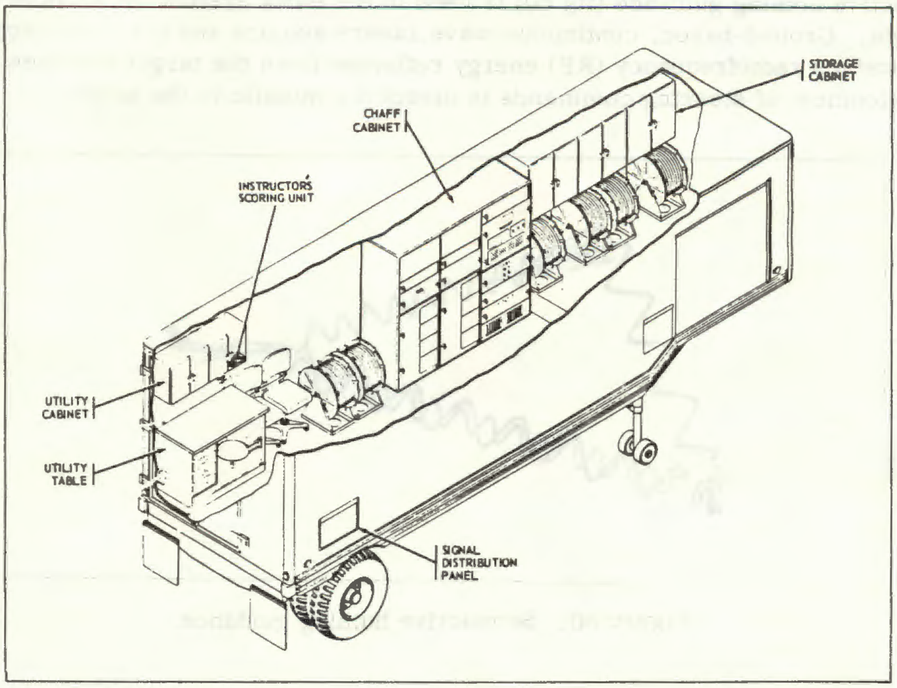
The AN/MPQ-T1 is a compact, transistorized engagement simulator designed for the Nike Hercules and Improved Nike Hercules systems and associated radars (HIPAR and AAR). The improved simulator introduces realistic target simulation, sophisticated ECM, and chaff. Masking effects and radar clutter, variable with antenna elevation, as well as identification responses from friendly aircraft, can be simulated.

Up to six independent simulated targets, generated by controlled electronic signals, can be displayed on the radar screens. Each target can travel at speeds up to 2,000 knots and at altitudes up to 150,000 feet, dive at a rate of 80,000 feet per minute and climb at half that rate, and turn at rates up to 20° per second. Size of targets can be varied to produce calibrated returns of any desired dimension from 0.1 to 100 square meters. The device can simulate a Nike Hercules missile, initiate the burst command by either the computer or simulator, program missile malfunctions, and fire additional missiles after a burst order.

The addition of ECM and chaff cabinets provides one of the most important capabilities of the simulator—the ability to simulate several types of countermeasures which an enemy may be expected to use. Effects of mechanical jamming and five types of electronic jamming can be produced and displayed on the radar screens of the Nike Hercules system. Chaff, for instance, can be simulated as being dispensed forward, laterally, or to the rear of the simulated target or targets.



(1) Left side view.



(2) Right side view.

Figure 59. Nike Hercules system engagement simulator AN/MPQ-T1.

Training under simulated tactical conditions is provided by the AN/MPQ-T1, enabling Nike Hercules fire control operators to develop the speed and accuracy necessary to engage successfully actual combat targets. This simulator provides an improved, much-needed aid in training operators by use of organic scoring panels and error recorders. These timers and sensing devices provide a permanent record of operator performance.

All components of the AN/MPQ-T1 are housed in a semitrailer that has a dolly and towbar at the front. Equipped with a prime mover, the simulator is mobile over primary or secondary roads.

Four AN/MPQ-T1 simulators are presently available at McGregor Range for use by units engaged in short notice annual practice (SNAP). In recent years, 100 percent of all targets used for scored firings at McGregor Range were generated by simulators, resulting in substantial monetary savings to the Government.

HAWK

Use of guided missiles for air defense provided a solution against high-speed, high-altitude targets. There was, however, tne possibility of sneak attack by low-flying aircraft. Realization of this threat indicated the need for a new guided missile system to combat effectively an attack of this sort. The Hawk missile system was designed to counter the low-altitude threat. The system is reliable, mobile, and accurate and has the capability of engaging two targets simultaneously. Several missiles can be in flight at the same time. Each missile battery has the personnel, equipment, and facilities required for operation or movement of the complete unit.

Semiactive homing guidance (fig 60) is used in the Hawk system for missile control during flight. Ground-based, continuous-wave radars acquire and track the target. The missile receives radiofrequency (RF) energy reflected from the target and uses this energy in the development of steering commands to direct the missile to the target.

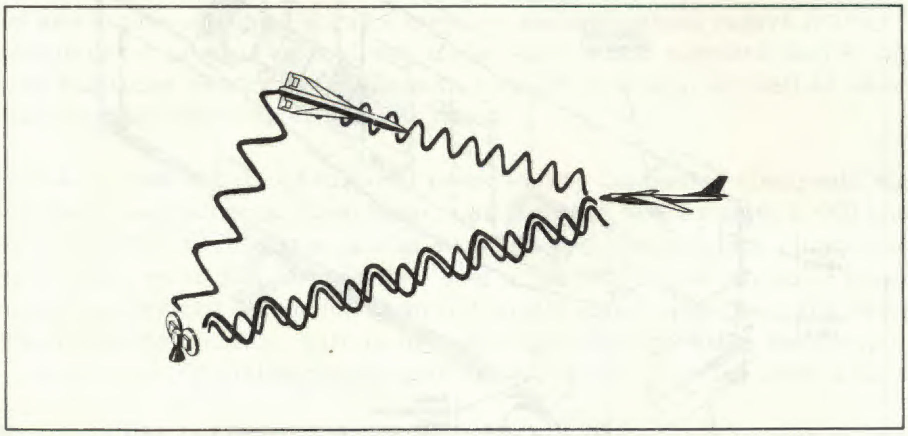


Figure 60. Semiactive homing guidance.

SCHEME OF OPERATION

Like all air defense artillery missile systems, Hawk must accomplish four basic tasks: detection, identification, tracking, and target kill (fig 61). Hawk can perform these functions (fig 62) at extremely low altitudes while retaining a high degree of mobility.

Figure 61. Hawk target kill.

To detect targets, the Hawk system uses two acquisition radars. One of these, the continuous-wave acquisition radar (CWAR), covers the low-altitude zone, the primary zone of consideration for Hawk. This radar utilizes the doppler effect, produced by a change or shift in frequency due to the movement of the object reflecting that frequency, to detect low-flying targets. If the transmitted energy strikes a stationary object, such as a hill or building, it is returned to the radar with frequency unchanged.

Within the radar, a comparison is made between the transmitted and received frequencies, and, if there is no change, no video is presented on the associated radar screen. However, if the transmitted energy strikes a moving object, such as an aircraft, its frequency will be changed. The amount of change, which is the doppler effect, is directly proportional to the radial speed of the aircraft with respect to the radar. When the reflected energy returns to the radar receiver, a comparison is again made with the transmitted frequency. This time the radar will detect the frequency change, and video will be presented on the associated radar screen representing the radial speed of the target. The video will appear at the azimuth determined by the radar antenna position at the time of detection. Thus, low-flying targets are readily detected because reflections from stationary objects on the ground (ground clutter) are not presented on the radar screen.

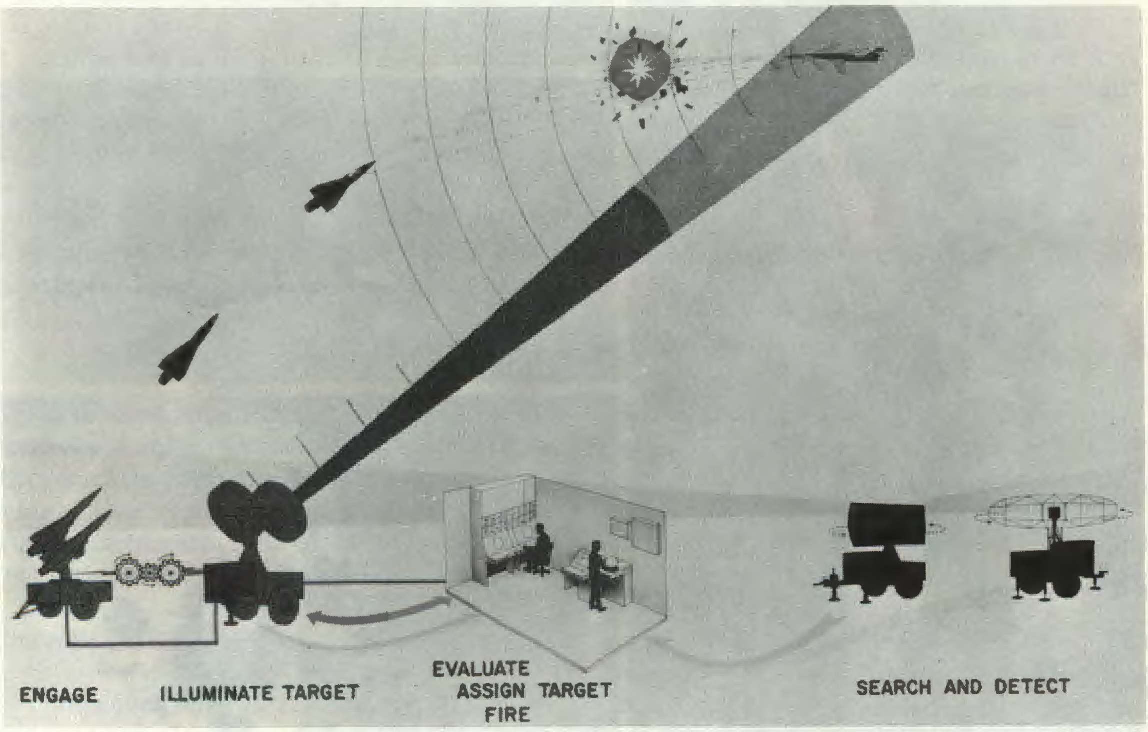


Figure 62. Hawk system scheme of operations.

The other detection radar, the pulse acquisition radar (PAR), complements the coverage area of the CWAR by providing a medium-altitude, medium-range detection capability to the system. The PAR provides azimuth synchronization for the CWAR. This pulse radar is very similar to those found in other air defense artillery missile systems but has some significant improvements over earlier types. The PAR has a limited capability at very low altitudes because its beam is directed slightly upward to avoid reflections from stationary ground objects.

Synchronized rotation of the two acquisition radars permits coordinated, continual searching for targets. Target information from both radars is automatically relayed to the battery control central by means of data cabling. Within the battery control central, all operations of the battery are integrated and controlled during an engagement. Target identification is accomplished in the Hawk missile battery by use of the Mark X IFF equipment, or through communications control with higher headquarters.

The third basic function, the tracking phase, is initiated upon target assignment to a firing section. A firing section consists of one illuminator radar and three launchers with missiles. Each launcher can accommodate up to three Hawk missiles. Upon receiving a target assignment, the illuminator in the assigned section is positioned to the azimuth of the detected target; then it searches a small area of the sky for the target. When the illuminator receives a reflected signal bearing a frequency change, it locks on the target and automatically tracks it during the remainder of the engagement.

Similar to the operation of the CWAR, the illuminator detects targets and tracks them on the basis of radial speed. As this radar also uses the doppler effect, it can track targets even though they are flying at treetop level. Once the illuminator is locked on the target, the firing operator in the battery control central selects one launcher within his firing section for firing. The illuminator and the selected launcher are now slaved together, causing the missiles on the selected launcher to be aimed directly at the target. In the battery control central, the firing console operator is observing all of these actions closely, and the tactical control officer is monitoring the engagement. When all conditions for firing have been met, the firing pushbutton is pressed, lead angle and superelevation are automatically inserted in the launcher, and the Hawk missile is launched.

Launching the missile marks the beginning of the kill phase, the fourth basic function. The Hawk missile homes on energy reflected by the target. It continually watches its target through a tracking antenna onboard the missile while the semiactive homing guidance system continually adjusts the missile's course to insure successful intercept. Target speed is determined by continuous comparison of the transmitted energy of the illuminator with the reflected energy from the target. Target maneuver is determined by the position of the missile's target tracking antenna. Using this information to make continuous adjustments in its course, the Hawk missile travels the most direct route to the intercept point.

PULSE ACQUISITION RADAR

The function of the pulse acquisition radar (PAR) (fig 63) is to detect moving targets and continually furnish target range and azimuth to plan position indicators (PPI) in the battery control central. The IFF system is also contained in the PAR. The PAR antenna control system supplies antenna synchronizing data to the CWAR. The PAR transmitter generates pulses of RF energy directed against an antenna reflector. As these pulses are being radiated, the antenna is rotating at 20 revolutions per minute. The antenna, therefore, scans 6,400 mils every 3 seconds. When a target enters the radar radiation field, pulses of RF energy which strike the target are reflected. This reflected energy is processed and sent as video information to the display consoles in the battery control central. The PPI displays are synchronized to represent target position relative to the PAR location. The radar uses moving target indicator circuitry to suppress stationary target return signals on the display consoles.

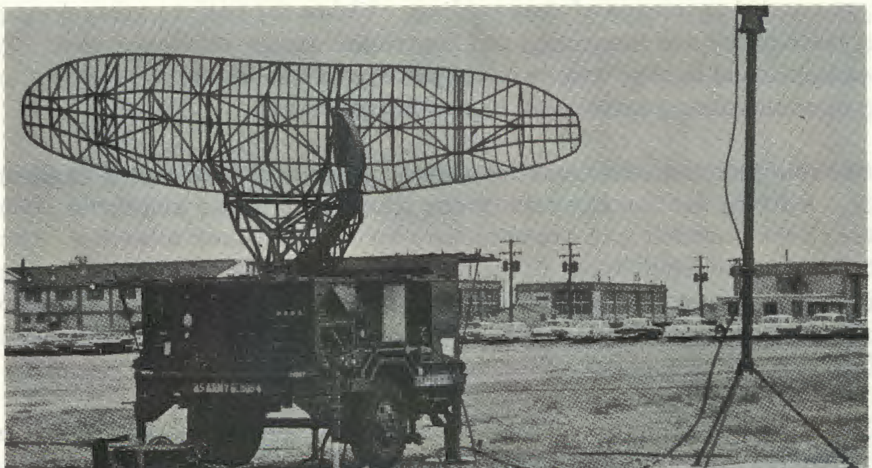


Figure 63. Pulse acquisition radar (PAR).

CONTINUOUS-WAVE ACQUISITION RADAR

Because it uses the continuous-wave principle, the CWAR has two antennas, the transmitter being in the upper portion of the antenna and the receiver in the bottom portion. A beam of RF energy transmitted by the CWAR (fig 64) is continually swept through 6,400 mils

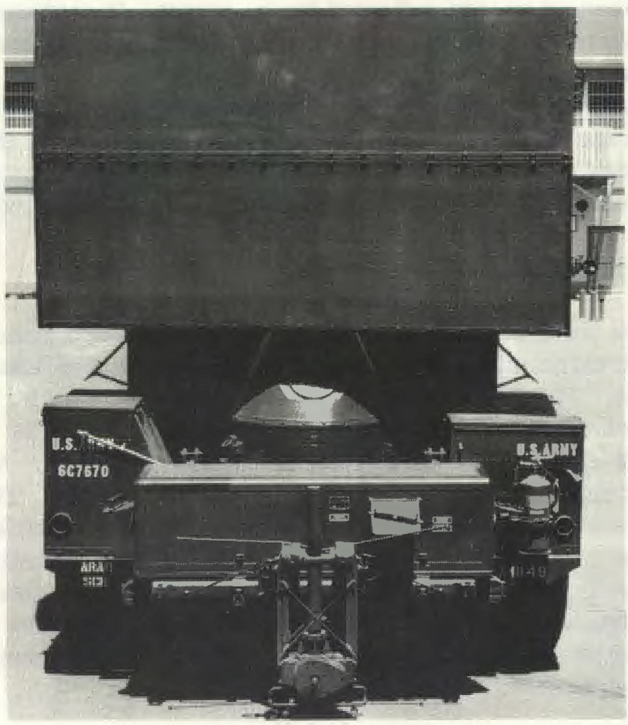
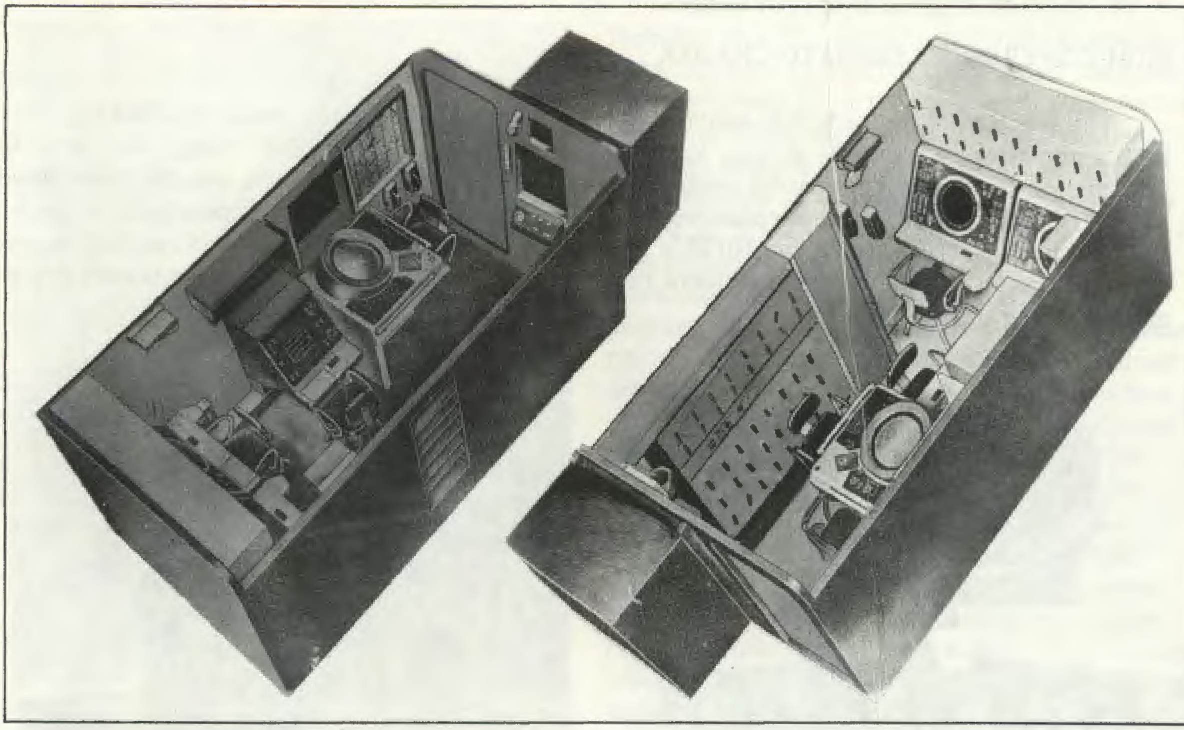


Figure 64. Continuous-wave acquisition radar (CWAR).

by rotation of the antenna. When the beam strikes a moving object, a portion of the energy is reflected to the radar, is resolved into radial speed and azimuth, and is then displayed as video information in the battery control central. The CWAR normally rotates synchronously with the PAR; thus, the target data presented on composite displays can be easily correlated.

BATTERY CONTROL CENTRAL

The battery control central (fig 65) is a centrally located operations shelter that provides equipment for control of the overall operation of the Hawk battery during tactical firing operations. This shelter and the design of the Hawk system permit continuous tactical control of the missile battery by an officer designated as the tactical control officer. Four additional personnel are required for normal operation of the battery control central, each operator being stationed at one of the consoles.



(1) Right interior. (2) Left interior.

Figure 65. Battery control central.

The tactical control console provides a cathode-ray tube display for observing targets detected by the CWAR and PAR, presenting PPI video from the PAR and plan speed indicator (PSI) video from the CWAR. This console also provides controls for maintaining overall coordination and command control of the engagement. Associated with this console are components for the remote operation of the IFF equipment.

The continuous-wave target detection console (CWTDC) provides a cathode-ray tube display for observing low-altitude targets detected by the CWAR. The azimuth-speed indicator utilizes a rectangular display which shows radial speed and azimuth of the targets. The console also provides power controls for remotely activating the CWAR.

Each of the two identical firing consoles contains a cathode-ray tube display used in tracking targets and evaluating intercepts. The firing console indicators present target information from the pulse acquisition radar, continuous-wave acquisition radar, range-only radar, and associated illuminator. Each firing console also provides controls for remotely activating its associated illuminator radar and launchers, for alinement of the illuminator radar on the target to be engaged, for selection of a launcher, and for firing missiles.

A battery status indicator panel displays alert status, target altitude, and fire control commands from the AADCP. Fire control commands of the tactical control officer and status of the firing sections appear as illuminated labels on the battery status indicator (BSI).

HIGH-POWERED ILLUMINATOR RADAR

The function of the remotely controlled high-powered illuminator radar (HIPIR) (fig 66) is to automatically track the target, keep the target illuminated with RF energy, and provide information to the battery control central, launchers, and missiles. The missile uses direct RF energy from the HIPIR and reflected RF energy from the target to compute its own guidance commands. There are two HIPIR's in the Hawk missile battery, one for each firing section. Because this is a continuous-wave radar, separate antennas are used for transmitting and receiving.

Figure 66. High-powered illuminator radar (HIPIR).

Figure 67. Range-only radar (ROR).

RANCE ONLY RADAR

During an ECM environment (jamming), range data on a target may be degraded. For that reason, the Hawk system has a range-only radar (ROR) that is used when required as an auxiliary means of providing range information for the system. The ROR (fig 67) is a quick-response, range-measuring pulse radar that operates in a different frequency band from that used by the other radars in the system. It is normally operated remotely from the battery control central. The ROR can be activated manually by the fire control operator or automatically by one of the illuminator radars. Once activated, it is slaved to the associated illuminator in azimuth and elevation and presents a video signal to the battery control central where formulation of range data is accomplished.

LAUNCHER

Figure 68. Hawk launcher and missiles.

