NIKE-HERCULES SYSTEM

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FIELD COMMAND, DASA
Sandia Base, Albuquerque, New Mexico

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FOR RESIDENT INSTRUCTION ONLY

SECTION I

INTRODUCTION

1-1. The first U.S. Army Air Defense Artillery guided-missile system, Nike-Ajax, became operational in late 1953. The first generation of the Nike system provided a weapon system whose range, altitude capabilities, and warhead lethality were far superior to the gun-type antiaircraft artillery. Most important, the Nike-Ajax missile, unlike the tube-fired antiaircraft projectile, could be controlled along a trajectory. The Nike-Ajax is now considered obsolete; therefore, it has no anticipated tactical use.

1-2. The Nike-Hercules, a second generation of the Nike system, is a result of modification to the original system and attained operational readiness in 1958. Nike-Hercules was developed to provide the air defense system with an improved weapon to accomplish the task of denying penetration of our defenses. With the Nike-Hercules system, targets can be detected, fired upon, and destroyed with either high explosive or nuclear warheads, at ranges greater than 75 miles. The capability of carrying a nuclear warhead to the kill point further increases the lethality of the Nike system and, for the first time, provides a deadly weapon for use against formations of aircraft.

1-3. Some considerations given in planning the Nike-Hercules from the Nike-Ajax were: to increase payload capability, range, and speed, and to enable engagement of formations of aircraft. Also considered was a means to eliminate liquid fuel which was hazardous to handle, took extensive time to fuel the missile, and was corrosive to the Ajax missile.

1-4. The mission of air defense artillery is to detect, track, and destroy hostile aircraft attempting to penetrate our defended areas. The Nike-Hercules system also has the ability of delivering a nuclear warhead to a surface target.