During the Hawk firing sequence, the launcher (fig 68) receives tactical commands from the battery control central and positioning commands from its associated illuminator. When the illuminator is locked on the target, a selected launcher slews to the same azimuth and elevation as the illuminator antenna. As the radar tracks the target, the antenna position changes constantly. The three-place launcher automatically aims the missiles in azimuth and elevation to agree with the antenna position information received from the illuminator. Approximately 3 seconds after a fire command is transmitted from the battery control central, the missile is launched. The 3-second delay enables stabilization of the missile tracking antenna and permits the launcher to select a missile, activate the missile power supplies, and position the lead angle commanded by the illuminator. If the missile selected by the launcher firing selector does not leave the launcher, the HANGFIRE lamp in the battery control central will light and the next ready missile is automatically selected.

HAWK MISSILE

The Hawk missile (fig 69), propelled by a two-stage, solid-propellant motor, uses semiactive homing guidance. It is 16 feet 6 inches long and 14 inches in diameter, weighs 1,295 pounds, and has a dart-cruciform configuration. It has three basic functional systems: propulsion, guidance, and warhead. The missile body is divided structurally into two parts. The front body section consists of the radome, target tracking antenna with a hydraulic assembly which positions the antenna, hydraulic accumulator, electronic guidance and control chassis, and electrical power unit. The rear section consists of the warhead section, rocket-motor section, elevon actuator section, and four wing assemblies.

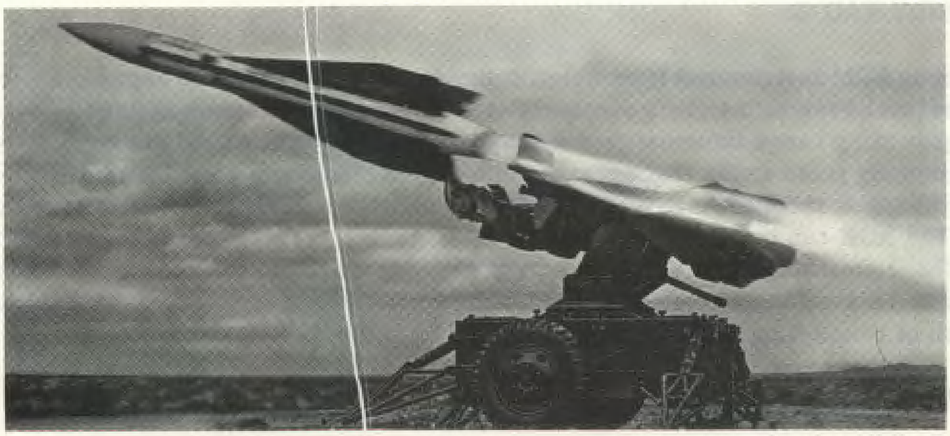


Figure 69. Hawk missile at launch.

Initial thrust to boost the missile to operational speed and sustaining thrust to maintain that speed are provided by the propulsion system. The guidance system uses energy reflected from the target to compute continually a collision course. The warhead system explodes the missile warhead at the optimum point to insure target kill. For safety purposes, a destruction system is provided to destroy the missile in flight if required.

PALLET

Pallets are used for storing and transporting ready missiles. The pallet, which may be mounted on a 2-ton, two-wheel trailer (fig 70), consists of three missile support arms and two index fittings connected to the skid. The missile support arms are contoured to the shape of the missile, each arm having a forward and rear missile latch to secure a missile. The index fittings are provided to position the loader properly for the transfer of missiles to or from the pallet. A pallet with three missiles can be transported by helicopter when the trailer is detached.

LOADER-TRANSPORTER

The lightweight loader-transporter is a full-track, self-propelled vehicle used to transfer from one to three missiles between the pallet and launcher (fig 71). When rigged as a crane, a secondary function of the loader-transporter is to pick up and transfer individual missiles and missile components. During movement of the battery, the three loader-transporters (organic to the battery) are carried in the cargo beds of extra-long-wheelbase $2\frac{1}{2}$-ton trucks.

Figure 70. Hawk pallet mounted on 2-ton trailer.

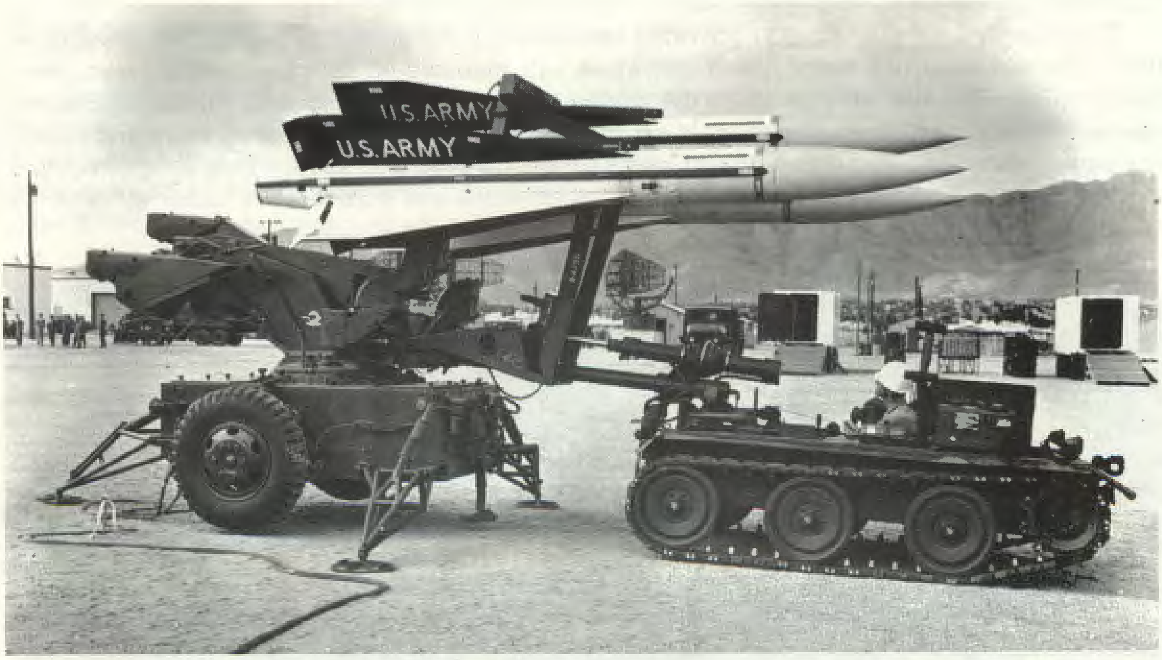


Figure 71. Loader-transporter transferring Hawk missiles to launcher.

ASSAULT FIRE COMMAND CONSOLE

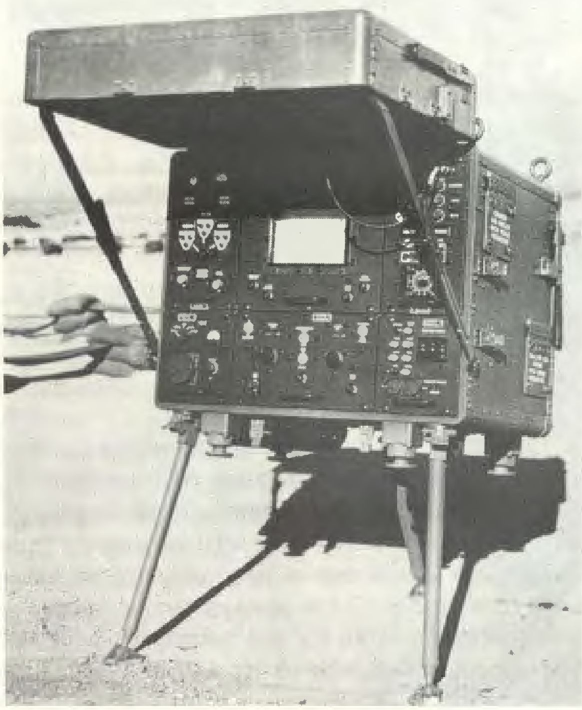


Figure 72. Assault fire command console.

The assault fire command console (AFCC) is an auxiliary item of control equipment contained in a compact, lightweight, rectangular case (fig 72). The console has permanently attached folding legs and can be emplaced in any convenient location. Six electronic panels mounted on the AFCC provide the capability for remote control of one firing section of the battery. The AFCC is utilized as the alternate battery control central if the battery control central is not available. Also, this item of equipment enables the battery to move by echelon, keeping one firing section operational while the other firing section is moving. The AFCC provides a means of control of one CWAR, one HIPIR, and three launchers with a total of nine missiles.

MISSILE TEST SHOP

The missile test shop (fig 73) provides facilities for the assembly and test of Hawk missiles. The test shop is a mobile, self-contained unit mounted on the chassis of a 1-ton, two-wheel trailer. The test shop includes the cables and accessories necessary to operate when it is connected to the missile under test. It carries the common and special tools and accessory equipment necessary to set up and maintain the missile test shop. This item of equipment is capable of missile and missile test shop checkout and maintenance under all-weather or blackout conditions.

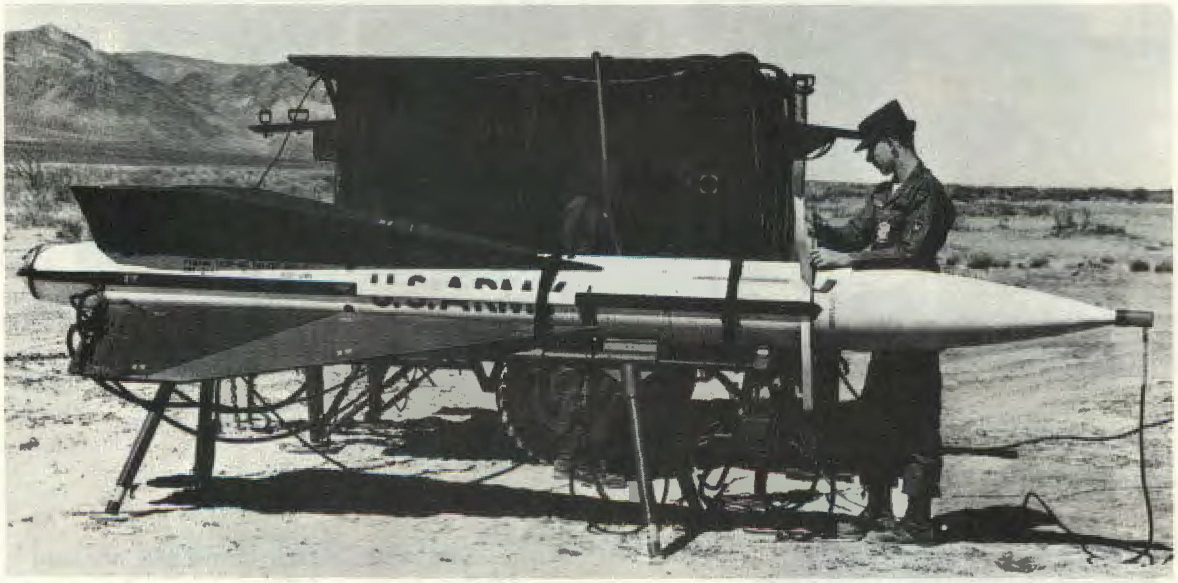


Figure 73. Hawk missile test shop.

IMPROVED HAWK

The Improved Hawk missile system, which incorporates state-of-the-art improvements, is designed to replace the existing Hawk missile system. The configuration of the Hawk battery has been changed very little in the Improved Hawk program. Visible changes are the addition of a trailer to house the information coordination central (ICC), the relocation of the omnidirectional antenna which is now mounted on top of the pulse acquisition radar (PAR), and the absence of the missile test shop.

The ICC trailer houses the general-purpose computer, which is the brains of the Improved Hawk system. Utilizing data from the Hawk radars, the computer will detect and evaluate the target, assign the target to a firing section, and order a missile to be fired against a hostile target; thus, the Improved Hawk's system reaction time will be greatly minimized. The battery control officer (BCO) will be able to select one of two modes of engagement, manual or fully automatic. In the automatic mode the BCO can always override the computer. The ICC will also serve as the communications center for the battery as well as house the identification, friend or foe (IFF), equipment and data converter AN/GSA-77.

The battery control central has been modified to permit display of additional information at the tactical control console.

Several modifications have been made to the radar system. The only change to the PAR was the relocation of the omnidirectional antenna as mentioned above. The continuous-wave acquisition radar has been extensively redesigned. Extensive use is being made of solid-state devices. The high-powered illuminator radar has been given greater target tracking capability as well as improved circuitry.

The greatest changes have occurred in the Hawk missile. The Improved Hawk round is designed along the certified round concept. The round will require no electrical checkout or repair in the field, thus eliminating the requirement for a missile test shop.

The Hawk system engagement simulator AN/TPQ-21 has been modified so as to be compatible with the increased capabilities of the Improved Hawk system, the nomenclature being changed to AN/TPQ-29.

SELF-PROPELLED HAWK

The self-propelled Hawk system is designed to enhance the maneuverability and effectiveness of Hawk in the field army area. The self-propelled platoon has three self-propelled launchers, one CWAR, one HIPIR, and one platoon command post (PCP) (fig 74). The self-propelled launchers are identical with the conventional launchers except that they are mounted on tracked vehicles (fig 75). The radars are the same as those used in conventional towed Hawk units. The PCP contains a modified AFCC and IFF together with communications and other equipment normally found in a command post.

EMPLOYMENT

The primary employment guideline for Hawk units is to position the fire units well forward along low-altitude routes of approach to effect enemy target destruction prior to release of weapon regardless of the delivery technique employed. Hawk units providing air defense for vital area defense and priority targets within the field army likewise would be located well forward along the low-altitude routes of approach into the area.

Figure 74. Self-propelled Hawk platoon command post.

Figure 75. Self-propelled Hawk launcher and HIPIR.

AIR DEFENSE ARTILLERY ENGAGEMENT SIMULATOR; GUIDED MISSILE SYSTEM RADAR-SIGNAL SIMULATOR STATION AN/TPQ-21 (HAWK)

Until the development of the Hawk system engagement simulator AN/TPQ-21, the Hawk unit commander had insufficient means at his disposal for adequate realistic training of on-site radar operators. To train Hawk battery control central operators, it was necessary to obtain high-performance aircraft equipped with ECM emitters. In CONUS, the cost and availability of aircraft and the Federal Aviation Administration's control of flight patterns and use of electromagnetic emanations all contributed to a reduction of training effectiveness. In oversea forward areas, tactical aircraft have difficulty in simulating hostile actions and emitting ECM without providing the enemy with information of an intelligence nature. This situation has been improved considerably by use of the AN/TPQ-21 (fig 76), now issued to Hawk units.

When connected to the Hawk system, this simulator provides an artificial tactical environment for the training of operators. No change in operation of the battery control central is apparent to the operators when using the AN/TPQ-21 for target engagement. Along with the technique of inserting video, doppler, and other simulated effects, the ECCM features of the Hawk radars are used and the operator can be evaluated as to his ability to counter ECM.

The AN/TPQ-21 is enclosed in a Craig shelter similar to the battery control central and has the same transportability feature (helicopter, cargo aircraft, or truck). It is capable of simulating six airborne targets, each independently maneuverable against the Hawk battery. ECM effects appearing to be produced by the simulated targets can be generated if so programed. Targets may be designated as hostile or friendly, and the size can be varied to produce returns of any desired cross section from 1 to 25 square meters.

The simulator also can produce complete AADCP symbology, IFF and launcher effects, radar ground clutter, and simulated responses from the five radars of the Hawk battery.

A quick-disconnect feature permits the simulator to be electrically switched in or out of the Hawk functional system in a few seconds; thus, a change from a training status to combat readiness can be made immediately.

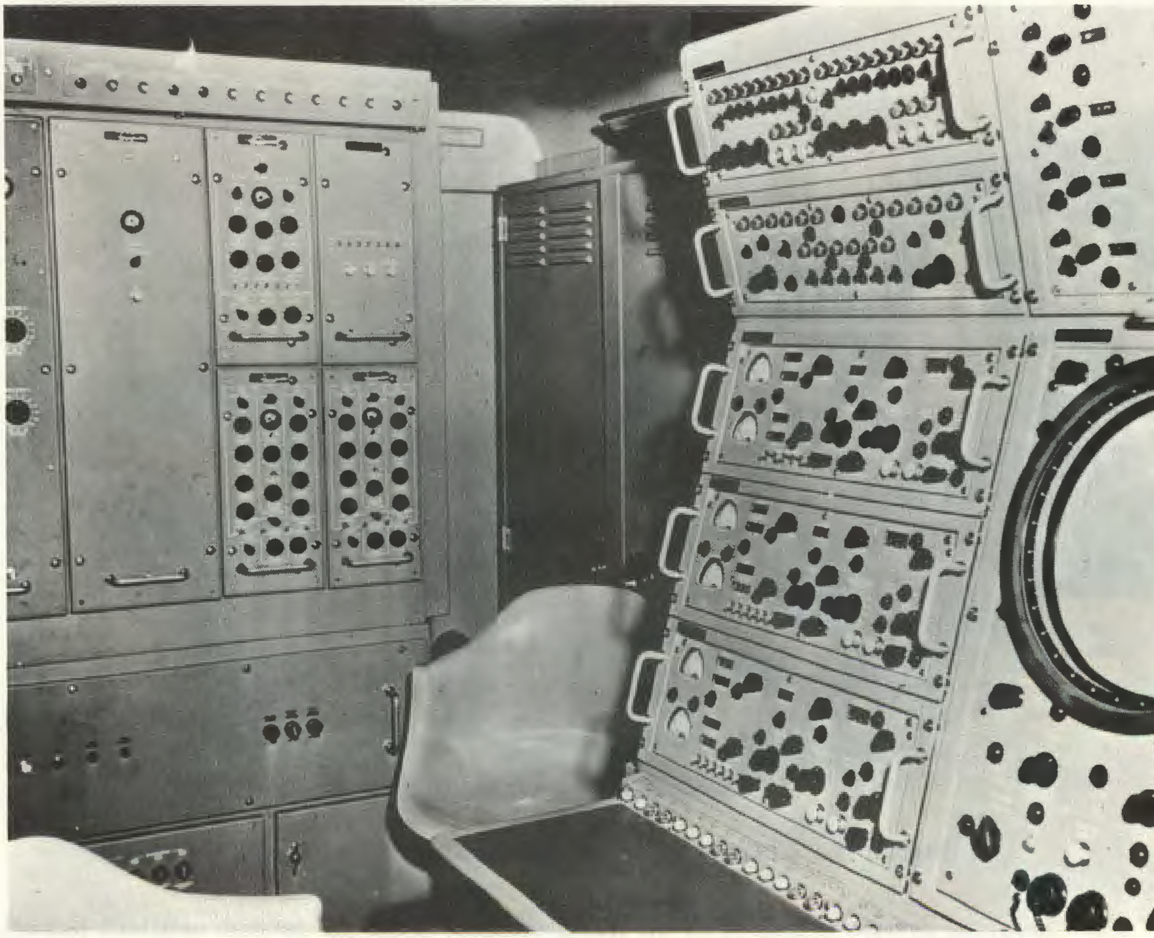


Figure 76. Hawk system engagement simulator AN/TPQ-21 (interior view).

CHAPARRAL

One of the newest additions to the family of air defense artillery weapons is Chaparral. Under development since 1965 and initially fielded in early 1969, Chaparral provides units in the forward battle area with protection against attack by hostile aircraft operating at low altitudes. Using infrared-sensitive, passive homing guided missiles, the Chaparral system augments the low-, medium-, and high-altitude defense provided by Hawk and Nike Hercules systems farther to the rear.

The Chaparral system XM48 (fig 77) consists of three major subsystems: a full-tracked carrier XM730 that provides mobility, a missile launching station XM54 that provides a means of aiming and launching guided missiles, and guided missiles XMIM-72A. The system has a mobility range of 300 miles, a top road speed of 40 miles per hour, and a cross-country travel capability. It can ford or swim streams as required. It carries four ready-to-fire guided missiles on launch rails and eight additional missiles in onboard stowage compartments.

Figure 77. Chaparral self-propelled weapon system.

The Chaparral system is fielded as the firing element of the air defense artillery battery, two of which are organic to the Chaparral/Vulcan battalion. The battery is organized in three platoons of four Chaparral fire units each. Each fire unit is manned by a squad of five men: a squad leader, a senior gunner, a driver, and two gunner/observers.

Chaparral is usually employed in an area-type defense weighted along likely avenues of approach. Because of its widely dispersed deployment and its reliance on visual target detection and tracking, control of fire is exercised by SOP with the squad leader engaging targets he has positively identified as hostile.

VULCAN

The Vulcan weapon system is the newest Army air defense automatic weapon system to be fielded. This weapon is employed in the forward combat area for defense of vital areas and small installations against the low-altitude air threat. It is also capable of effective engagement of hostile ground targets and waterborne targets.

Figure 78. Vulcan weapon system on armored carrier XM741.

Two Vulcan batteries are organic to the Chaparral/Vulcan air defense artillery battalion. Each battery is composed of 12 Vulcan fire units. Self-propelled Vulcan units will be assigned to infantry, armored, and mechanized infantry divisions, while the towed version is being programed for airborne and airmobile divisions and corps level units. The Vulcan battery is organized with three firing platoons of four fire units each. The weapon is manned by a squad of four men: squad leader, senior gunner, driver, and gunner/observer.

The self-propelled Vulcan XM163 (fig 78) consists of an electrically operated and fired, six-barrel, 20-mm cannon XM168; a fire control system with a range-only radar AN/VPS-2 and lead-computing sight XM61; an electrically operated, servo-controlled turret; a linkless ammunition storage and feed system; and a full-tracked armored chassis XM741.

The cannon can be fired at selected rates of either 1,000 or 3,000 rounds per minute. At the high rate of fire, burst length is controlled at 10, 30, 60, or 100 rounds as selected by the gunner. The linkless ammunition feed system (fig 79) and ammunition storage drum hold about 1,000 rounds of ammunition that can be fired before reloading is required. An additional 800 rounds is carried onboard the vehicle.

The fire control system, using range data, tracking angles and rates, and ballistic data, computes lead and superelevation and inserts this information into the sight. The gunner aims the cannon by using the servo controls in the mount to track the target in the sight reticle.

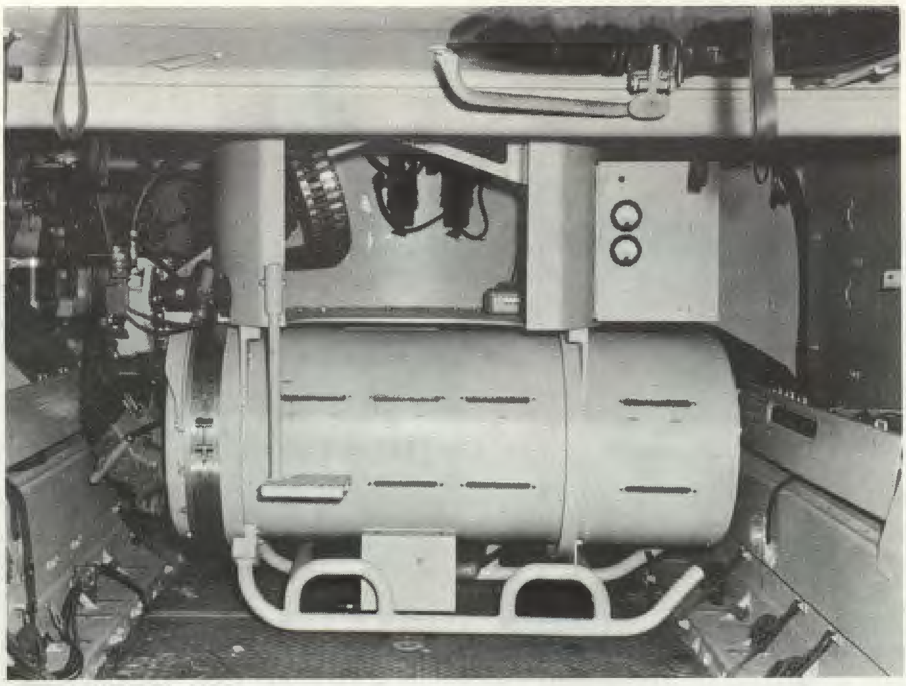


Figure 79. Vulcan linkless ammunition feed system.

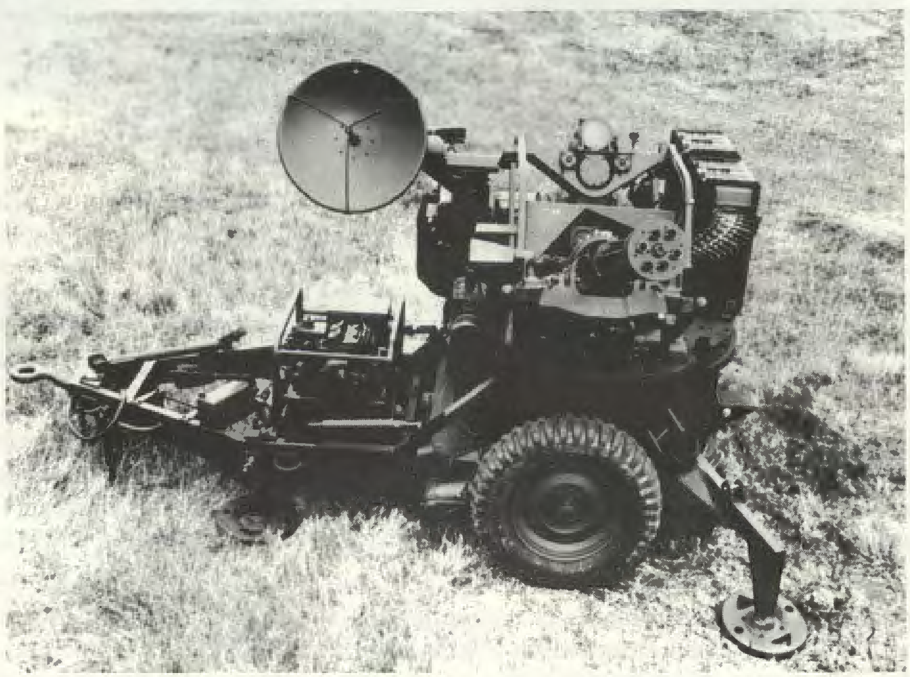


Figure 80. Towed Vulcan weapon system.

The towed version of Vulcan (fig 80) weighs 3,000 pounds and is air-transportable by cargo aircraft or helicopter. Firing capabilities and fire control are identical to those of the self-propelled version. This system uses a linked belt of ammunition and carries 400 rounds in a ready-to-fire configuration. Until the M561 (Gamma Goat) is available for issue, the 2-1/2-ton cargo truck M35A2 is the approved prime mover. It may be towed at speeds up to 45 mph over paved surfaces.

FORWARD AREA ALERTING RADAR

The forward area alerting radar (FAAR) AN/MPQ-49 is being developed to assist Chaparral, Vulcan, and Redeye in defending the forward battle area from low-altitude aerial attack. FAAR will detect and identify aircraft operating in the forward area and transmit target location and tentative identification to fire units.

Figure 81. Forward area alerting radar (FAAR).

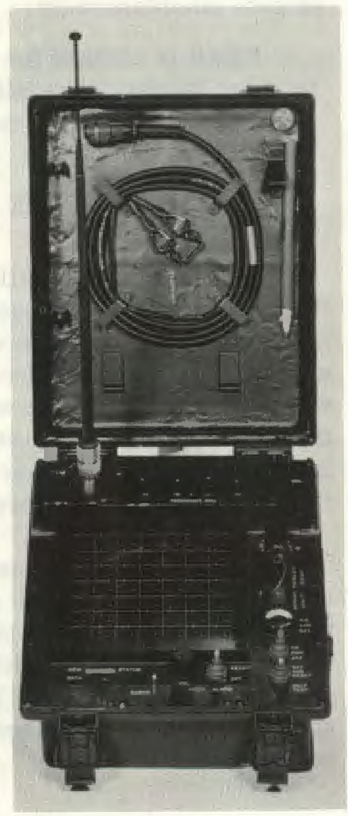


Figure 82. Target alert data display set AN/GSQ-137.

FAAR will consist of a lightweight, pulse-doppler radar (fig 81) mounted in a standard S-250 shelter and transported by a 1-1/4-ton truck (Gama Goat) M561. Power for the radar is provided by a 5-kilowatt generator set transported in a 3/4-ton trailer towed by the truck. Included in the system is the latest IFF equipment, AN/TPX-50, and a radiofrequency data link (RFDL) that sends target data to the target alert data display set (TADDS) AN/GSQ-137 located at fire unit sites.

FAAR is being designed to provide continuous coverage of the air defense space assigned Chaparral/Vulcan batteries and to be capable of detecting low-altitude targets in a heavy clutter environment. The onboard IFF equipment provides the ability to electronically challenge and identify all targets detected. Target location and identity are displayed on a plan position indicator (PPI). The radar operator actuates controls to electronically transmit target data to the TADDS located at each Chaparral and Vulcan platoon headquarters and each fire unit and to Redeye teams in the area.

TADDS (fig 82) is a lightweight FM receiver and display panel that receives and displays target data provided by the FAAR RFDL. The display is a matrix of 49 squares, each square containing two two-color disks. A green disk exposed within a square indicates the presence of a friendly target within the area represented by the square; a red disk represents a hostile or unidentified target within the area. The unit can display up to 49 friendly and 49 hostile targets simultaneously.

FAAR is planned for deployment as a platoon of 12 radar sections organic to headquarters and headquarters battery of the Chaparral/Vulcan battalion. Each FAAR section has one radar manned by a crew of three men: section chief, senior FAAR operator, and FAAR operator.

AIR DEFENSE ARTILLERY AUTOMATIC WEAPONS EMPLOYMENT

Since the end of hostilities in Korea, tactical doctrines have been revised and refined in the light of combat experiences and the improved capabilities of the materiel available for air defense. Also, the reorganization of the Army divisions imposed new requirements on air defense artillery units. This reorganization has increased the problem of providing a workable air defense for widely dispersed forward elements of the field army. These divisions require strong and effective air defense if they are to live and fight from day to day, Air defense artillery, now more than ever, must provide the active air defense of units in the forward areas to afford defense against air attack.

Much of the air defense of forward areas presumably will be furnished by missile systems; however, it may be expected that terrain features will result in air corridors below the radar horizon. This lack of air defense artillery radar coverage of the division front will provide the enemy with airspace in which to achieve surprise and in which aggressive air attacks may persist. These air corridors will be virtually uncontested avenues of approach, not only endangering forward area units, but air defense artillery and other support units as well.

To fill this missile gap at low altitudes and in the forward areas of the battlefield, air defense artillery automatic weapon units will form a definite part of the air defense. Gun-type air defense artillery weapons will provide the division with a defense against attack aircraft and airmobile forces. They also possess a secondary capability of attacking point surface targets, a capability well demonstrated during World War II and in Korea.

Aircraft should not be permitted to cross the forward edge of the battle area unobserved; therefore, the primary employment guideline for automatic weapons is to position the fire units well forward along the low-altitude routes of approach that are not effectively covered by other air defense artillery systems.

TWIN 40-MM SELF-PROPELLED GUN M42

The twin 40-mm self-propelled, full-tracked gun M42 is a lightly armored air defense artillery weapon. This vehicle (fig 83) was designed for employment with divisions for air defense, but because of its rapid rate of fire, it has also proved a valuable support weapon against ground targets. It has a cruising range of 100 miles at speeds up to 45 miles per hour, a fording depth of 40 inches, and a weight of approximately 25 tons.

Figure 83. Twin 40-mm self-propelled gun M42.

Major armament is the dual 40-mm automatic gun M2A1 on the mount M4E1. The 40-mm gun is a high-velocity, flat-trajectory, clip-fed, automatic-loading weapon capable of firing 240 rounds per minute. Also mounted on the M42 is a 7.62-mm machinegun M60. The cyclic functioning of each gun is automatic from the firing of one round to the next.

The welded armorplate gun mount is an open-topped cylinder in the center section of the vehicle. This mount, supported on a ball bearing race ring, can be traversed 360° in either direction by power (9 seconds) or manually (10.3° per crank revolution). Crew positions for the squad leader, gunner, and two cannoneers are in the gun mount.

Three sighting devices are incorporated into the fire control system: the computing sight M38, reflex sight M24C, and speed ring sight. The computing sight M38 is designed to provide an effective means of controlling fire of the 40-mm gun against either a vehicular or aerial target. The reflex sight M24C is designed to superimpose a reticle pattern in the gunner's line of sight and is used in conjunction with computing sight M38 during power operation. The speed ring sight is used during manual operation if a power failure or local control system malfunction occurs. It has a rear peep element and a series of concentric circles as a front element.

The communications system of the M42 gun consists of radio set AN/VRC-46, radio receiving set AN/GRR-5, an intercommunications set, and interphones. This equipment is shock mounted on support shelves in the driving compartment. The AN/VRC-46 is used for intervehicular and command communication, and the AN/GRR-5 provides air defense artillery intelligence.

The M13 periscope is used by the driver and commander while operating under combat conditions during daylight, and the M19 periscope, a binocular-type, enlarged-view device, is used when the vehicle is being driven under blackout conditions. Infrared rays are projected forward from the blackout headlights to illuminate the field of view. The M19 periscope converts the infrared image to a visible image which is viewed through conventional eyepieces.

MULTIPLE CALIBER .50 MACHINEGUN TRAILER MOUNT M55

The multiple caliber .50 machinegun trailer mount M55 (fig 84) is a power-driven, semiarmored gun mount with a self-contained power unit. The mount is constructed to accommodate four caliber .50, heavy barrel, turret-type Browning machineguns. It is equipped with reflex sight M18 through which the gunner may sight while seated in the gunner's seat inside the mount. The mounts are designed to be traversed through 360° and elevated through an arc of -10° to +90° from the horizontal. Power is directed by a pair of control handles placed directly in front of the operator's seat on the mount.

The caliber .50 Browning machineguns used on these mounts are air-cooled, recoil-operated guns and are fed by metallic link belts. It is fundamentally an automatic weapon fired by means of a solenoid and will automatically fire and load as long as pressure is applied to one or both triggers located in the control handles. The gun must be manually loaded and cocked for firing the first round.

The reflex sight M18 is a reflector sight of speed ring type and is the standard fire control device (direct sighting) for the M55 mount. The sight projects a reticle image, focused at infinity, upon an inclined glass plate. As the gunner looks through the inclined plate he sees the target and the reticle image. The reticle image consists of four concentric circles and three dots on a vertical line in the center of the field of view. The four concentric circles correspond to midpoint leads for speeds of 100, 200, 300, and 400 miles per

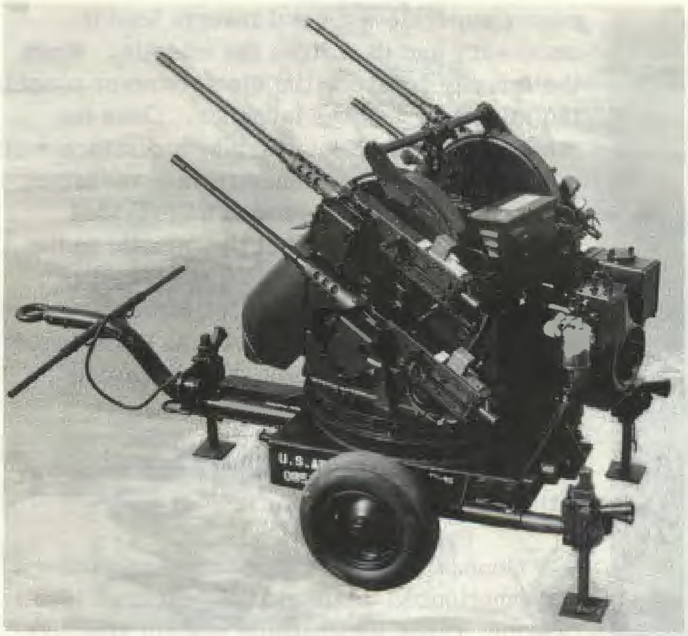


Figure 84. Multiple caliber .50 machinegun trailer mount M55.

hour at midpoint range of 1,000 yards, while the three dots are used to determine line of sight and to compensate for gravity pull on the projectile.

The primary mode of transportation for the M55 is emplacement in the bed of a 2-1/2-ton cargo truck. It may also be towed by a 1/4-ton vehicle. The mount weighs 2,950 pounds and is helicopter-transportable.

The weapon was designed to provide protection against low-flying aircraft in the forward area; however, it has proven extremely effective in the ground support role, especially in fire base security, convoy security, and airmobile operations.

REDEYE

The Redeye weapon (fig 85) is the first man-portable, shoulder-fired air defense system to be used for protection of frontline troops against attack by low-altitude aircraft. Redeye, which is being deployed with battalion/squadron and company/troop/battery units, is capable of engaging a wide variety of targets to include jets, helicopters, and reconnaissance aircraft.

The Redeye weapon is composed of two basic elements, a missile and a launcher. The missile comes sealed in the launcher and cannot be removed in the field except by firing. A shipping and storage container holds one missile and three battery/coolant units. A test set is provided for use at depots and ammunition supply points (fig 86).

The missile, stabilized by four fins at the rear and steered by two movable fins near the front, has an infrared homing guidance system, an eject motor and a sustainer motor, and a high-explosive warhead. The missile is fired from a launcher (fig 87) approximately 4 feet long and 3-1/2 inches in diameter. The Redeye weapon weighs about 29 pounds. It is operated by one man and requires a minimum of organizational maintenance.

The firing procedures are relatively uncomplicated and rapid (fig 88). After a quick go/no-go check, basically a visual inspection, the gunner is ready to engage hostile aircraft. On sighting an aircraft, identification is made and, if hostile, it is determined how best to engage the target. The gunner tracks the hostile target in the sight's range ring and, at the appropriate time, energizes the missile electronics. A vibrating acquisition indicator informs the gunner that the infrared seeker has locked on the infrared (IR) radiation being emitted by the aircraft. After insuring that the target is within range, the

Figure 85. Redeye in the field.

gunner superelevates and inserts lead if necessary and then fires the missile. When the missile is fired, the ejector motor propels the missile out of the launcher. Once the missile clears the launcher by a distance sufficient to protect the gunner from blast effect, the sustainer motor ignites and provides sufficient thrust to propel the missile to the target. The IR generated by the target provides the necessary signal for homing guidance. After firing, the gunner discards the launcher. In a training environment, the discarded launchers are salvaged for reuse. The Redeye weapon is employed by a two-man firing team which will have its own transportation and communications.

Gunner training includes nomenclature and functioning, maintenance, aircraft identification, range estimation, system effectiveness and limitations, siting requirements, tactics of low-flying aircraft, communications procedures, Redeye team tactics, command and control, weather and terrain effectiveness, and safety. This training is now being conducted in a 120-hour course. At the end of training, gunners participate in a range firing exercise with one out of every five gunners firing a live missile. Replacement gunners will be trained on a one-for-one basis. Qualified Redeye gunners are identified by an additional skill identifier.

The Air Defense School presently offers a 2-week Redeye Missile Systems Controller course for Redeye section headquarters personnel who then receive gunner training from the 1st Advanced Individual Training Brigade (Air Defense) at Fort Bliss. In addition, the Air Defense School and other combat arms schools conduct a 2-hour orientation course (prepared by the Air Defense School) for officers and supervisory personnel.

Since actual training cannot be conducted on the tactical hardware for all Redeye gunners, three training devices have been developed. One of these is guided missile training set M76 (fig 89) which consists of a tracking head trainer M49E3, a full-scale model identical to the Redeye weapon in weight, size, position of controls, and handling characteristics; four dry batteries; a battery charger; and storage container. When using the tracking head trainer, prelaunch infrared tracking and sensing capabilities are identical to the actual weapon. Another training device, the field handling trainer, contains no electronics and is used primarily to teach proper weapon handling.

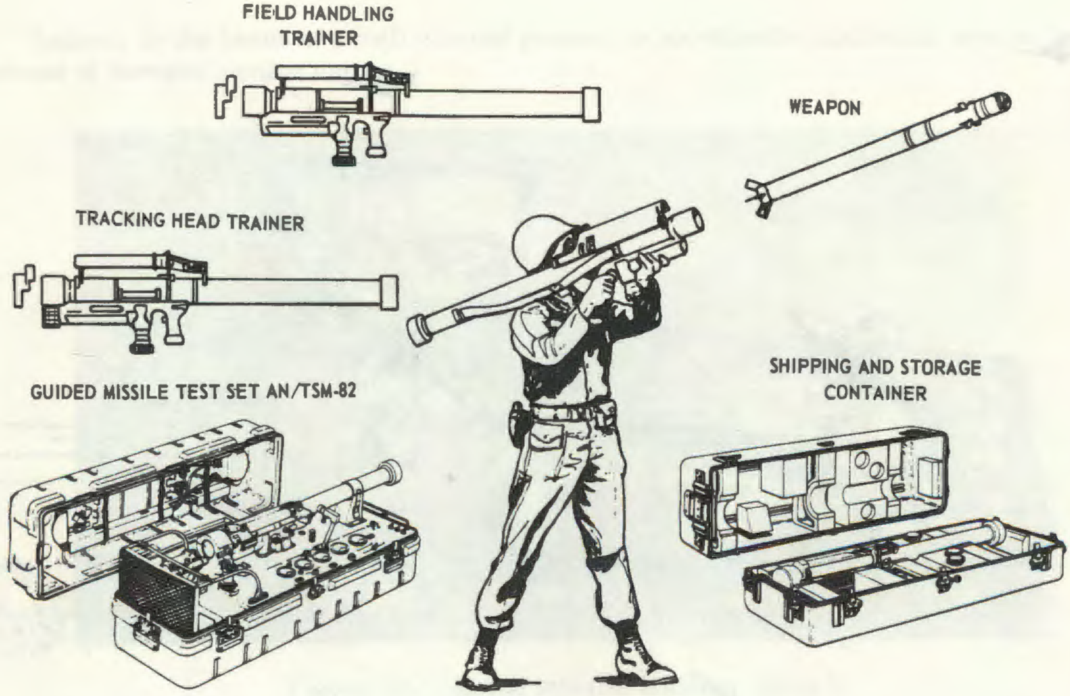


Figure 86. Redeye weapon system.

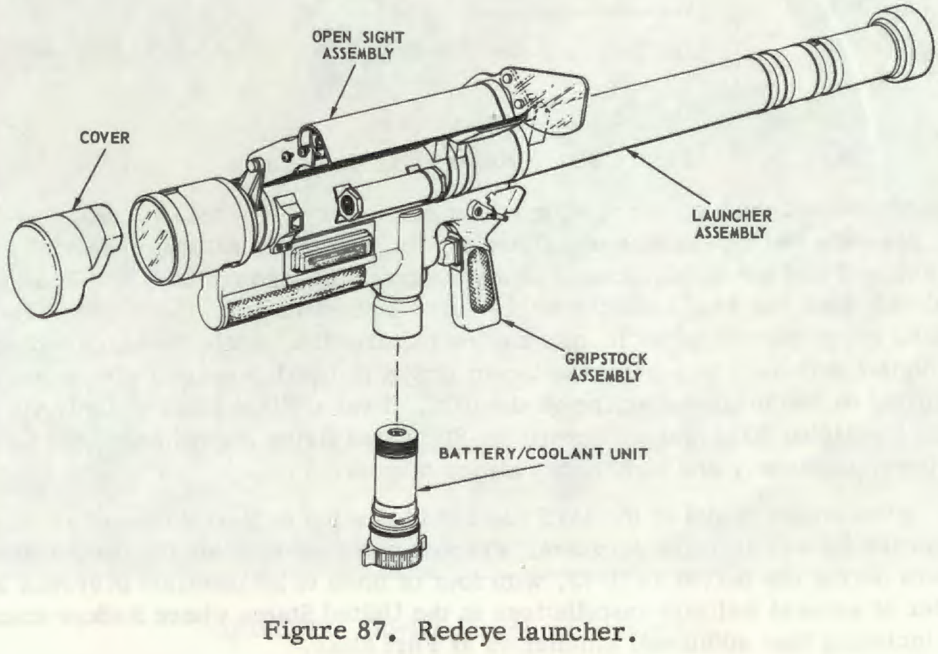


Figure 87. Redeye launcher.