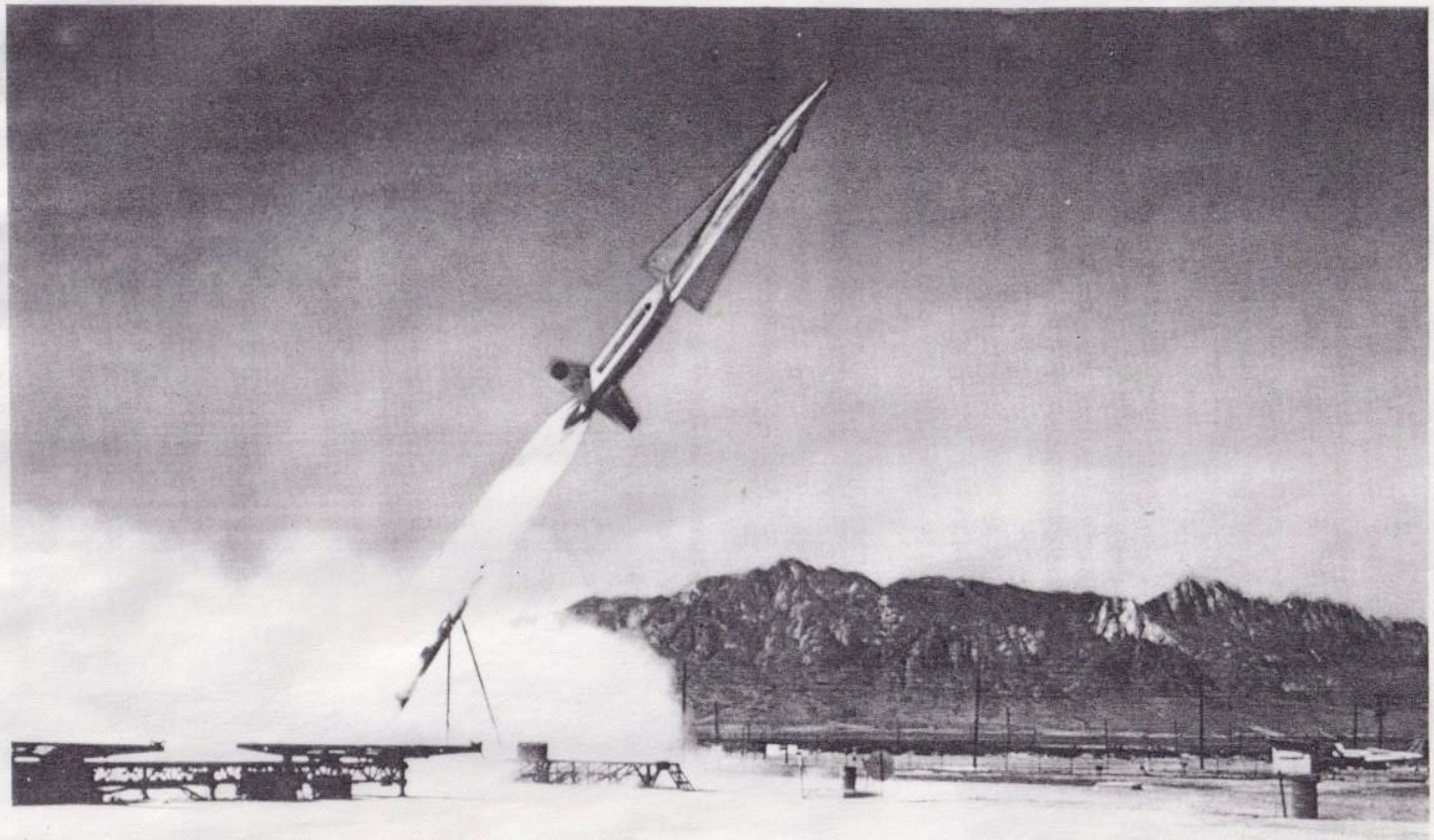

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Figure 1. --Nike-Hercules In Flight.

SECTION II

NIKE-HERCULES BATTERY

The Nike-Hercules battery, also known as a fire unit, is divided into three areas: Battery-Control Area, Assembly and Service Area, and Launching Area. All elements of the system are located in these areas, which are separated by 1,000 to 6,000 yards. The minimum distance is limited by maximum tracking rate of the Missile-Tracking Radar (MTR). The maximum distance is limited by the length of interarea cables issued with the system and by parallax that is inserted into the computer.