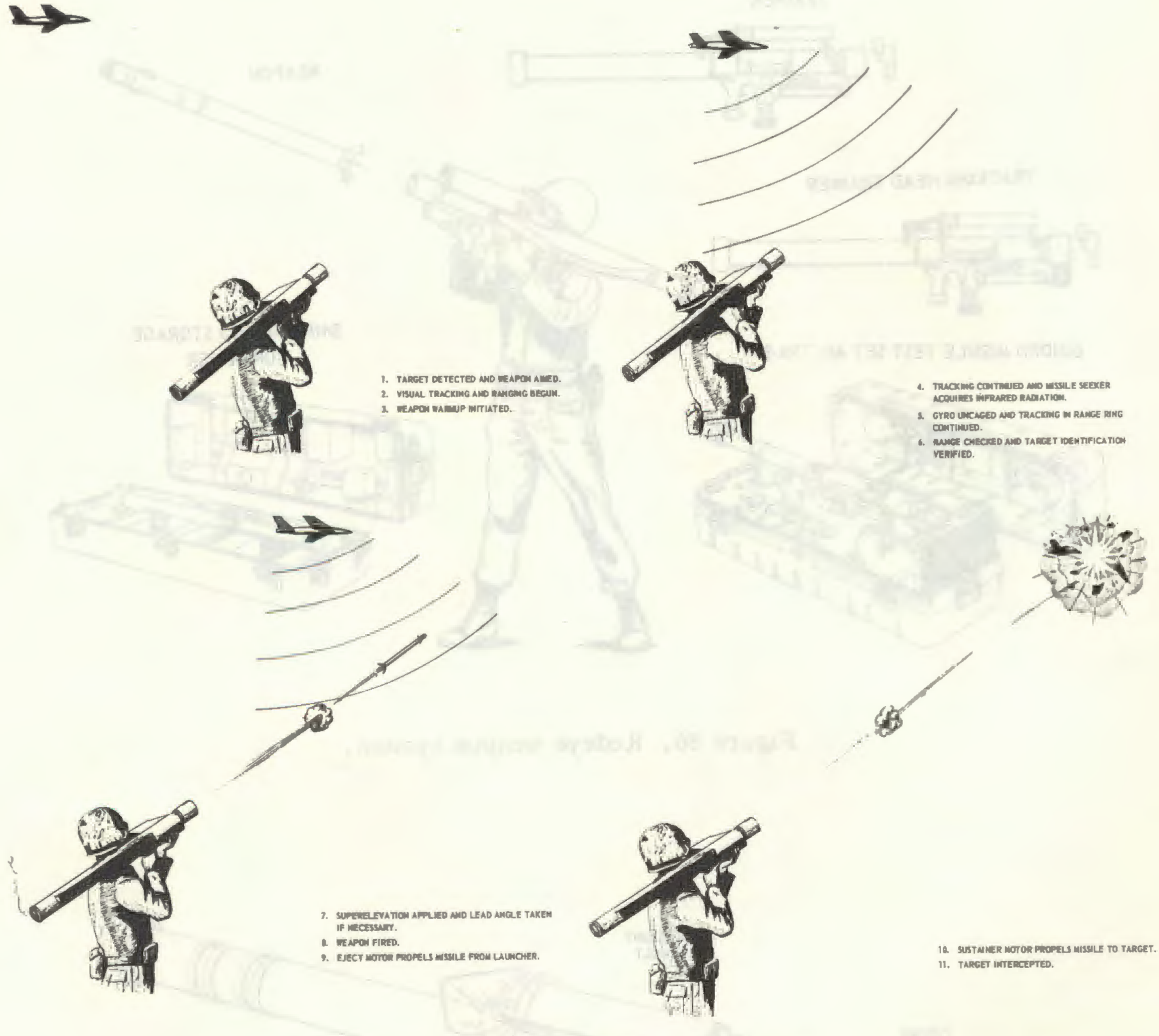


Figure 88. Redeye firing procedures.

A third training device, the moving target simulator (MTS) M87 (fig 90) now in production, presents the appearance of a flying aircraft against a natural spherical background 180° in azimuth and 90° in elevation. Using the tracking head trainer, the Redeye trainee is provided with realistic sound effects and infrared emissions from the target. The target image used for projection is on 16-mm motion picture film, while the target sound effects and the digital data used to control the target image projection system for each trajectory are recorded on two magnetic strips on the film. Twelve films are supplied with the simulator, each containing 20 target trajectories. Simulated firing engagements can be conducted against low-, medium-, and high-performance targets.

One development model of the MTS has been installed at Fort Bliss and is being used in support of the Redeye training program. Present plans provide for the procurement of 17 simulators during the period 1971-73, with four of them to be installed overseas and the remainder at several military installations in the United States where Redeye training is conducted, including four additional simulators at Fort Bliss.

Redeye, in the hands of a well-trained gunner, is an effective and lethal weapon for the defense of forward combat units.

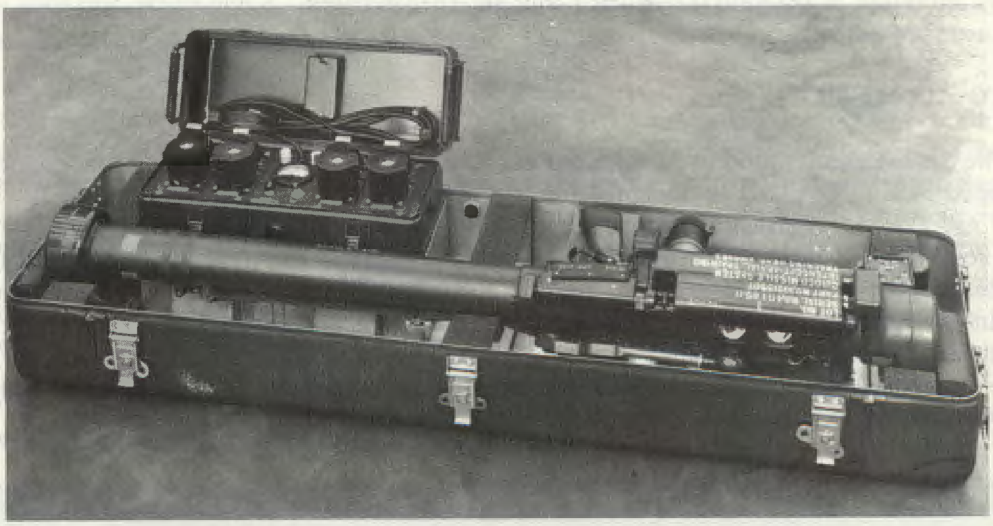


Figure 89. Guided missile training set M76.

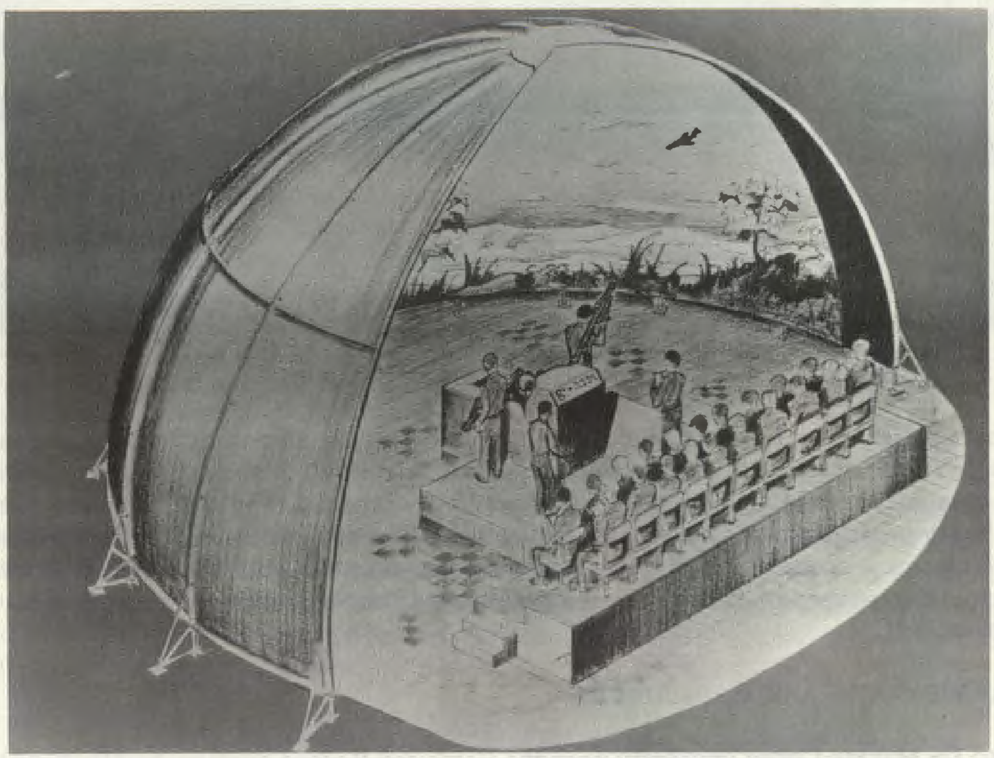


Figure 90. Moving target simulator M87.

ANTIAIR WARFARE WEAPONS OF THE US NAVY AND US MARINE CORPS

In fulfilling their antiair warfare (AAW) mission, the US Navy and the US Marine Corps employ missiles in both surface-to-air and air-to-air roles. Some of the weapons available are discussed below.

AIR-TO-AIR MISSILES

The Sidewinder, which uses infrared passive homing (heat-seeking) guidance, was developed by the Navy and is designed for use in attacks against jet aircraft. It is also used by the Air Force. Against a mach 2 target at 80,000 feet altitude, the missile has a range of approximately 8 miles. This solid-propellant missile is the first air-to-air missile to have destroyed aircraft under actual combat conditions, having been successfully employed by Chinese Nationalists in the defense of Quemoy in 1958 and by US forces in Vietnam. The Sidewinder (fig 91) is more than 9 feet long, weighs more than 155 pounds, and delivers a high-explosive warhead. Sidewinders are carried as armament in the F4 Phantom and F8 Crusader.

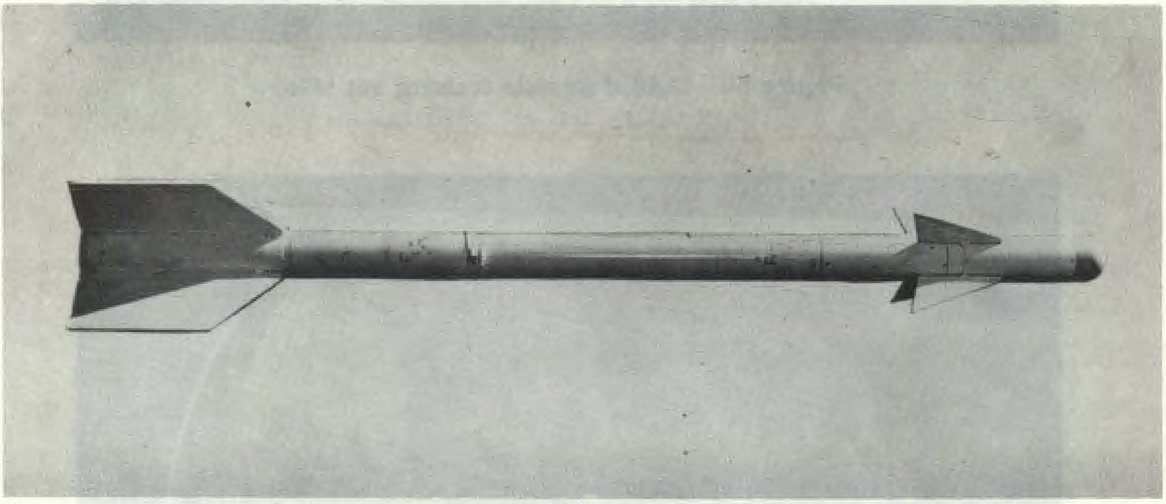


Figure 91. Sidewinder missile.

Sparrow III is the latest in this series of missiles. Its electronic homing guidance system permits attack of high-performance aircraft from all aspects, including head-on. An all-weather missile, its low-altitude capability, accuracy, and kill probability are excellent. Sparrow III is about 12 feet long and weighs about 400 pounds. This solid-propellant missile attains a speed of 1,500 miles per hour, has a ceiling of 90,000 feet, and employs a high-explosive warhead. Sparrow is carried aboard the Navy's all-weather fighter, the F4B Phantom II.

US MARINE CORPS AAW CAPABILITIES

The US Marine Corps currently uses the Hawk and Redeye surface-to-air missile systems described herein. In addition, the Marine Tactical Data System (MTDS) (fig 92) is employed as a component part of the Marine integrated antiair-warfare system to automatically collect, store, and process data relating to the AAW battle. MTDS further enables positive control, rapid and accurate decision making, and dissemination of commands and information to ground and Naval surface-to-air missile (SAM) units, fighter-interceptor aircraft, and other AAW elements.

MTDS has proven itself by more than 2-1/2 years of outstanding combat service in Vietnam. In its first year in Vietnam, the system operated more than 10,000 hours with no downtime attributed to the system itself despite the problem usually attendant to deploying a complex new electronic system into a combat area. More than 55,000 aircraft received navigational assistance during this first year, with a record total of 16,000 assists provided during a 1-month period. The tactical data communications central (TDCC) component of the system has also been deployed to Vietnam, giving the Marine Corps the capability to exchange real time digital data to the NTDS ships in the Tonkin Gulf, ATDS aircraft, and the Air Force BUIC system. It has also functioned in the Republic of Vietnam as an alternate CRC for the Air Force. The TDCC has proven extremely reliable and has been extensively utilized in working with both Navy and Air Force in Vietnam.

NAVY SURFACE-TO-AIR MISSILES

Terrier (fig 93) has been operational with the US Fleet since 1956. It uses beam-rider or homing guidance, is 13 inches in diameter and about 27 feet long, and, with booster, weighs about 3,000 pounds. It has a range of 40 miles up to an altitude of 80,000 feet and carries a high-explosive or nuclear warhead. This missile is fired in a sequence that is automatic from selection of the ready round in the magazine through launching; only seconds are required for the entire sequence. These missiles are currently operational on cruisers, destroyers, and a few carriers.

Talos, a surface-to-air, beam-riding missile (fig 94) uses a solid-fuel rocket motor for boost and a ramjet engine sustainer to attain a range of 100 miles. Talos is 30 inches in diameter and 32 feet in length and weighs 3,000 pounds (more than 7,000 pounds including booster). First fired at sea in 1959, the missile delivers a high-explosive or nuclear warhead at supersonic speed up to 80,000 feet altitude.

Tartar (fig 95) is designed for use on destroyer-type ships of the fleet. It is effective against both low- and high-altitude targets and carries a high-explosive warhead to a range of 17 miles and up to 65,000 feet altitude. A dual-thrust, solid-propellant rocket accelerates the missile to supersonic velocity. Its overall length is about 12 feet, and its diameter is slightly more than 1 foot. Tartar is used as a secondary battery aboard Talos-equipped cruisers.

Sea Sparrow, a short-range, basic point-defense surface missile system, uses a modified Sparrow missile and its control radar. The concept of operation is essentially the same as the airborne Sparrow system.

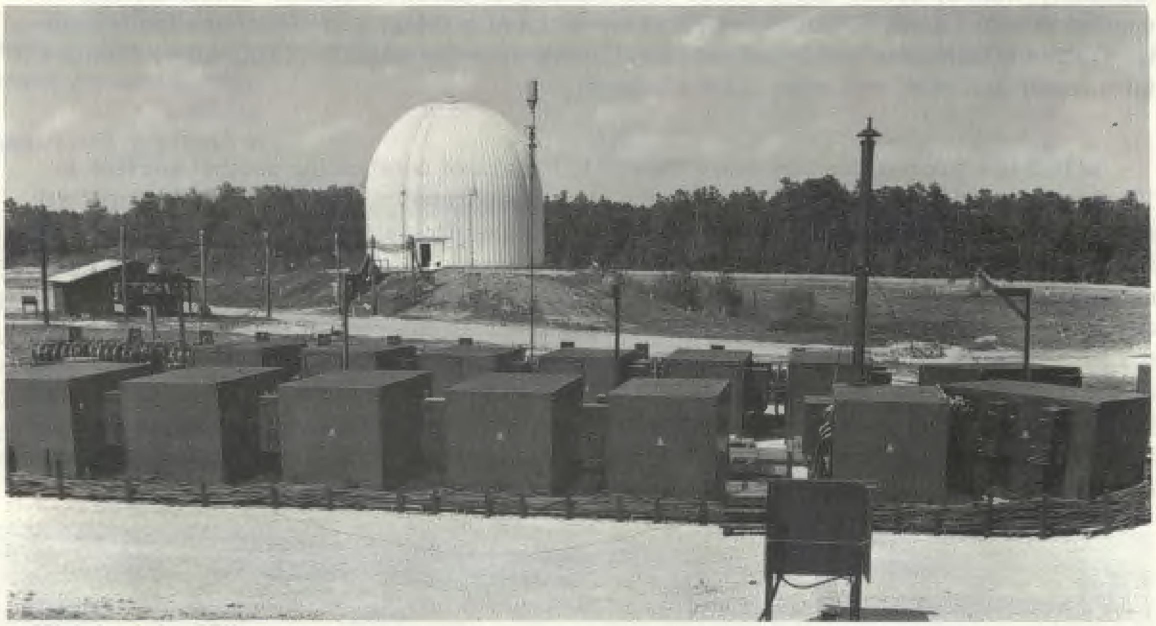


Figure 92. Marine Tactical Data System and associated AN/TPS-34 three-dimensional radar.

Figure 93. Terrier missile batteries on U.S.S. Boston.

Figure 94. Talos missile battery on guided missile cruiser U.S.S. Galveston.

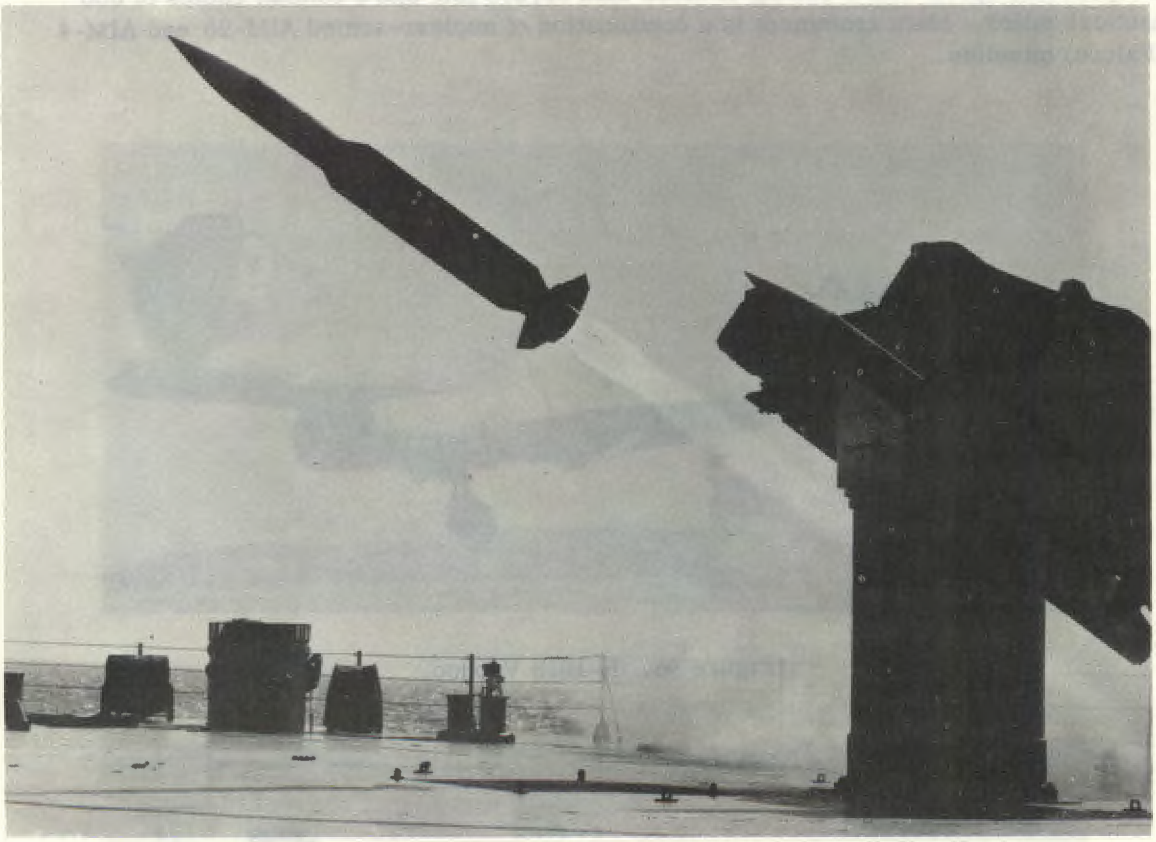


Figure 95. Tartar missile being fired from U.S.S. Norton Sound.

AIR DEFENSE WEAPONS OF THE US AIR FORCE

AEROSPACE DEFENSE COMMAND INTERCEPTORS

The USAF Aerospace Defense Command employs three types of all-weather interceptors plus a variety of air-to-air missiles and rockets to accomplish its mission and act as a deterrent air defense force.

The F-101B Voodoo (fig 96) can develop a speed of mach 1.2 at 40,000 feet with a ceiling of more than 50,000 feet and a combat radius of 600 nautical miles. This interceptor is armed with a combination of AIR-2 (Genie) nuclear rockets and AIM-4 (Falcon) missiles.

The F-102 Delta Dagger (fig 97) was the world's first supersonic all-weather jet interceptor and the first to incorporate the area rule (coke bottle) fuselage design. Using all electronic equipment, the radar locks on the target and, at the right instant, the electronic fire control system automatically prepares and fires its weapon. Operational data show a supersonic speed with a ceiling of more than 50,000 feet and a combat radius of 600 nautical miles. Main armament is a combination of nuclear-armed AIM-26 and AIM-4 (Falcon) missiles.

Figure 96. F-101B Voodoo.

Figure 97. F-102 Delta Dagger.

The F-106A Delta Dart (fig 98), evolved from the F-102 Delta Dagger, has a more powerful engine; a redesigned tail, fuselage, and fuel tank; and improved electronics and armament. The aircraft's electronic guidance and fire control system has the capability of flying the aircraft soon after takeoff through a cruise position to an attack position, detecting targets, firing at optimum range, and immediately breaking off to seek other targets. At one time, the F-106A held the world speed record at 1,525.9 miles per hour. Its combat radius is 600 nautical miles. The F-106A is armed with AIR-2 (Genie) rockets and AIM-4 (Falcon) missiles. Many other jet aircraft, including the F-100, F-105, F4C, and F5A, can be used as fighters or interceptors; however, their prime mission is as fighters.

Figure 98. F-106A Delta Dart.

AIR-TO-AIR MISSILES

The primary armament of interceptor aircraft is air-to-air missiles. The Falcon family (fig 99) of air-to-air missiles comprises the smallest USAF guided missiles in production, having a length of approximately 6 feet, a diameter of about 6 inches, and a weight of about 100 pounds. Five basic versions of the Falcon have been produced. Some use radar-homing guidance; others use infrared homing. All have solid-propellant rocket motors. One later model has a nuclear warhead. All of the missiles have supersonic velocity (mach 2 plus the speed of the aircraft), a ceiling above 50,000 feet, and a range greater than 5 miles.

Figure 99. Falcon family of missiles (left to right): nuclear-capable AIM-26A, infrared AIM-4, radar homing AIM-4A, radar homing AIM-4E, and infrared AIM-4F.

AIM-26A, an advanced version of the Falcon family, combines the nuclear capability of the AIR-2 with AIM-4A accuracy. Carrying a small-yield nuclear warhead, its semiactive radar guidance system enables low-altitude intercept. The AIM-26A can be used on all F-102 aircraft.

AIR-2A, popularly known as Genie (fig 100), is an air-to-air rocket that carries a nuclear warhead. It is unguided and uses a solid-propellant rocket motor. Genie is carried in the missile bays of the F-101 and F-106. The missile has a length of 10 feet, a diameter of 17 inches, and a weight of approximately 800 pounds. The missile reaches supersonic velocity (mach 3. plus the speed of the aircraft) and can destroy targets at altitudes above 50,000 feet and at ranges of about 10 miles.

Figure 100. Genie rocket being loaded on F-106A Delta Dart.

SURFACE-TO-AIR MISSILES

The CIM-10B (Bomarc) missile resembles an aircraft in configuration (fig 101 and uses a solid rocket booster and two supersonic ramjet engines to develop speeds in excess of mach 2 and reach altitudes above 70,000 feet. It is guided from the ground to the vicinity of the target by commands from the SAGE system. As the missile approaches the target, a homing guidance system on the missile takes control and steers the missile to intercept. The nuclear warhead is detonated by a proximity fuze. Bomarc has a wing span of 18 feet, a length of about 57 feet, a height of 10 feet, a weight of about 15,000 pounds, and a range in excess of 400 nautical miles.

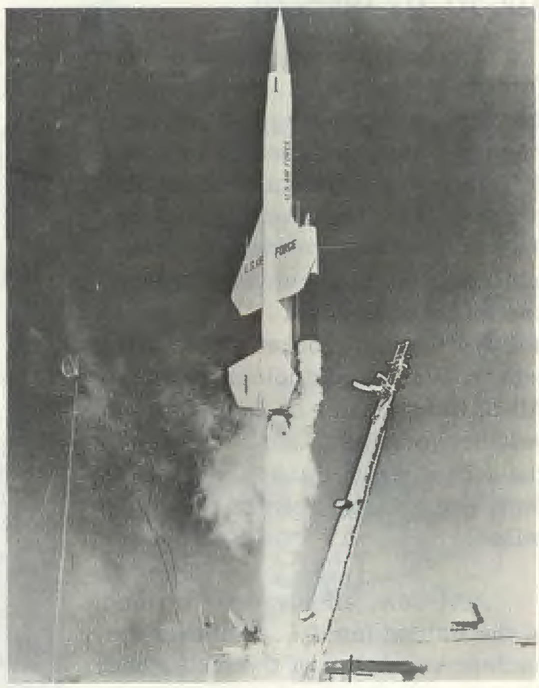


Figure 101. CIM-10B (Bomarc) missile at instant of firing.

Chapter 4
Proposed Air Defense Artillery Systems

SAFEGUARD BALLISTIC MISSILE DEFENSE SYSTEM

In September 1967, Secretary of Defense McNamara made public the decision to deploy a light ballistic missile defense for the United States against a possible nuclear attack by China in the mid-1970's. Thus, the decision was made to begin a production of a thin ballistic missile defense for the United States. The system was named Sentinel, and production was begun by the end of 1967.

The program progressed steadily during the period November 1967 through March 1969. A system manager at Department of the Army general staff level was appointed, and commands to administer, develop, support, and evaluate the system were organized. A Centralized Training Facility, consisting of ordnance, engineer, and air defense artillery components, was established at the US Army Air Defense School. Research and development activities continued to prove the feasibility of the system as evidenced by the activation of a prototype missile site radar at Kwajalein Missile Range and successful test firings of Spartan missiles at Kwajalein Missile Range and Sprint missiles at White Sands Missile Range.

During the period January-March 1969, the Sentinel program was reevaluated by the Administration and decisions were made by the President to alter the program and initiate a phased deployment program instead of the package deployment initially planned. The emphasis was shifted to defense of our land-based offensive retaliatory forces. As a result of these changes in the program, the name was changed from Sentinel to Safeguard.

President Nixon, on 14 March 1969, in announcing his decision to deploy the Safeguard ballistic missile defense system, said:

> "After carefully considering the alternatives, I have reached the following conclusions: (1) The concept on which the Sentinel program of the previous administration was based should be substantially modified, (2) the safety of our country requires that we should proceed now with the development and construction of the new system in a carefully phased program, (3) this program will be reviewed annually from the point of view of (a) technical developments, (b) the threat, (c) the diplomatic context including any talks on arms limitation.
>
> "The modified system has been designed so that its defensive intent is unmistakable. It will be implemented not according to some fixed, theoretical schedule, but in a manner clearly related to our periodic analysis of the threat. The first deployment covers two missile sites; the first of these will not be completed before 1973. Any further delay would set this date back by at least 2 additional years. The program for fiscal year 1970 is the minimum necessary to maintain the security of our Nation.

"This measured deployment is designed to fulfill three objectives:

1. Protection of our land-based retaliatory forces against a direct attack by the Soviet Union.

2. Defense of the American people against the kind of nuclear attack which Communist China is likely to be able to mount within the decade.

3. Protection against the possibility of accidental attacks from any source."

Two Safeguard sites are presently under construction at Malmstrom Air Force Base and Grand Forks Air Force Base.

The hardware in the Safeguard system, a derivative of Nike X, is made up of two phased-array radars, a digital data processing system, power generation and environmental equipment, and two interceptor missiles. The multifunctional radars are housed in hardened structures. Phased-array radars differ from conventional radars in that directional control of the radar beam is accomplished by electronic switching of the many small radiating devices in the face of a stationary antenna array as opposed to the mechanical rotation of a conventional radar antenna.

The perimeter acquisition radar (PAR) (fig 102) is a long-range search radar. The PAR has common apertures for transmitting and receiving. Its purpose is to detect targets and secure position data of the targets in sufficient time to pass this early warning information to the missile site radar (MSR) which will utilize the interceptor missiles, Sprint and Spartan, to engage the target.

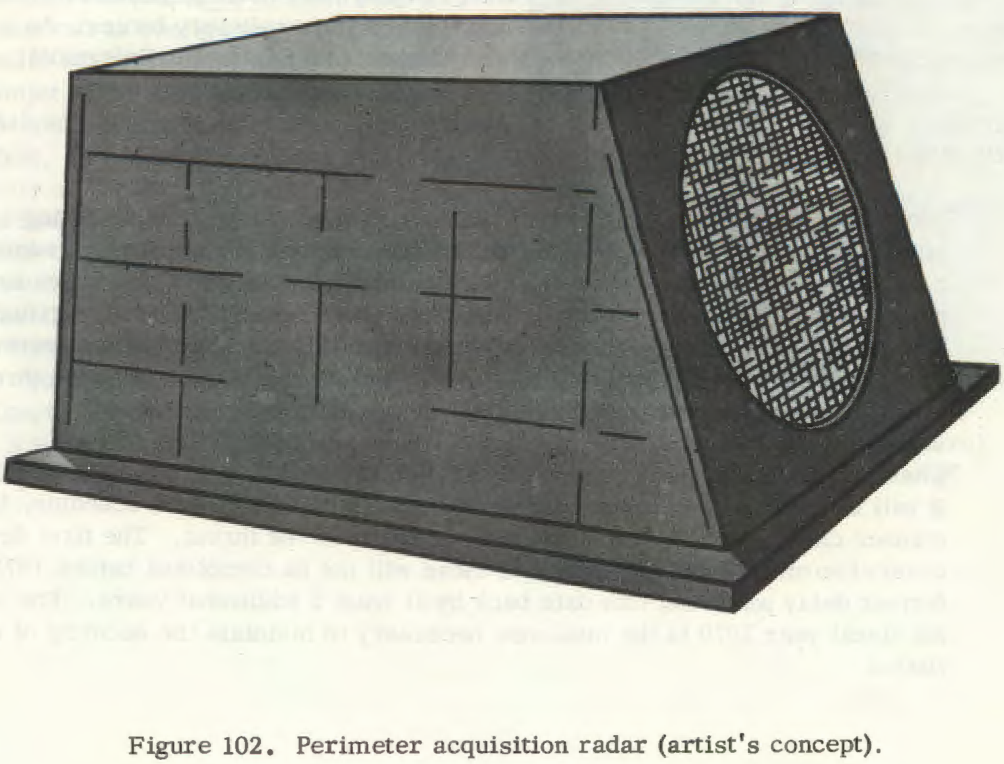


Figure 102. Perimeter acquisition radar (artist's concept).

The missile site radar (MSR) is a shorter range radar housed in a semiunderground, three-story building, approximately 240 feet square (fig 103). It uses the same antenna array for both transmitting and receiving. The primary purpose of the MSR is to perform missile and target tracking functions; however, it will have other built-in modes of operation which will be controlled automatically.

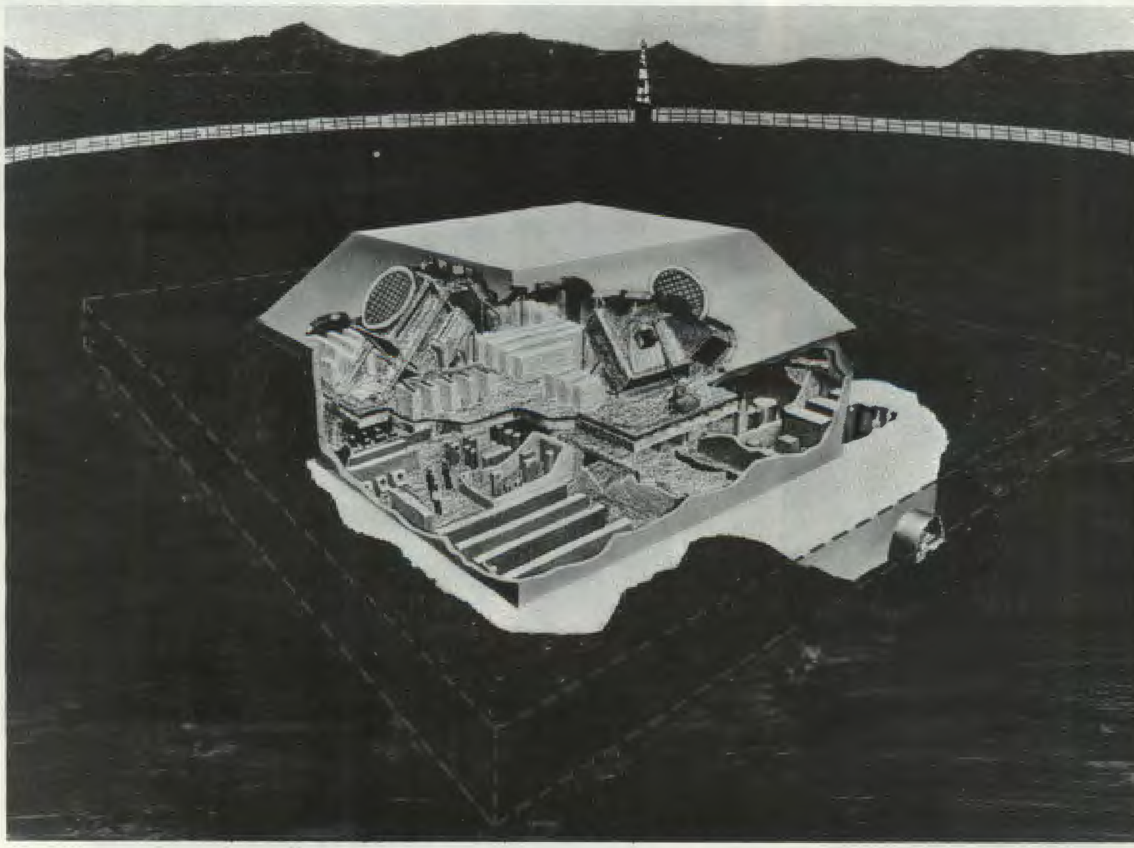


Figure 103. Missile site radar (artist's concept).

The data processing system directs the radars, both PAR and MSR, in their data-gathering functions. In addition, any information that is acquired by the radars is processed and analyzed by the data processing system. The data processing system will determine required functions, and through man-machine interface equipment, provide the means to execute defense operations within the stringent time requirements. If any action or response is required, it will be initiated by the data processing system, either automatically or through manual actions. These operations will be in the form of command and control functions to the system sensors (radars), the system reactors (missiles), or to other elements of the Safeguard system, such as the fire coordination center or the ballistic missile defense center.

The Spartan missile (fig 104) is a three-stage, solid-propellant missile used for long-range intercepts outside the atmosphere. It delivers a nuclear warhead and is used as an area defense weapon. It is emplaced vertically in an underground launch cell (fig 105).

Figure 104.
Spartan missile
(artist's concept).

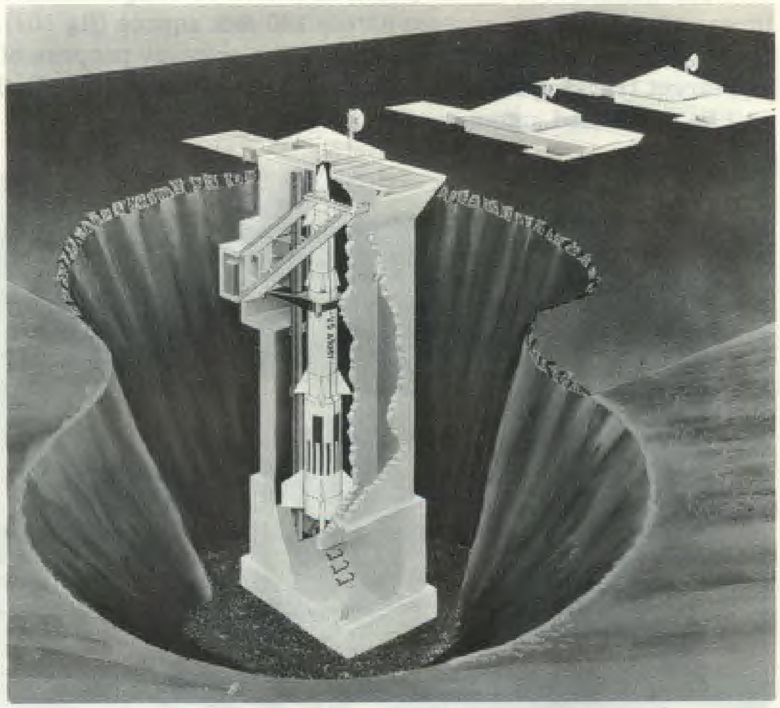


Figure 105. Spartan missile in launch cell (artist's concept).

Figure 106. Sprint missile (model).

The Sprint missile (fig 106) delivers a nuclear warhead at great speed within the earth's atmosphere to target intercept. It is used as a local defense weapon and, like the Spartan, is emplaced vertically in an underground launch cell (fig 107). The complement of missiles for an MSR site is called the Spartan and/or Sprint missile farm.

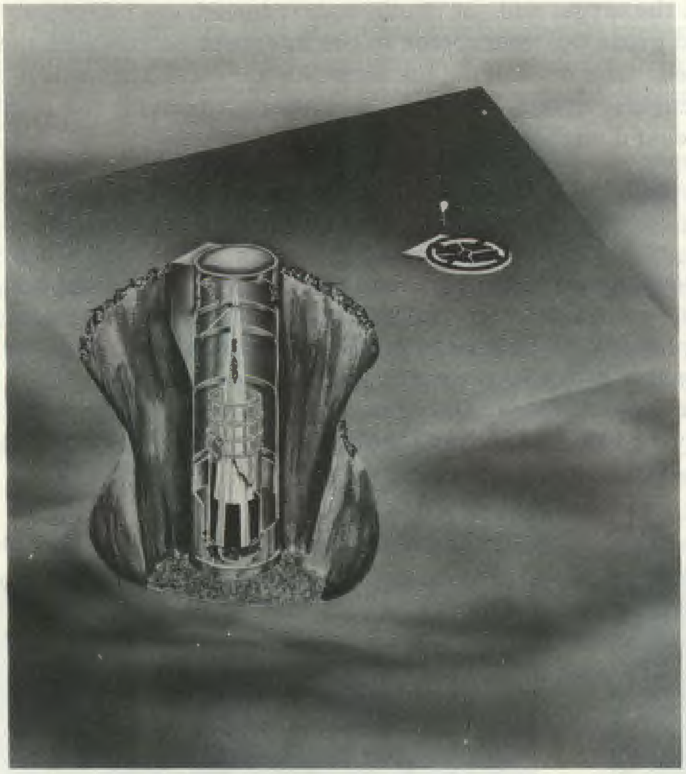


Figure 107. Sprint missile in launch cell (artist's concept).

Figure 108. Sprint firing.

The tactical support equipment includes the on-site powerplant and environmental control equipment. Power requirements for a PAR or MSR site vary from about 10 to 20 megawatts. Much of the radar and data processing equipment and the missiles require environmental control.

The nature of the sophisticated missile attack against which the Safeguard system must defend requires that the reaction time of the system—from a standby mode to a full engagement mode—approach zero. These criteria place stringent demands on the design of the Safeguard system. The radars must be capable of continuous operation in the surveillance mode. The Spartan and Sprint ballistic missiles must be maintained in a ready-to-fire condition at all times. A single failure within the system must not cause the entire system to fail. Individual failures must be correctable while the system is operating in other than the engagement mode. Critical time to repair must be reduced by automatic fault detection which will quickly localize the fault to a replaceable unit. Finally, a capability must be provided for self-sufficient operation in a nuclear environment.

A typical sequence of events during an engagement would be as described below:

The PAR would locate the incoming object in space and relay this information to the fire coordination center. The fire coordination center, upon receipt or autonomous initiation of a hostile identification of the target, will assign the target to an MSR operating under its control. The MSR would precision track the target and, at man's order, launch the intercept Spartan or Sprint missile (fig 108) and guide the interceptor to the intercept point where the interceptor warhead would be detonated, thus destroying the incoming target. Throughout this sequence of events, the data processing system would be continually resolving the complex problems associated with a successful engagement.

SAM-D

SAM-D (surface-to-air missile development) will be an air defense system for use in both battlefield and continental air defense against high-performance aircraft and short-range missiles (fig 109). SAM-D can be deployed as a battery to provide defensive coverage over a sector. A fire section, which will consist of one fire control group and several launchers, may be detached from the major control elements for autonomous operation. A battery in the field will be mounted on approximately 12 vehicles and will include these main elements: fire control, launcher, battery control, and communications groups.

(1) Mobile radar.

(2) Mobile launcher (artist's concept).

Figure 109. SAM-D air defense system.

A fire control group contains a radar, a weapon-control computer, communications, and prime power on the same vehicle. The multifunction phased-array radar will perform all of the functions requiring several radars in other systems. It will detect targets, acquire them, track them, and track and issue guidance commands to the missile in flight.

The battery control group will coordinate firings within a battery and serve as a communications center. It houses a computer for handling high data rates, and for processing and coordinating information between radars and passing on fire control information.

The launcher group will carry several single-stage, solid-propellant missiles in launching-shipping containers. The missile is cradled within the canister supported by teflon-coated launch rails. At launch, the motor blast shatters the rear plastic cover and the missile breaks through the forward plastic cover. The system is capable of firing missiles from their canisters either singly or in close-sequence salvos at selectable azimuths and elevations.

The missile, controlled by four aerodynamic tail surfaces powered by control actuators, can carry either a high-explosive or nuclear warhead. It is segmented into nose, warhead, guidance, motor, and control sections.

Special features are being incorporated into SAM-D early in the design phase to contribute to, and prolong, operational capabilities. These include a built-in self-test and fault-isolation capability, redundant circuitry, use of reliable solid-state devices, missiles that require no on-site maintenance, and backup maintenance and supply facilities to perform repairs as close to the origin of failure as possible. In addition, the operators of SAM-D will be trained to use the fault-isolation equipment and replace certain faulty components without calling for maintenance assistance.

Chapter 5
Air Defense Artillery Training Matters and Instruction

NONRESIDENT INSTRUCTION

ARMY CORRESPONDENCE COURSE PROGRAM

The Army Correspondence Course Program of the US Army Air Defense School provides home-study courses in air defense subjects and related subjects for members of Army components, members of other services, and eligible civilian employees of any agency of the Federal Government. The program consists of career development courses for officers and enlisted men and special correspondence courses that provide knowledge for particular job assignments. A course consists of a number of subcourses, each of which deals with a specific subject area.

Officer career development courses parallel as closely as possible the resident career courses (basic and advanced) presented by the US Army Air Defense School. Reserve officers may complete the basic or advanced course by correspondence or by a combination of resident instruction and correspondence.

Enlisted career courses provide assistance in improving job knowledge and performance, in qualifying for promotion, and in preparation for evaluation tests in MOS career group 16 (air defense artillery). A transition subcourse is provided for MOS career group 24 (air defense missile electronics maintenance) to MOS 16Z50, air defense artillery senior sergeant. Also, an air defense artillery senior NCO career development course is provided to qualify NCO's for enrollment in the Command and General Staff College special correspondence course for sergeants major and operations sergeants.

Special correspondence courses provide knowledge required for particular assignments. For example, a preparatory course is provided for those officers who anticipate attending the resident Air Defense Artillery Officer Basic Course and a transition course is provided for officers transferring to the air defense artillery branch from another branch.

Eligible personnel may enroll in any individual subcourse offered by the US Army Air Defense School. Individual subcourses of interest to battery support personnel are in the areas of leadership and supervision, communications, wheeled vehicle repair, administration, supply, and mess. Individual subcourses of special interest to civilian employees of the Federal Government are in the areas of effective writing, finance, personnel records, automatic data processing, electronic maintenance, motor maintenance, and managerial skills.

Correspondence course students may enroll in a group study program and study together under a study leader. Group study provides an opportunity for two or more individuals with common educational or occupational interests and needs to study together and participate in joint discussions and critiques for mutual benefit. Group study provides commanders at all echelons with an additional instructional medium which may be tailored to meet requirements for training individuals.