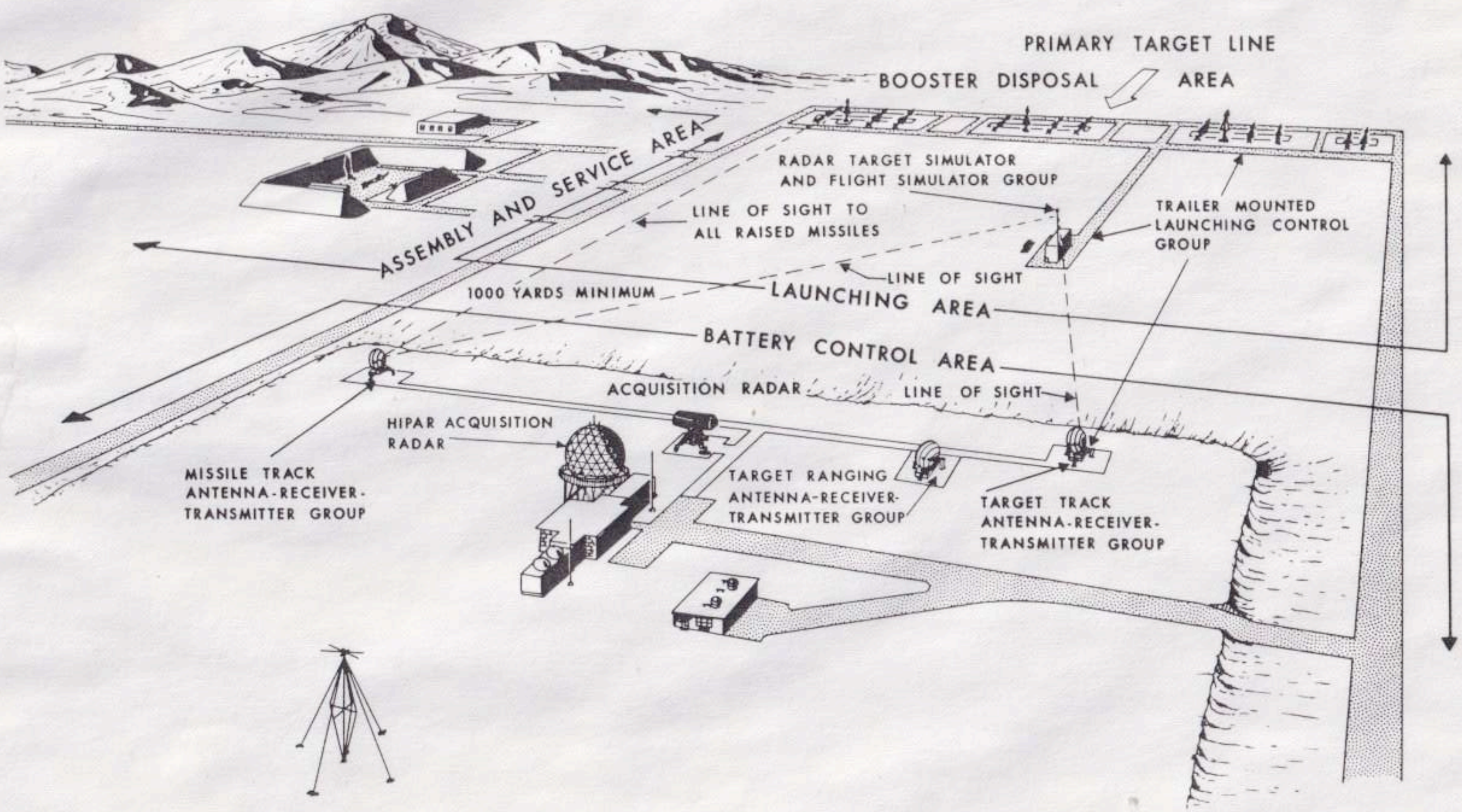

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Figure 2. --Nike-Hercules Missile Battery Site.

SECTION III

IMPROVED NIKE-HERCULES

3-1. CURRENT THREAT.

3-1.1 Due to technological advances in the field of airborne weapons and electronic warfare, an analysis of the threat during the 1960-70 time frame was made. This threat was evaluated as both a bomber with an advanced Electronic Countermeasure (ECM) capability, and a missile of small reflective size.

3-1.2 The problem that the bomber would pose would be denial of range information by effective jamming. The missile would be difficult to detect, difficult to transfer, and initially difficult to track because of its speed and small reflective size.

3-2. IMPROVEMENTS TO THE NIKE-HERCULES SYSTEM.

3-2.1 A study made to determine whether the Nike-Hercules system could be used against the current threat, indicated that it could, provided the battery control area was given an increased capability. The missile and launching area equipment would not have to be changed. Two additional radars, the High-Power Acquisition Radar (HIPAR), and a range-only radar called the Target-Ranging Radar (TRR), were added to the battery control area. Modifications were made to existing radars and the equipment within the battery control area to complete the Nike-Hercules improved system.

SECTION IV

SCHEME OF OPERATION OF NIKE-HERCULES SYSTEM DURING ENGAGEMENT

4-1. GENERAL. Whenever the possibility of an attack exists, each battery is provided with location and identification information by the Army Air Defense Command Post (AADCP). This early warning and target information enables the battery control officer to determine which target is to be engaged by his battery.

4-2. TARGET SELECTION AND ACQUISITION. When a target is within range of the acquisition radar and has been identified as hostile, the battery control officer will direct the acquisition radar operator to designate this target to the target-tracking radar (TTR). This action will cause the present position data of the target to be made available to the TTR in terms of azimuth and range.

4-3. TARGET TRANSFER. When the target has been designated, the TTR operator will hold the acquire switch, causing the TTR to slue automatically in azimuth and range to the target. The elevation operator will search in elevation until he has located the target; and, at that time, the TTR will send the target's present-position data to the computer.

4-4. MISSILE SELECTED AND TRACKED. Prior to the time the battery control officer designates the target to be engaged, numerous simultaneous operations are being conducted in all areas. Personnel in the launching area have armed and erected the missiles on the launchers. The battery control officer will request the mission-missile warhead combination to be used as soon as possible after receiving early warning information. At the command of the launching control officer, a launcher with a missile that matched the battery control officer's request, will be designated. The missile-tracking radar (MTR) slues to this missile, tracking commences, and the missile's present-position information is sent to the computer. The MTR will continue to track the missile until the missile is detonated.

4-5. FIRE ORDER (LAUNCH). When the battery control officer observes that the burst point is within range of the system, he will press the fire switch. The rocket motor cluster will ignite, thrusting the missile almost vertically into the air. After the rocket motor cluster burns out, it will drop away from the missile; the missile motor will start; and, at the proper time, steering commands will be sent to the missile.