USAADS Pamphlet 350-8, Correspondence Courses Catalog, lists all courses and subcourses offered by the NRI Department of the School. This pamphlet also explains enrollment and administrative requirements and procedures. For a copy of USAADS Pamphlet 350-8, or additional information about the correspondence course program or group study, write to: Commandant, US Army Air Defense School, Box 5300, ATTN: NRI Department, Fort Bliss, Texas 79916.

INSTRUCTIONAL MATERIAL FOR RESERVE COMPONENT STAFF TRAINING

The School publishes annually a Special Catalog of Staff Training Material for Reserve Components. The catalog lists units of instruction recommended by the School and available from correspondence courses, bookstore, resident units of instruction, or USAR School material. The catalog gives prices of the material and instructions for ordering.

MONTHLY LIST OF INSTRUCTIONAL MATERIAL

The School publishes a monthly list of instructional material primarily for use by instructors at Army service schools and Army instructors at other service schools. This material assists in the preparation of subject matter, and insures correctness and timeliness of doctrine. This list is also sent to Army National Guard advisors, MAAG's, missions, and other selected agencies.

ROTC SUPPORT PROGRAM

The US Army Air Defense School provides orientation instructional material for college institutions offering general military science in their ROTC program. For collegiate institutions offering Air Defense Artillery branch training in their ROTC program, subject schedules are prepared and supporting instructional material is provided.

USAR SCHOOL AIR DEFENSE ARTILLERY PROGRAM

The USAR School Air Defense Artillery program provides a means for Reserve officers not on active duty to complete the Air Defense Artillery Officer Basic or Advanced Course primarily by classroom instruction. Common subjects subcourses are presented at USAR schools. ADA subjects are presented at the US Army Air Defense School during 2-week periods of annual active duty training. Three 2-week periods are required for the basic and advanced courses. An additional 2-week period of annual active duty training is required for the Advanced Course; however, this may be completed by correspondence. Reserve officers desiring information about the USAR school program should contact the USAR school in their area.

TRAINING LITERATURE

The US Army Air Defense School has the responsibility for preparing all Army-wide, applicatory-type, air defense artillery training literature published as field manuals, training circulars, DA pamphlets, Army training programs, Army training tests, and MOS and non-MOS Army subject schedules. The School is also responsible for preparing training literature pertaining to the all-arms Redeye guided missile system.

Training literature prepared by the US Army Air Defense School and published and distributed by Department of the Army since April 1969 follows:

FM 44-1-1	U.S. Army Air Defense Artillery Operations (Oct 69)
(C) FM 44-4A	Procedures and Drills for Chaparral Self-Propelled Weapon System (Aug 69)
FM 44-19	Qualification Program, Air Defense Artillery Weapon Systems (Apr 70)
FM 44-62	Air Defense Artillery Automatic Weapon Gunnery (Aug 69)
(C) FM 44-82A	Procedures and Drills for Nike Hercules Missile Battery (U) (Jun 70)
FM 44-99	Procedures and Drills for Hawk Missile Battery (Towed and Self-Propelled) (May 69) and Change 1 (Apr 70)
FM 44-100	Procedures and Drills for Vulcan Towed Weapon System (Feb 70)
TM 44-210	Digital Computers (Feb 70)
ASubjScd 23-17	Redeye Gunner and Air Defense Section Training (May 69)
ASubjScd 44-5	Reconnaissance, Selection, and Occupation of Position for Air Defense Artillery Units (Sep 69)
ASubjScd 44-6	Air Defense Artillery Forward Area Alerting Radar Platoon (Jun 69)
ASubjScd 44-10	Air Defense Section, Airspace Control Element, Tactical Operations Center (Nov 69)
ASubjScd 44-12	Air Defense Artillery Service Practice Procedures (Jan 70)
ASubjScd 44-14	Automatic Weapon Section (M42) (Sep 69)
ASubjScd 44-17, Change 1	Machinegun Squad (M55) (Jun 69)
ASubjScd 44-33	Assembly and Monitoring Team (Missile Warhead Support Detachment) (Jun 69)
ASubjScd 44-34	Hawk Self-Propelled Platoon (Oct 69)
ASubjScd 44-41	Communications Section (Jun 69)
ASubjScd 44-42	Air Defense Artillery Communications (Jul 69)

ASubjScd 44-00G20	Advanced Individual Training and Refresher Training of Target Aircraft Crewman, MOS 00G20 (Jan 70)
ASubjScd 44-16D10	Advanced Individual Training and Refresher Training of Hawk Missile Crewman, MOS 16D10 (Feb 70)
ASubjScd 44-16E10	Advanced Individual Training and Refresher Training of Hawk Missile Fire Control Crewman, MOS 16E10 (Feb 70)
ASubjScd 44-16F10	Advanced Individual Training and Refresher Training of Light Air Defense Artillery Crewman, MOS 16F10 (Jul 69)
ASubjScd 44-16R10	Advanced Individual Training and Refresher Training of Chaparral/Vulcan Crewman, MOS 16R10 (Apr 70)
ATP 44-8	Air Defense Artillery Target Detachment (Jul 69)
ATP 44-85	Air Defense Artillery Automatic Weapon Units (Jul 69)
ATP 44-235	Air Defense Artillery Battalion, Hawk (Jul 70)
ATP 44-325	Air Defense Artillery Battalion, Chaparral/Vulcan, Self-Propelled (Jul 70)
ATP 44-725	Air Defense Artillery Battalion, Chaparral (Self-Propelled)/ Vulcan (Towed) (Jun 70)
ATT 44-85	Air Defense Artillery Automatic Weapon Units (Jul 69)
ATT 44-235	Air Defense Artillery Missile Units (Hawk) (Apr 70)
ATT 44-725	Air Defense Artillery Battalion, Chaparral (Self-Propelled)/ Vulcan (Towed) (Jun 70)

Training literature being prepared by the US Army Air Defense School or already forwarded to US Army Publications Agency for printing and distribution, which will be published during 1970 according to the present schedule, includes the following:

FM 23-17	Redeye Guided Missile System (revision)
FM 44-4	Procedures and Drills for Chaparral Self-Propelled Weapon System (revision)
FM 44-5	Procedures and Drills for Vulcan Self-Propelled Weapon System (revision)
FM 44-20	Service Practice for Air Defense Artillery Missile Units (revision)
FM 44-97	Air Defense Artillery Engagement Simulator; Guided Missile System Radar-Signal Simulator Station AN/MPQ-T1 (Nike Hercules) (revision)
FM 44-99	Procedures and Drills for Hawk Missile Battery (Towed and Self-Propelled) (change)

ASubjScd 23-17	Redeye Gunner and Air Defense Section Training (revision)
ASubjScd 44-7	Air Defense Artillery Chaparral/Vulcan Squad (revision)
ASubjScd 44-33	Assembly and Monitoring Team (Missile Warhead Support Detachment) (revision)
ASubjScd 44-34	Hawk Self-Propelled Platoon (revision)
ASubjScd 44-35	Assembly, Service, and Maintenance Section (Hawk) (revision)
ASubjScd 44-37	Command and Acquisition Section (Hawk) (revision)
ASubjScd 44-39	Launching Platoon Headquarters and Launching Section (Nike Hercules) (revision)
ASubjScd 44-40	Assembly and Service Section (Nike Hercules) (revision)
ATP 44-2	Headquarters and Headquarters Battery, Air Defense Artillery Brigade (Group) (revision)
ATP 44-535	Air Defense Artillery Battalion, Nike Hercules (change)
ATT 44-2	Air Defense Artillery Brigade (Group) (change)
ATT 44-325	Air Defense Artillery Battalion, Chaparral/Vulcan, Self-Propelled (revision)
ATT 44-535	Air Defense Artillery Missile Units (Nike Hercules) (change)

The US Army Combat Developments Command Air Defense Agency, located at Fort Bliss, is responsible for preparing all doctrinal air defense artillery training literature published as field manuals. These publications now include FM 44-1, FM 44-2, FM 44-3, FM 44-95, and FM 44-96. The Agency also prepares all air defense artillery tables of organization and equipment.

Air defense artillery training literature superseded or rescinded since April 1969 includes the following:

(S) FM 44-1A (Sep 65)	Superseded by FM 44-1A (Oct 69)
FM 44-19 (Dec 68)	Superseded by FM 44-19 (Apr 70)
FM 44-62 (Sep 66)	Superseded by FM 44-62 (Aug 69)
(C) FM 44-82A (Nov 66)	Superseded by (C) FM 44-82A (Jun 70)
(S) FM 44-96A (Dec 63)	Superseded by FM 44-1A (Oct 69)
FM 44-99 (Sep 66)	Superseded by FM 44-99 (May 69)
TM 44-210 (Jun 67)	Superseded by TM 44-210 (Feb 70)
TC 44-12 (Jun 65)	Superseded by FM 44-1-1 (Oct 69)
ASubjScd 23-17 (Mar 67)	Superseded by ASubjScd 23-17 (May 69)
ASubjScd 44-5 (Jul 67)	Superseded by ASubjScd 44-5 (Sep 69)
ASubjScd 44-10 (Aug 65)	Superseded by ASubjScd 44-10 (Nov 69)

ASubjScd 44-12 (Jul 67)	Superseded by ASubjScd 44-12 (Jan 70)
ASubjScd 44-14 (Jul 67)	Superseded by ASubjScd 44-14 (Sep 69)
ASubjScd 44-33 (Sep 67)	Superseded by ASubjScd 44-33 (Jun 69)
ASubjScd 44-41 (Jun 67)	Superseded by ASubjScd 44-41 (Jun 69)
ASubjScd 44-42 (Jun 67)	Superseded by ASubjScd 44-42 (Jul 69)
ASubjScd 44-105.1 (Aug 60)	Superseded by ASubjScd 44-00G20 (Jan 70)
ASubjScd 44-151.6 (Apr 63)	Rescinded
ASubjScd 44-13F10 (Jan 68)	Superseded by ASubjScd 44-16F10 (Jun 69)
ASubjScd 44-16D10 (Jun 67)	Superseded by ASubjScd 44-16D10 (Feb 70)
ASubjScd 44-16E10 (May 67)	Superseded by ASubjScd 44-16E10 (Feb 70)
ASubjScd 44-16R10 (Feb 68)	Superseded by ASubjScd 44-16R10 (Apr 70)
ATP 44-8 (Jul 67)	Superseded By ATP 44-8 (Jul 69)
ATP 44-85 (Dec 67)	Superseded by ATP 44-85 (Jul 69)
ATP 44-235 (Dec 67)	Superseded by ATP 44-235 (Jul 70)
ATP 44-325 (Aug 68)	Superseded by ATP 44-325 (Jul 70)
ATT 44-85 (Jul 67)	Superseded by ATP 44-85 (Jul 69)
ATT 44-235 (May 66)	Superseded by ATT 44-235 (Apr 70)

TRAINING FILMS AND GRAPHIC TRAINING AIDS

The US Army Air Defense School assists the US Continental Army Command (CONARC) in the development of a long-range, air defense artillery training film and graphic training aids program for Army-wide use and assists in the production of approved training films. The annual air defense artillery training film and graphic training aids program is planned by the film liaison officer in the Office of Doctrine Development, Literature, and Plans, who coordinates the production of these films and training aids. Recently released air defense artillery training films are listed below:

(C) TF 44-3980	The Hawk Battery—Operation in an ECM Environment (U)
TF 44-4063	Air Defense Artillery Weapon System, Vulcan, SP—Part I—Introduction: Vulcan Squad in Action
TF 44-4078	Introduction to Air Defense Artillery Radars
TF 44-4094	Air Defense Artillery Weapon System, Vulcan, SP—Part II—Target Engagement Techniques
TF 44-4095	Air Defense Artillery Weapon System, Vulcan, SP—Part III—Ammunition Handling and Loading
TF 44-4133	Air Defense Artillery Weapon System, Chaparral, SP—Part I—Introduction: The Chaparral Squad in Action

TF 44-4135	Air Defense Artillery Weapon System, Chaparral, SP–Part II Emplacement and Preparation for Action
TF 44-4134	Air Defense Artillery Weapon System, Chaparral, SP–Part III–Target Engagement Techniques
TF 44-4209	Air Defense Artillery Weapon System, Chaparral, SP–Part IV–Missile Loading and Unloading

Air defense artillery training films scheduled for release in the near future include:

(C) TF 44-4138	Electronic Countermeasures Against Air Defense Artillery Radars–Part I–Introduction (U)
(C) TF 44-4139	Electronic Countermeasures Against Air Defense Artillery Radars–Part II–Jamming (U)
(C) TF 44-4140	Electronic Countermeasures Against Air Defense Artillery Radars–Part III–Deception (U)
(C) TF 44-4141	Electronic Countermeasures Against Air Defense Artillery Radars–Part IV–ECM Tactics (U)
(C) TF 44-4160	Introduction to Radar ECCM (U)
(C) TF 44-4120	The Hawk Battery Engagement Simulator AN/TPQ-21–Part III–ECM Programing (U)
TF 44-4173	The Direct View Storage Tube

Air defense artillery training films currently in production include:

(C) Project 20074	High-Power Acquisition Radar (HIPAR) Antijam Improvement (AJI)–Part I–Automatic Jam Avoidance Circuitry (AJAC) (U)
(C) Project 20236	High-Power Acquisition Radar (HIPAR) Antijam Improvement (AJI–Part II–Automatic Cancellation of Extended Targets (ACET) (U)
(C) Project 20238	High-Power Acquisition Radar (HIPAR) Antijam Improvement (AJI)–Part IV–Higher Transmitter Power (U)
Project 20140	Nike Hercules Battery, Radar Alinement–Part I–Leveling
Project 20141	Nike Hercules Battery, Radar Alinement–Part II–Optical Adjustments
Project 20142	Nike Hercules Battery, Radar Alinement–Part III–Collimation
Project 20143	Nike Hercules Battery, Radar Alinement–Part IV–Orientation

MOS EVALUATION TESTS

The US Army Air Defense School provides the US Army Enlisted Evaluation Center, an agency of the Office of Personnel Operations, Department of the Army, with the necessary material for publication of military occupational specialty (MOS) test aid pamphlets and evaluation tests for all air defense artillery and fire distribution system maintenance MOS. Currently, this material is provided for 27 MOS containing 56 skill levels, requiring the annual review and change of approximately 11,200 test items.

AUTOMATION OF PRESENTATIONS FOR MISSILE ELECTRONICS INSTRUCTION

The Missile Electronics Division, Missile Electronics and Fire Distribution Systems Department, USAADS, is continuing experiments with automatic audiovisual presentations. These presentations are reviews, using a tape recorder; a 35-mm slide projector; and a programer.

Several refinements are being made in the material and equipment. The quality of the slides is being improved. Closer coordination between theory and practical instruction is being accomplished by showing the same circuits in the classroom that the student will be working with in the laboratories. Where possible, slides of actual equipment or components are being used instead of only schematic drawings.

It is planned to use two-track stereo recorders so that the slide changing signal is not heard by the audience. Having the narration on one track and the slide changing signal on the second track allows more voice variation, resulting in improved narration.

Material is being prepared to use 35-mm slide projections during the regular platform instruction. Schematic drawings of circuits and waveforms will be reproduced on negative slides and projected on the chalkboard. This will result in a saving of time for the instructor, eliminating the requirement for him to draw the diagram on the chalkboard. The slide projector is remotely controlled from the platform which allows the instructor to make the projections quicker and with less distraction as compared to using an overhead projector.

Using slides in a certain sequence also tends to standardize instruction and eliminate omission of material.

GUIDED MISSILE SYSTEMS OFFICER COURSE (4F-1181)

The Guided Missile Systems Officer Course (4F-1181) (fig 110), conducted at the Air Defense School, is an advanced educational-type course in which the sciences relating to guided missiles and space technology and the practical aspects of guided missiles are taught. Its primary purpose is to provide commanders with staff officers capable of analyzing past, present, and future developments and trends in the scientific field as related to concepts of modern warfare. No other course in the Army school system so adequately prepares officers for the duties of senior staff adviser, systems analyst, technical intelligence officer, liaison officer to civilian or military agencies, research and development specialist, or evaluator on missile systems.

This program offers a special opportunity for those officers interested in a comprehensive and advanced course of instruction at college level. Those who meet the prerequisites can pursue undergraduate and graduate level engineering studies in this $7\frac{1}{2}$-month course under a select faculty distinguished by advanced degrees in electrical engineering, mechanical engineering, aeronautical engineering, and physics.

The need for officers who possess such advanced education has been well established. Effective development and employment of the technically complex systems which characterize the modern army requires the availability of individuals who possess both military experience in the field and a theoretical knowledge of the engineering disciplines involved. The Guided Missile Systems Officer course is designed to produce such individuals.

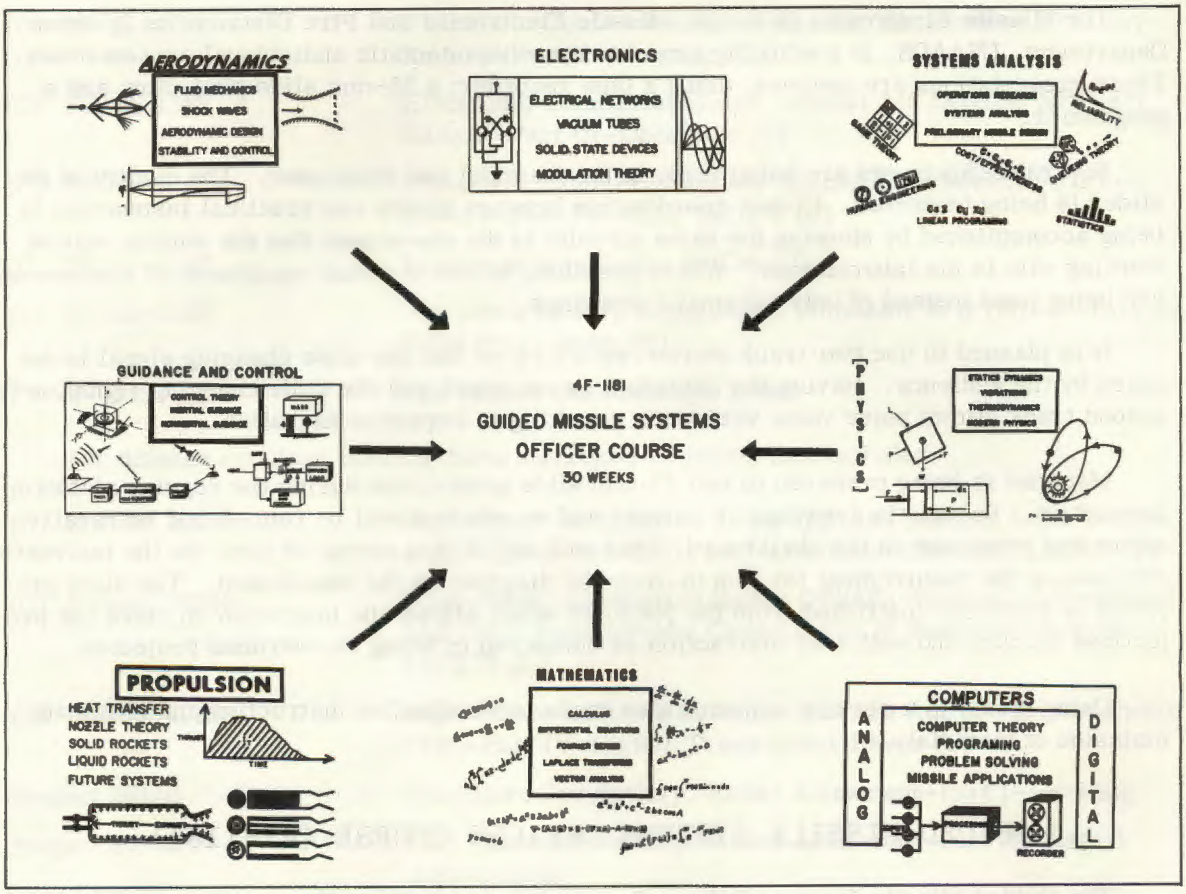


Figure 110. Guided Missile Systems Officer Course (4F-1181).

The course includes a wide range of engineering subjects. Mathematics instruction includes differential and integral calculus, differential equations, vector analysis, and Laplace transforms. Instruction in electrical engineering progresses from direct and alternating current theory through the study of vacuum tubes, solid-state devices, AM and FM, and waveshaping to the investigation of microwave theory and radar systems. The study of static and dynamic mechanics, mechanical vibrations, heat transfer, and thermodynamics provides the background for extensive instruction in aerodynamics, aerospace dynamics, and propulsion. The theory and application of both analog and digital computers are considered. The study of guidance and control systems includes inertial and noninertial guidance and servomechanisms. Instruction is also given in systems analysis, nuclear physics and reactors, and the status of various guided missile systems. Students participate in field trips to White Sands Missile Range, Fort Sill, and to selected aerospace industries on the West Coast where they receive briefings on current research and development projects and on hardware production.

The minimum course prerequisites are one semester of integral and differential calculus and one semester of college physics, or engineering subjects. However, an undergraduate degree in mathematics, physics, or engineering is strongly recommended and is necessary for any student desiring to participate in the advanced degree program. A security clearance of interim SECRET and a minimum rank of first lieutenant are required.

The Guided Missile Systems Officer course is open to all branches of all services and to selected foreign officers from England and Canada. The input to each of the two classes per year—one starting in February, the second in June—is by Department of the Army selection and individual application. Unit personnel officers will assist in preparing application forms. Further information can be obtained from the Missile Science Division, Command and Staff Department, US Army Air Defense School.

MULTILEVEL TRAINING

In a policy letter of September 1966, CONARC provided the US Army Air Defense School with the following challenge:

> "USCONARC is required to provision the Army's operating forces with soldiers trained in many varied electronics skills. In the foreseeable future, no significant change can be expected in the aptitude and intelligence of the input, nor to the fact that most will be committed for only 2 years' service. Under the current training procedures, useful service remaining after training and other nonproductive activity can be as little as 12 months. We simply can't afford a training investment that yields a one-to-one, training time to production time, return. The ratio should be more like one-to-ten. In this formula, the available time and the average aptitude are, for the moment, constants; the method of training is the only variable to manipulate."

Using these CONARC guidelines, the Air Defense School's Low Altitude Air Defense Department developed a multilevel concept of instruction designed to teach maintenance technicians the skills and knowledge required to perform the duties at their level of maintenance. This concept is currently divided into two major phases of training.

The entry-level phase is designed to train the first-term enlistee or inductee to effectively troubleshoot and repair the complex equipment found on his job. Using functional context methods, the philosophy of entry-level training is maximum practical application, limiting of theory instruction to the functional level, use of new fault isolation procedures (developed by Low Altitude Air Defense Department and adopted by Department of the Army), and use of practical examinations exclusively to test the student's ability to apply what he has learned. Upon successful completion of the course, the technician is awarded the 20 skill designator.

This phase has been tested on four occasions, three times using the Hawk Continuous-Wave Radar Maintenance course (MOS 24B) as a testing ground and once using the Hawk Fire Control Maintenance course (MOS 24F), emphasizing equipment-centered, job-oriented instruction. Training time was reduced from 26 to 13 weeks and 36 to 18 weeks, respectively. An end-of-course test was administered to the entry-level students and graduates of a conventional course. The results showed that the entry-level students were as proficient as the conventionally trained students in weekly/monthly check procedures and more proficient in troubleshooting.

The second phase of multilevel training will be the career course. Inputs to this course will be those entry-level students who reenlist and have had site experience. This course, also employing functional context methods, is designed to give the electronics maintenance technician a comprehensive understanding of management techniques, basic electronics, digital computers, maintenance techniques, equipment theory, and integrated systems. Upon completion of this course, the electronics maintenance technician will be awarded a 40 skill designator.

The Low Altitude Air Defense Department has requested authorization from CONARC and Department of the Army to begin multilevel training in all Hawk MOS-producing courses in 1970 and has recommended that this concept of training be implemented in all applicable US Army electronics schools.

ALLIED STUDENT PROGRAM

Each year, hundreds of Allied students, many with dependents, arrive at Fort Bliss to receive instruction on the Nike Hercules, Hawk, and automatic weapon systems. The US Army Air Defense School is charged with providing them with academic opportunity, administrative and logistical support, and an information program which presents the American way of life.

Training is accomplished through two Government programs: the Military Assistance Program (MAP) and the Military Assistance Sales (MAS) Program. MAP is the United States vehicle for providing military assistance under the Mutual Security Act of 1954 as distinct from economic aid. This assistance includes the furnishing of military materiel and training assistance through grant aid or military sales to eligible nations as specified by Congress. Under the MAS Program, purchase of an air defense artillery system by a country and training of that country's personnel at Fort Bliss are authorized.

Training is conducted for individual students and groups (package training) to provide the key personnel required for a complete unit, such as a battalion.

The Air Defense School has been an active participant in the Allied student training program since 1953. To date, more than 14,000 Allied students from 55 countries have been trained at the Air Defense School (fig 111).

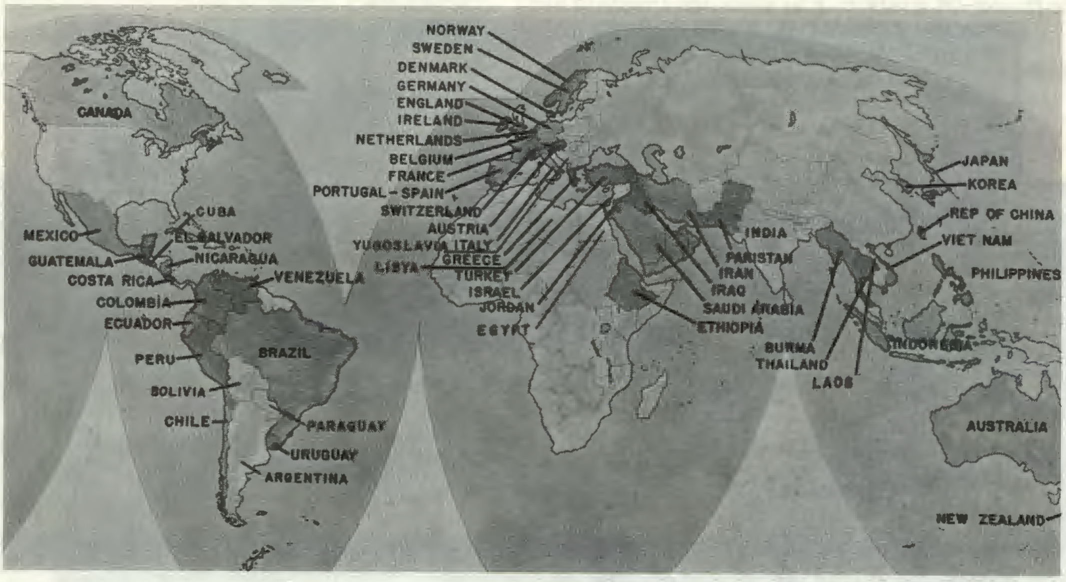


Figure 111. Students from 55 countries have been trained at the Air Defense School.

The Allied Student Battalion was organized to provide administrative and logistical support for this large input of Allied students. The battalion is composed of the Operations and Administrative Branch, German Training Activities Branch, Supply Branch, Activities Branch, Mail Section, Language Section (English Language Enhancement Laboratory), and Mess Section.

OPERATIONS BRANCH

Prior to the arrival of Allied students at Fort Bliss, escorts are appointed from the staff of the Allied Student Battalion. All escorts are equal to or higher in rank than the students they greet. After meeting the incoming students (fig 112) a primary concern of the escort is to insure that the students are comfortably settled in quarters. The first week normally is devoted to administrative processing which prepares the student for his schooling and stay at Fort Bliss.

Administrative and logistical support rendered includes the issue of ID cards to include dependents, briefings on local customs, post and school regulations, rules, requirements, and privileges extended. A tour of Fort Bliss is conducted to familiarize students with post facilities, such as the post exchange, commissary, Officers and NCO and Service Clubs, theaters, post office, and the various departments of the Air Defense School.

Subsequent administrative requirements include the enrollment of students and the publishing of class and security rosters. Further, financial documents for payment of per diem/travel claims and the payment of MAP students are prepared and processed. Port calls and transportation are arranged for those departing students requiring this assistance. Reports pertinent to the students' background, academic achievements, and recommended personnel actions are prepared and forwarded to higher headquarters.

Figure 112. Allied students arriving at El Paso International Airport.

GERMAN TRAINING ACTIVITIES BRANCH

The German Training Activities Branch, affiliated with the Operations and Administrative Branch, meets the interpreter requirements and maintains liaison among the Allied Student Battalion, German Air Force Air Defense School, and German Air Force Training Command. It also provides administrative support, such as the preparation of ID cards and maintenance of an official locator file.

MAIL SECTION

Two mail facilities are provided for the Allied students and German Air Force Air Defense School. Hours of operation are established to complement student class schedules.

ENGLISH LANGUAGE ENHANCEMENT LABORATORY

CONARC regulations establish the requirement to conduct English language refresher training in service schools for students from non-English-speaking countries, as well as to provide facilities for those students and their dependents to enhance their English-speaking capabilities on a volunteer basis. In addition, all CONARC schools administer an English proficiency examination to Allied students reporting for training at US service schools. Students from English-speaking countries and students programed for special courses conducted with the aid of interpreters are excluded from this requirement.

These requirements are met at the Allied Student Battalion through the facilities of the English Language Enhancement Laboratory. This element consists of a modern 20-position language laboratory (fig 113), as well as a classroom for formal instruction. Formal courses are offered in the evenings at the elementary, intermediate, and advanced levels with an average enrollment of 75 students and an average course length of 20 weeks.

Figure 113. Allied students participating in English language laboratory.

For United States and Allied personnel interested in learning foreign language fundamentals or for maintaining a degree of proficiency in a foreign language previously studied, material in the form of tapes and related texts is available for use in several different languages.

SUPPLY BRANCH

The Supply Branch, Allied Student Battalion, provides billets for incoming enlisted students, supplies them with necessary equipment and bedding, and issues uniforms, as required. Janitorial service for prescribed areas of the Allied billets is also arranged by the Supply Branch.

MESS SECTION

The Allied Student Battalion operates a standard US Army field ration mess for personnel from 12 to 15 different countries. The mess steward and his personnel attempt to satisfy national preferences and customs, religious requirements, and nutritional needs. These changes are normally met by substitution and/or split preparation; i.e., rice for potatoes, beef for pork. The messhall hours of operation are established to meet the varying needs of the students.

ACTIVITIES BRANCH

The battalion has the responsibility for conducting an informational program through which the student is able to gain a more informed impression of this country. The information program, conducted by the Activities Branch, is oriented toward the off-duty hours of the student. Governmental Institutions; The Judicial System and the Doctrine of Judicial Review; The Role of the Opposition in a Two-Party System; The Role of Press, Radio, and Television; The Diversity of Life in the United States; The Position of Minority Groups in the United States; Agriculture; The Economy; Labor; Education; and Public and Social Welfare are areas explored by the program.

The Activities Branch is organized into four sections: Tours, Sports, Special Events, and the Host Family. A brief description of each follows:

The Tours Section organizes local and out-of-town tours (figs 114 and 115) as well as offering assistance to those traveling on their own. These tours are conducted on afternoons, weekends, and holidays.

Tours to places in the immediate El Paso area are conducted on weekday afternoons upon the individual classes' request. Trips to banks, manufacturing companies, Government agencies, schools, refineries, television studios, newspapers, and food processing companies are common. Each tour lasts about 2-1/2 hours and is conducted by a representative of the company or agency concerned.

One-day trips by commercial bus to points within a 200-mile radius of El Paso are conducted on weekends. These trips are held in conjunction with various industries, National Park Service, and various chambers of commerce. Tours visit Carlsbad Caverns, White Sands National Monument, Kennecott Copper Corporation, Elephant Butte dam, and the Mescalero Indian Reservation. These tours are furnished at no cost to the student, except for lunch, and are on a first-come, first-served basis. From 25 to 120 students participate in each tour. Approximately four trips are conducted each month.

Special out-of-town tours are taken over 3- or 4-day holiday periods. Tours are conducted in coordination with local travel agencies. Students visit San Diego, Los Angeles, Las Vegas, Grand Canyon, Phoenix, Tucson, and other places of interest. The cost of these trips is paid entirely by the student, and a US escort accompanies them.

Figure 114. Allied students tour the Grand Canyon.

Figure 115. Allied students stop at the Arizona-Sonora Desert Museum on one of the out-of-town tours.

Vacation assistance is offered each student traveling on his own. Through close coordination with State travel bureaus, the battalion is able to furnish each student with maps, brochures, and guides to each point of interest on his trip. Additionally, the student receives a personal letter of introduction. Reservations at various military installations, YMCA's, and motels are also made upon request.

The sports program at the Allied Student Battalion is a unique one. An international program is offered to meet the diversified interests of the students. Among the sports offered are judo, karate, kendo, European handball, soccer (fig 116), volleyball, fencing, and billiards.

Figure 116. German and Korean students hold playoff in Allied Soccer League.

Intercountry competition is conducted in European handball, soccer, and volleyball, and trophies are presented. Since all countries are interested in keeping their personnel physically fit while attending the Air Defense School, the program is an active one.

The Special Events Section is responsible for keeping the students up to date on happenings in and around the El Paso area and Fort Bliss. Through a weekly newsletter, distributed to all students, they are kept informed of musical concerts, plays, art exhibits, rodeos, sports events, and other special happenings which they may attend. Students are encouraged to participate in as many of these events as possible so that they will gain some idea of American culture. For many events, tickets are donated by individual El Pasoans, and for others, the battalion purchases tickets for interested students. In other cases, if free tickets are not made available, the student is able to purchase them at a reduced military rate.

Another important function of the Special Events Section is the guest speaker program. Through close liaison with the El Paso community, requests from various civic, church, social and school groups for Allied students to speak on subjects related to their native lands are fulfilled. Students give talks on religion, education, culture, and general subjects about their countries.

Additionally, this Section is responsible for insuring that each student receives an El Paso Honorary Citizenship Card, signed by the Mayor of El Paso, which is presented to the student by the Commanding Officer or his representative.

The most effective introduction to the United States is accomplished through the host family program. This program is one of informal hospitality, El Paso and Fort Bliss families inviting Allied personnel into their homes.

The battalion works with the Allied Military Division of the El Paso Council for International Visitors. This division has accepted responsibility for locating families who would like to have Allied personnel in their homes on a sustained basis. In essence, the committee supplies the families and the battalion contacts the students and provides administrative assistance.

Families entertain students and dependents a minimum of once a month. In actual practice, visits are more frequent. During these visits they participate in a variety of events, including barbecues, dinners, watching television, and/or just talking. Families are asked not to furnish lavish entertainment, but rather to include the students in their everyday activities.

Only students who speak English, those who will be at Fort Bliss for 3 months or longer, and who desire a host family participate in the program.

For Allied students who will be at Fort Bliss less than 3 months, and who speak conversational English, a short-term hospitality program is offered. This program is basically the same as the host family program and affords students attending short courses the opportunity to become acquainted with and visit American families.

Through these programs the students get a firsthand idea of what a typical American family is like; what its problems, ideas, and interests are; and how it utilizes its leisure time. The families, in return, have the opportunity to associate with people from other countries and learn more concerning life in other parts of the world.

These programs have contributed greatly in promoting understanding. Favorable comments are continually being received by families from their former students after they return home. In addition, as an indirect result of the program, El Paso clubs have been formed in at least four different countries.

The informational program, as established at the Allied Student Battalion, is a unique one. Although everything except the initial orientation is voluntary, the program is constantly expanded to include the vast number of students desiring to participate. During their stay here, Allied personnel are anxious to see and learn as much as possible about the United States. Through offering assistance and a variety of events in which to participate, the informational program is able to fulfill the student's wish.

Chapter 6
United States Army Air Defense Activities

UNITED STATES ARMY AIR DEFENSE SCHOOL

Figure 117. Hinman Hall, US Army Air Defense School.

HISTORY

The US Army Air Defense School (fig 118 traces its lineage back to the Artillery Corps for Instruction (later named the Coast Artillery School) established at Fortress Monroe, Virginia, on 5 April 1824.

By March 1942, the antiaircraft portion of the Coast Artillery School had outgrown the facilities at Fort Monroe. This portion of the Coast Artillery School was then transferred to Camp Davis, North Carolina, and was established as the Antiaircraft Artillery School coincident with the activation of the Antiaircraft Command, Army Ground Forces, an outgrowth of the Office of the Chief of Coast Artillery. In October 1944, the School moved to Fort Bliss, Texas.

The period following 1944 witnessed outstanding technological progress in air defense artillery weapons and a rapid growth in the responsibilities of the Air Defense School. Technologically, weapons have progressed from the 40-mm, 90-mm, and 120-mm guns through the Skysweeper, Nike Ajax, and Nike Hercules, to Hawk, Self-Propelled Hawk, Improved Hawk, Improved Nike Hercules, Chaparral/Vulcan, Safeguard, and SAM-D systems.

On 1 July 1957, after several changes in its name, the School was designated as the US Army Air Defense School.

US ARMY AIR DEFENSE SCHOOL

The US Army Air Defense School (fig 118) provides all required career and specialist school education and training for selected students, both officer and enlisted, of all components of the Army. Emphasis in instruction is on the art of leadership and the military application of guided missile systems. The School also provides career and specialist school education and training for selected students of other US military services, military students from friendly nations, civilian personnel employed by US Government agencies, and personnel of industrial and research organizations under contract to the US Government.

ASSISTANT COMMANDANT

The Assistant Commandant supervises the operation of the US Army Air Defense School, acts for the Commandant as directed, and assumes the duties and responsibilities of the Commandant during his absence.

DEPUTY ASSISTANT COMMANDANT

The Deputy Assistant Commandant assists in the supervision of the operation of the US Army Air Defense School and acts for the Assistant Commandant as directed.

SENIOR USAF-USMC REPRESENTATIVES

The Senior US Air Force Representative develops and presents instruction on US Air Force subjects; performs liaison between US Air Force agencies and the School and USAADCENFB agencies; and advises the Commandant, staff, and faculty on organization, functions, doctrine, procedures, and capabilities of the US Air Force.

The Senior US Marine Corps Representative develops and presents instruction on US Navy and US Marine Corps subjects, performs liaison between US Marine Corps and US Navy agencies and the School and USAADCENFB agencies, and exercises supervision over US Marine Corps personnel stationed at Fort Bliss.

SENIOR FOREIGN REPRESENTATIVES

The Senior Foreign Representatives represent their respective countries as required in matters of liaison, administration, and instruction.

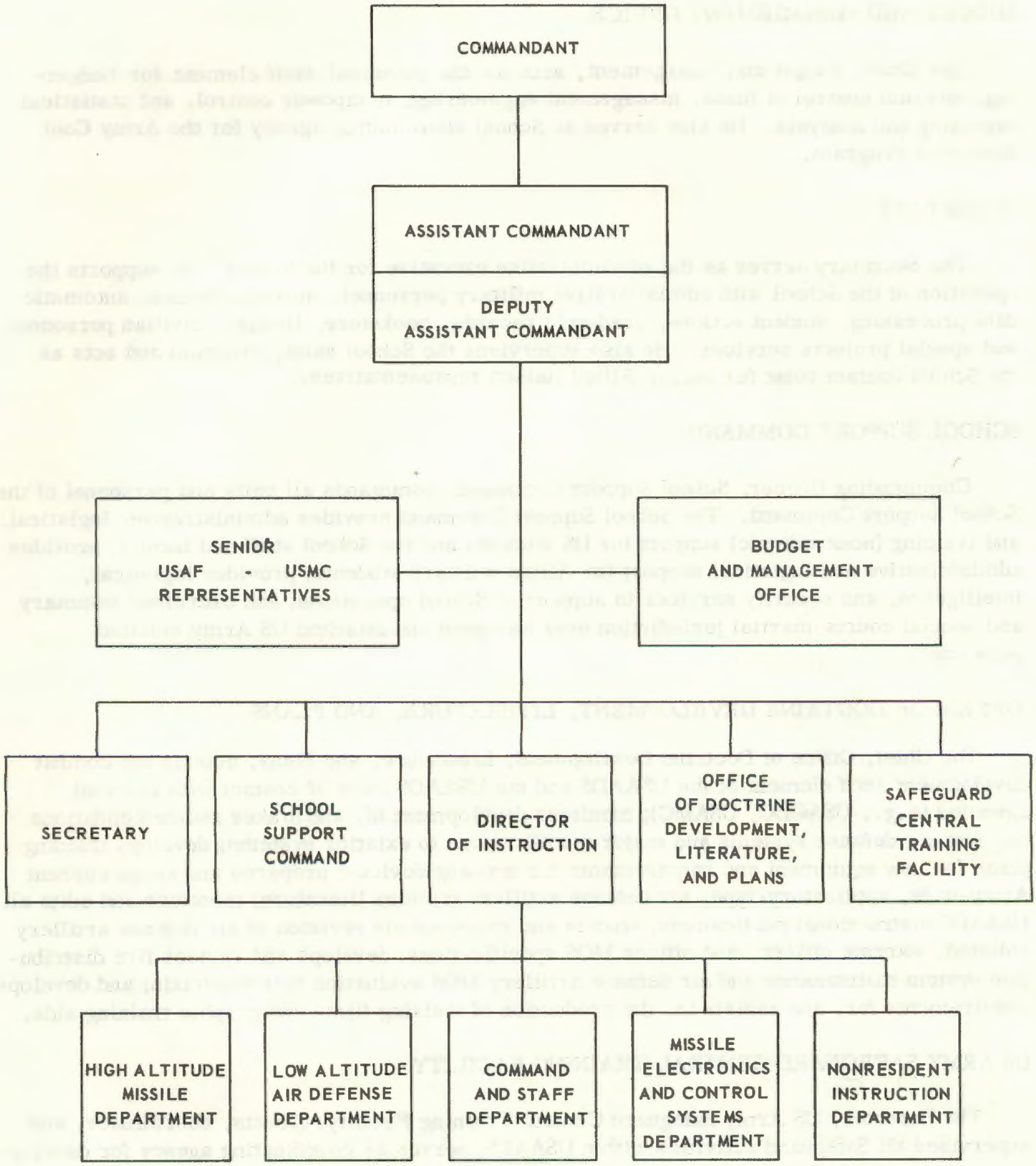


Figure 118. US Army Air Defense School organization.

BUDGET AND MANAGEMENT OFFICE

The Chief, Budget and Management, acts as the principal staff element for budgeting, internal control of funds, management engineering, manpower control, and statistical reporting and analysis. He also serves as School coordinating agency for the Army Cost Reduction Program.

SECRETARY

The Secretary serves as the administrative executive for the School. He supports the operation of the School with administrative military personnel, message center, automatic data processing, student actions, academic records, bookstore, library, civilian personnel, and special projects services. He also supervises the School safety program and acts as the School contact point for senior Allied liaison representatives.

SCHOOL SUPPORT COMMAND

Commanding Officer, School Support Command, commands all units and personnel of the School Support Command. The School Support Command provides administrative, logistical, and training (nonacademic) support for US students and the School staff and faculty; provides administrative and logistical support for Allied military students; provides logistical, intelligence, and security services in support of School operations; and exercises summary and special courts-martial jurisdiction over assigned and attached US Army enlisted personnel.

OFFICE OF DOCTRINE DEVELOPMENT, LITERATURE, AND PLANS

The Chief, Office of Doctrine Development, Literature, and Plans, acts as the combat development staff element of the USAADS and the USAADS point of contact with external agencies (e.g., USACDC, USAMC); monitors development of, and makes recommendations on, new air defense systems and major modifications to existing systems; develops training plans for new equipment and requirements for training devices; prepares and keeps current Army-wide, applicatory-type, air defense artillery training literature; monitors and edits all USAADS instructional publications; studies and recommends revision of air defense artillery enlisted, warrant officer, and officer MOS specifications; develops and revises fire distribution system maintenance and air defense artillery MOS evaluation test materials; and develops requirements for, and assists in, the production of training films and graphic training aids.

US ARMY SAFEGUARD CENTRAL TRAINING FACILITY

The Director, US Army Safeguard Central Training Facility, directs, coordinates, and supervises all Safeguard activities within USAADS; serves as coordinating agency for development of the CONARC Safeguard Integrated Training Plan; participates in and monitors development of the Safeguard system and plans for the preparation and conduct of individual training for Safeguard-peculiar MOS; functions as USAADS Safeguard Executive Agent; executes the Safeguard information program for US Army Air Defense Center and Fort Bliss, its subordinate elements, and USAADS; maintains liaison with the military and contractor agencies engaged in the Safeguard program; provides appropriate Safeguard instructional material for use by CONARC schools; coordinates CONARC logistical support and site activation plan inputs when directed by CONARC; monitors the continuing research and development activities for the ballistic missile defense program; and assists Nonresident Instruction Department in preparation of Safeguard correspondence courses.

DIRECTOR OF INSTRUCTION

The Director of Instruction directs the academic departments, coordinates their instructional activities, supports the conduct of School operations, prepares plans for the academic requirements, and provides television instructional facilities for the School. He maintains liaison with, provides guidance and support to, and acts as the School's point of contact for the US Army Air Defense Human Research Unit. He supports the Safeguard Central Training Facility to provide administrative assistance in the preparation and submission to CONARC of programs of instruction, provides the scheduling and operational support and assists in planning for student inputs and facility requirements, and conducts the instructor training and instructional supervisors course.

COMMAND AND STAFF DEPARTMENT

The Director, Command and Staff Department, is responsible for conducting instruction in command and staff matters of air defense, combined arms, nuclear weapons, and missile science; participates in the evolution and formulation of doctrine; participates in the preparation, review, and revision of Army-wide training literature, training films, and MOS evaluation tests; supports air defense instruction at other service schools; monitors School troop demonstrations and field exercises; and sponsors senior officer courses of instruction.

MISSILE ELECTRONICS AND CONTROL SYSTEMS DEPARTMENT

The Director, Missile Electronics and Control Systems Department, is responsible for conducting instruction in electronics, digital technology, and fire distribution systems; participates in the evolution and formulation of doctrine; participates in the preparation, review, and revision of Army-wide training literature, training films, and MOS evaluation tests; and maintains equipment.

LOW ALTITUDE AIR DEFENSE DEPARTMENT

The Director, Low Altitude Air Defense Department, is responsible for conducting instruction in the low-altitude air defense weapon systems, forward area weapons, and associated subjects; participates in the evolution and formulation of doctrine; participates in the preparation, review, and revision of Army-wide training literature, training films, and MOS evaluation tests; maintains equipment; and participates in the technical review of equipment publication manuscripts pertaining to Hawk materiel, forward area weapons, and such other low-altitude air defense artillery materiel as may be directed by USAADS.

HIGH ALTITUDE MISSILE DEPARTMENT

The Director, High Altitude Missile Department, is responsible for conducting instruction in the operational Nike Hercules missile systems, their associated engagement simulator, alternate battery and defense acquisition radars, and electronic warfare;

participates in the evolution and formulation of doctrine; participates in the preparation, review, and revision of Army-wide training literature, training films, and MOS evaluation tests; and maintains equipment.

NONRESIDENT INSTRUCTION DEPARTMENT

The Director, Nonresident Instruction Department, prepares and administers air defense correspondence courses, requests and administers subcourses from other service schools, prepares air defense common subject subcourses for Army-wide use, prepares and provides instructional material for Army Reserve components, and distributes School-published material to authorized agencies.

Average enrollment in the US Army Air Defense School Army Correspondence Course Program for calendar year 1969 was:

Basic officer courses	109
Advanced officer courses	326
Special courses	1,426
Senior NCO course	109
Individual subcourses	1,259
Average monthly enrollment	3,357

ACADEMIC ACCOMPLISHMENTS

Since the initiation of air defense artillery instruction in 1942, the Air Defense School has graduated more than 223,000 students. During World War II, more than 60,000 individuals were graduated from courses conducted at the School.

During fiscal year 1970, the School conducted 74 courses (US and non-US), varying in length from 4 days to 59 weeks. Included in the 6,320 graduates during fiscal year 1970 were representatives of 19 other countries. In terms of air defense artillery skills, the graduates included:

	US	Non-US
SUPERVISORY (3,031)		
Basic Officer	1,276	1
Air Defense Artillery Automatic Weapons	153	14
Battery Commander and Battalion Staff	424	104
Qualification	1,019	40
ORIENTATION (191)		
All Weapon Systems	191	0
OPERATIONS (265)		
Electronic Warfare	151	0
Fire Distribution Systems Controller	114	0

	US	Non-US
TECHNICIANS (2,833)		
Nike Hercules and Transition	802	135
Hawk	637	175
Chaparral/Vulcan	260	0
Fire Distribution Systems	376	79
Acquisition Radar	159	0
Engagement Simulators	88	19
ADA Automatic Weapons	99	4
Total	5,749	571

Total graduates for each fiscal year since 1963 are indicated in figure 119.

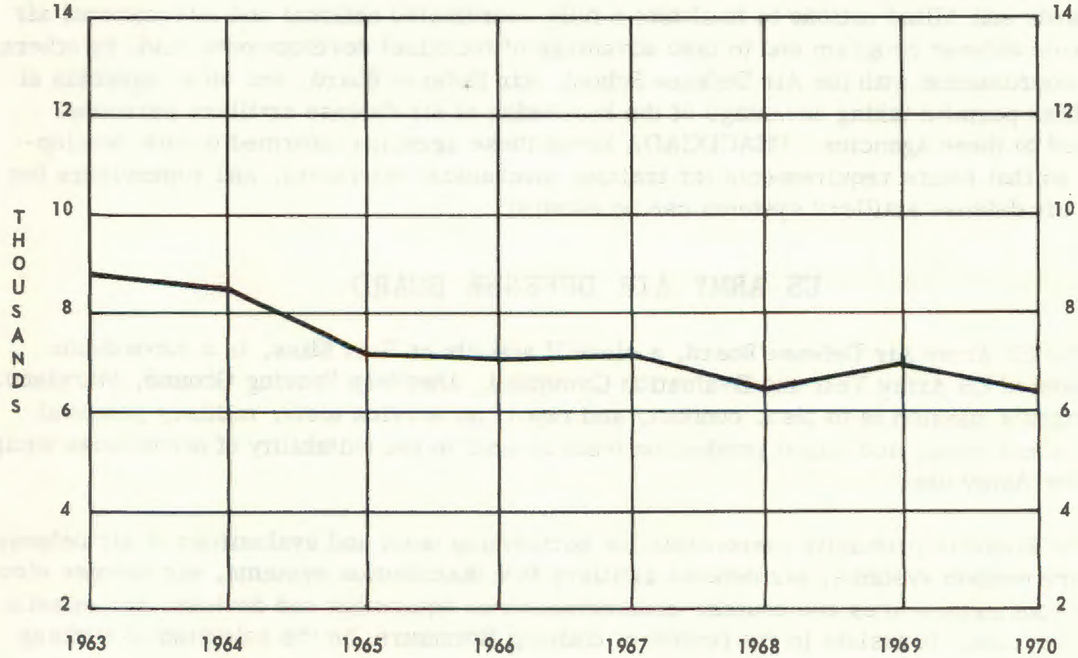


Figure 119. Air Defense School graduates by fiscal years.

US ARMY COMBAT DEVELOPMENTS COMMAND AIR DEFENSE AGENCY

The US Army Combat Developments Command Air Defense Agency (USACDCADA) was organized as a class II activity at Fort Bliss on 1 July 1962. This agency is part of the US Army Combat Developments Command (USACDC) established in the 1961 reorganization of the Army. USACDCADA is responsible to the Commanding General, USACDC, through the US Army Combat Developments Command, Combat Support Group, Fort Belvoir, Virginia, and is one of six branch or combat functional agencies of the Combat Support Group.

USACDCADA is charged with determining how air defense artillery units should be organized and equipped and how they should fight. These tasks are accomplished by studying future requirements and preparing tables of organization and equipment for all air defense artillery units, qualitative materiel development objectives, qualitative materiel requirements, small development requirements for air defense artillery equipment, and doctrinal field manuals on air defense artillery employment. USACDCADA represents the user in the development cycle, participates in development of the maintenance package, and reviews equipment technical manuals.

The development of organizational concepts, materiel requirements, and doctrine requires close coordination with many agencies. USACDCADA maintains liaison with the Communications-Electronics Agency, USACDC, for the use of frequencies; with the Aviation Agency, USACDC, for the use of airspace; and with other combined arms agencies as the plans and programs become more finalized. Liaison is also maintained with major oversea commands and Allied nations to facilitate a fully coordinated national and international air and space defense program and to take advantage of technical developments made by others. Close coordination with the Air Defense School, Air Defense Board, and other agencies at Fort Bliss permits taking advantage of the knowledge of air defense artillery personnel assigned to these agencies. USACDCADA keeps these agencies informed of new developments so that future requirements for training mechanics, operators, and supervisors for future air defense artillery systems can be planned.

US ARMY AIR DEFENSE BOARD

The US Army Air Defense Board, a class II activity at Fort Bliss, is a subordinate command of US Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland. The Board's mission is to plan, conduct, and report on service tests, military potential tests, check tests, and initial production tests related to the suitability of air defense equipment for Army use.

The Board is primarily responsible for performing tests and evaluations of air defense artillery weapon systems, air defense artillery fire distribution systems, air defense electronic countermeasures and counter-countermeasures equipment and devices, and missile target devices. It assists in the review of training literature, in the selection of training aids, and makes recommendations concerning the suitability and safety of test items for operational use. The Air Defense Board plans, directs, and controls a program in test methodology to insure proper testing and reporting in current and future years.

The Air Defense Board advises proponent agencies and developers during their development and study of air defense equipment. The data and information derived directly from test experience provides the basis for such advice. Close liaison is maintained with the Navy, Marine Corps, and Air Force and with United Kingdom and Canadian standardization representatives on air defense artillery items of mutual interest. Finally, the Board participates in the planning and conduct of engineering tests and the planning, supervising, and monitoring of confirmatory and troop tests as directed by Commanding General, US Army Test and Evaluation Command.

1ST ADVANCED INDIVIDUAL TRAINING BRIGADE (AIR DEFENSE)

The 1st Advanced Individual Training Brigade (Air Defense) has as its primary mission the conduct of advanced individual training (AIT) in eight air defense MOS's. Training is given to prospective Hawk and Nike Hercules missile and fire control crewmen, Chaparral/Vulcan crewmen, air defense automatic weapons crewmen (twin 40-mm gun M42 and multiple caliber .50 machinegun), air defense artillery operations and intelligence assistants, and acquisition and surveillance radar crewmen. Approximately 550 AIT trainees are graduated each month.

Other missions of the Brigade include the training of gunners and air defense section headquarters personnel for the Redeye guided missile system, training of prospective non-commissioned officers for air defense automatic weapons leadership in the Brigade's Air Defense Noncommissioned Officer Candidate School, and training NCO's from other career fields on the Chaparral/Vulcan weapon systems. The Brigade also conducts Nike Hercules nuclear warhead team training as well as training of Allied packages.

The 1st AIT Brigade (AD) is one of the oldest organizations at Fort Bliss. It had its beginning 25 years ago as the 1st Antiaircraft Artillery Guided Missile Battalion, organized in October 1945. This organization participated in the very beginning of development and testing of guided missiles in the US Army.

During the 1st Brigade's existence it has filled a vital role in the training of air defense missile units, both Active Army and National Guard. It has also trained Nike and Hawk units for Allied countries. Over the years the 1st AIT Brigade (AD) has trained more than 100 units. Among these have been Allied units from Japan, South Korea, West Germany, Italy, Belgium, France, Denmark, and Spain.

In 1965 the Brigade became a part of the reactivated US Army Training Center (Air Defense). With the inactivation of the Army Training Center in April 1970, the 1st AIT Brigade (AD) continues its primary mission of air defense artillery AIT training as a major subordinate command of the US Army Air Defense Center and Fort Bliss.

6TH ARTILLERY GROUP (AIR DEFENSE)

The 6th Artillery Group (Air Defense) was activated at Fort Bliss on 1 February 1952. At that time, the group's main air defense elements were automatic weapon units. However, when technological innovations of the 1950's were incorporated to produce the Nike Hercules and Hawk missile systems, wide-sweeping changes occurred in the basic organization and structure of the units comprising the 6th Artillery Group.

The 6th Artillery Group today is composed of three Hawk battalions and one Nike Hercules battalion with an engineer company and ordnance company attached. While maintaining their tactical and technical proficiency, these units provide support for construction and maintenance activities of the Air Defense Center and Fort Bliss.

The 6th Artillery Group has been assigned the overall mission of providing tactical control and administrative supervision of subordinate air defense artillery organizations and other assigned units employed in air defense operations. In addition, 6th Artillery Group has been given the Fort Bliss mission of achieving and maintaining required readiness conditions in personnel, training, and logistics.

Complying with this mission, the 6th Artillery Group is responsible for preparing and conducting training tests of all attached units and, as directed, furnishing administrative, logistical, and environmental support to United States Army Reserve units assigned to Fort Bliss for training.

15TH ARTILLERY GROUP (AIR DEFENSE)

The 15th Artillery Group (AD) was reactivated on 1 June 1966 at Fort Bliss. Current missions of the 15th Artillery Group include the command, control, and coordination of all TOE ADA units assigned a primary mission of supporting Air Defense School instruction. In addition, the unit has responsibility for the activation, training, testing, and preparing for deployment of all new Chaparral/Vulcan battalions.

The 15th Artillery Group provides two battalions and a separate machinegun battery for support of USAADS instruction. From these units, the 15th Artillery Group provides multiple machineguns M55, 40-mm guns M42, and Vulcan/Chaparral equipment and units for USAADS student instruction. Students are instructed in equipment emplacement and deployment, and actual firing of weapons and missiles. The 15th Artillery Group also provides personnel for secondary instruction on ADA weapon systems and other equipment.

The unit activation program, under which all tactical Chaparral/Vulcan units are trained, provides combat-ready forward area air defense artillery units fully prepared for integration into the field army. Three Chaparral/Vulcan battalions are currently undergoing basic and advanced unit training under supervision of the 15th Artillery Group.

US ARMY AIR DEFENSE HUMAN RESEARCH UNIT

The US Army Air Defense Human Research Unit is a military organization responsible for providing military support and guidance to contract agencies engaged in human factors research in air defense. The support and guidance are furnished to the collocated HumRRO Division No. 5. This division is an organizational element of the Human Resources Research Organization, an independent, nonprofit corporation operating under contract with Department of the Army and other Government sponsors.

Military research work units presently being conducted by HumRRO Division No. 5 are concerned with:

Determination of performance capabilities and training requirements for manual command and control functions of the Safeguard weapon system (Work Unit MANICON);

Training methods for forward area air defense weapons (Work Unit SKYFIRE);

Evaluating concepts for aircraft recognition training (Work Unit STAR);

Curriculum and instructional improvements for the air defense artillery officer advanced course (Work Unit SKYGUARD).

Exploratory research is being conducted to determine the desirability of conducting further in-depth research in the following areas:

General educational development. To determine the feasibility of developing a functionally oriented general educational development (GED) program (Exploratory Research 83).

Increasing effectiveness of training through low cost simulation. To determine the feasibility of developing methods of training with low-cost simulation as a supplement to training with actual equipment (Exploratory Research 82).

An equipment family model for training United States Army Security Agency (USASA) operators. To determine the feasibility of developing a method for identifying the characteristics of training equipment families which produce maximum transfer of skills for ASA operators (Exploratory Research 81).

Basic research is being conducted for the purpose of improving the ability to see military targets (Basic Research 16). Many military tasks involve visual recognition or identification of objects or shapes. In these visual tasks, observers must be trained to discriminate between similar shapes and to accurately classify (or identify) shapes that have a wide variety of spatial or geographical orientations.

McGREGOR GUIDED MISSILE RANGE

McGregor Guided Missile Range, organized under the Range Command, US Army Air Defense Center and Fort Bliss, is the largest inland air defense missile range in the free world. Located in New Mexico, the range encompasses 1,210 square miles (684,000 acres).

To meet the increasing need for a larger range and to replace the range at Red Canyon, New Mexico, McGregor Range was established on 13 July 1956. The range became operational as a Nike guided missile range in April 1957. From April 1957 until June 1959, the support of package firings remained the primary mission of McGregor Range.

Buildup continued and by mid-1959 McGregor Range was capable of supporting ARADCOM annual service practice units. On 12 August 1959, the first missile was fired at McGregor Range in an ARADCOM annual service practice. McGregor Guided Missile Range has supported Nike Ajax and Nike Hercules training firings by units from throughout the free world.

With the activation of the first Hawk battalion in 1959, plans got underway at McGregor Range for support of the Hawk training firing missions. The first Hawk missile was fired there in June 1960.

McGregor Range, in addition to its training mission, has hosted several outstanding programs under the supervision of the US Army Air Defense Center and Fort Bliss. Thousands of United States citizens and citizens of Allied countries have seen demonstrations of our air defense capabilities. More than 11,000 surface-to-air missileduring missions have been completed at McGregor Range.

KEEPING ABREAST OF TECHNICAL DEVELOPMENTS

Guided missile material is under constant study by manufacturers, tactical units, technical agencies, the US Army Air Defense Board, US Army Combat Developments Command Air Defense Agency, and the Air Defense School. Studies are conducted to detect materiel weaknesses and to improve maintenance and operational procedures.

To assist the School in keeping abreast of the latest air defense artillery materiel developments, representatives are stationed at the Pacific Field Office, Safeguard Project, Kwajalein Atoll, Marshall Islands; and at the Bell Telephone Laboratories, Whippany, New Jersey.

The close working relationship of the School with the Air Defense Board and Combat Developments Command Air Defense Agency is a contributing factor in keeping abreast of technical developments. The Air Defense Center Team Conference grew from this relationship.

AIR DEFENSE CENTER TEAM CONFERENCE

The Air Defense Center Team Conference was established to create a relaxed, friendly, and informal atmosphere for exchanging air defense artillery information and developing a mutual understanding of air defense artillery problems. The conference consists of monthly meetings of senior members of the principal organizations at Fort Bliss who have interest in air defense matters: the US Army Air Defense Center and Fort Bliss, US Army Air Defense School, US Army Air Defense Board, US Army Combat Developments Command Air Defense Agency, and US Army Air Defense Human Research Unit. These collocated agencies use their experience, knowledge, and capability to contribute to the support of doctrinal, educational, and training matters, the approach being at the executive command level. The spirit behind these meetings embodies the "center team" concept and lends command emphasis to the coordination of air defense activities of mutual interest.

To broaden the scope of information exchanged, standing invitations to participate are extended to other Army agencies closely associated with solving air defense problems. These include the Deputy Assistant Commandant and Directors, USAADS, and representatives from the US Army Air Defense Center and Fort Bliss (DPT and DIO), US Army Combat Developments Command Institute of Nuclear Studies, US Army Air Defense Command, US Army Missile Command, US Army Missile and Munitions Center and School, White Sands Missile Range, and Air Defense Directorate, ACSFOR.

APPENDIX

ABBREVIATIONS

AADC - Army air defense commander
AADCP - Army air defense command post
AAR - alternate acquisition radar
AAW - antiair warfare
ACE - Allied Command Europe; airspace control element
ACSFOR - Assistant Chief of Staff for Force Development
AD - air defense
ADA - air defense artillery
ADIZ - air defense identification zone
ADL - automatic data link
AFCC - assault fire command console
AM - amplitude modulation
ARADCOM - US Army Air Defense Command
2 ATAF - Second Allied Tactical Air Force
4 ATAF - Fourth Allied Tactical Air Force
ATBM - antitactical ballistic missile
ATT - Army training test
AUTOVON - automatic voice network
AW - automatic weapons

BCO - battery control officer
BDL - battery data link
BIRDIE - battery integration radar display equipment
BMEWS - ballistic missile early warning system
Bn OC - battalion operations central
BSI - battery status indicator
BUIC - backup interceptor control

CDG - coder-decoder group
CF ADC - Canadian Forces Air Defence Command
CINCAL - Commander in Chief, Alaska
CINCNORAD - Commander in Chief, North American Air Defense Command
CMMI - command maintenance management inspections
COC - combat operations center
CONAD - Continental Air Defense Command
CONARC - United States Continental Army Command
CONUS - continental United States
CPX - command post exercise
CRC - control and reporting center
CTOC - corps tactical operations center
C/V - Chaparral/Vulcan
CWAR - continuous-wave acquisition radar
CWTDC - continuous-wave target detection console

DAR - defense acquisition radar
DCA - Defense Communications Agency
DEW - distant early warning
DOT - Department of Transportation (Canada)
DT - detector-tracker
DTOC - division tactical operations center

ECM - electronic countermeasure
ECCM - electronic counter-countermeasure

FAA - Federal Aviation Administration
FAAR - forward area alerting radar
FACP - forward area control post
FATOC - field army tactical operations center
FEBA - forward edge of the battle area
FM - frequency modulation
FSM - frequency-shift-modulated
FUIF - fire unit integration facility

HIPAR - high-power acquisition radar
HIPIR - high-powered illuminator radar
HumRRO - Human Resources Research Office

ICBM - intercontinental ballistic missile
ICC - information coordination central
ICWAR - improved continuous-wave acquisition radar
IFF - identification, friend or foe
IP - identification of position
IR - infrared

LOPAR - low-power acquisition radar

MAP - Military Assistance Program
MAS - Military Assistance Sales

MOS - military occupational specialty
MSR - missile site radar
MTDS - Marine Tactical Data System
MTS - moving target simulator

NASA - National Aeronautics and Space Administration
NATO - North Atlantic Treaty Organization
NAVSPASUR - Navy space surveillance system
NCC - NORAD control center
NORAD - North American Air Defense Command
NRCC - NORAD region control center
NSA - National Security Agency

PACAF - Pacific Air Forces
PAR - pulse acquisition radar; perimeter acquisition radar
PCP - platoon command post
PPI - plan position indicator
PSI - plan speed indicator

RBS - radar bomb scoring
RDPC - radar data processing center
RF - radiofrequency
RFDL - radiofrequency data link
RHI - range-height indicator
ROR - range-only radar
RRIS - remote radar integration station

SAC - Strategic Air Command
SAGE - semiautomatic ground environment
SAM - surface-to-air missile
SAM-D - surface-to-air missile development
SCATANA - security control of air traffic and air navigational aids
SDC - Space Defense Center
SDS - space defense system
SIF - selective identification feature
SNAP - short notice annual practice
SOC - sector operations center
SP - self-propelled
SSB - single sideband

TACC - tactical air control center
TADDS - target alert data display set
TDCC - tactical data communications central
TOC - tactical operations center
TOE - table of organization and equipment
TPI - technical proficiency inspection

UHF - ultrahigh frequency
UNAAF - United Action Armed Forces
USAADCENFB - United States Army Air Defense Center and Fort Bliss
USAADS - United States Army Air Defense School
USACDC - US Army Combat Developments Command
USACDCADA - US Army Combat Developments Command Air Defense Agency
USAF ADC - US Air Force Aerospace Defense Command
USAMC - US Army Materiel Command
USAR - US Army Reserve
USARPAC - United States Army, Pacific

VHF - very high frequency

WMC - weapons monitoring center

—IMPORTANT NOTICE—

Users of this publication should retain copies because it is tentatively planned, as an economy measure, that only changes to this issue will be published in the future—not the complete publication.