4-6. COMPUTATION OF BURST POINT AND STEERING COMMANDS. The computer will compute the burst point and formulate steering commands to guide the missile to the intercept point based on the present-position data being received from the two tracking radars. The steering commands will be sent to the missile via the MTR; and, at the proper time, the burst command will be sent to the missile, causing the missile to detonate at the optimum time to destroy the target.

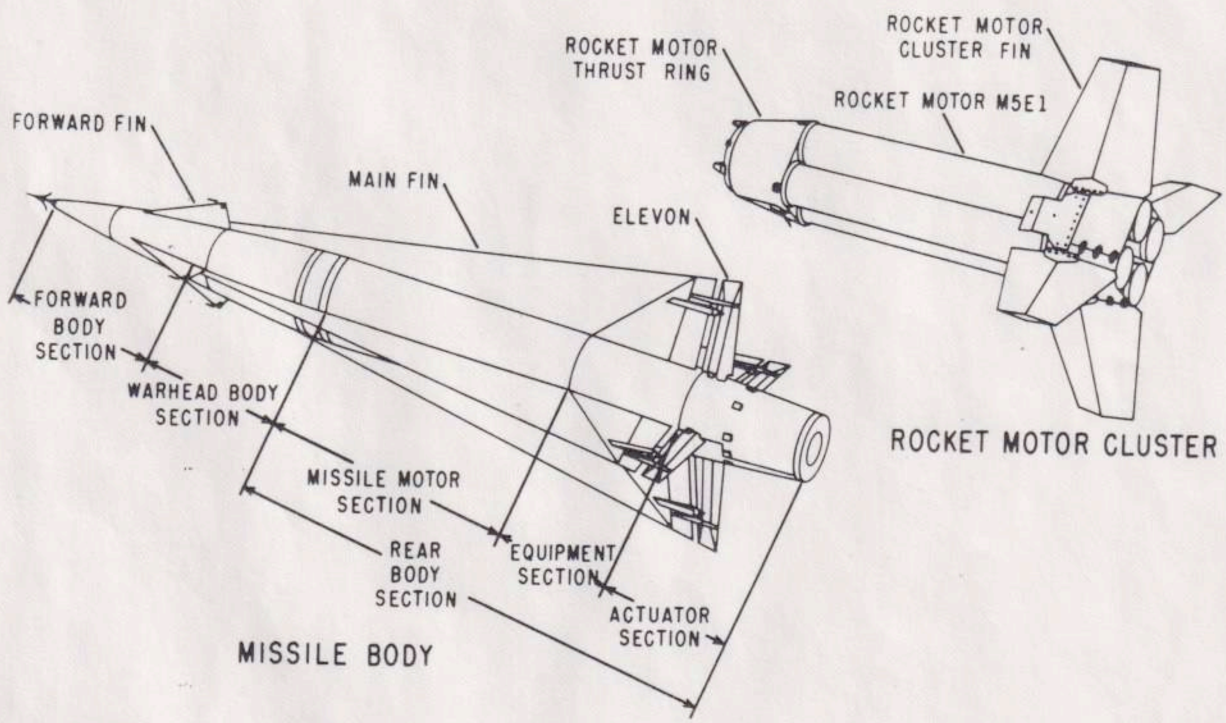
SECTION V

NIKE-HERCULES GUIDED MISSILE

5-1. GENERAL. The prime objective of the Nike-Hercules system is to direct the missile to a point in the sky to destroy hostile targets, or to a point on the ground to destroy enemy installations or troops. Certain changes were required in the evolution of the Nike-Hercules from the Nike-Ajax system. Besides the change in the battery control area, a new launcher and launcher-handling rail were designated to accommodate the added weight of the missile. However, the greatest changes were made in the missile. Because the entire system functions to detonate a warhead when it is at a desired position, knowledge of the missile, which contains the warhead, is essential in understanding the system.

5-2. PHYSICAL CHARACTERISTICS.

5-2.1 GENERAL. The Nike-Hercules missile, MIM-14B, consists of a missile body and rocket motor cluster. The overall length is approximately 39 feet, and the gross weight is approximately 10,700 pounds. Both stages utilize solid propellant motors. The Nike-Hercules has an overall dart configuration.



3536 Figure 3.--Nike-Hercules Missile and Rocket Motor Cluster.

5-2.2. MISSILE BODY. The missile body consists of the forward body section, warhead body section, rear body section, four main fins, and four elevons. The missile body is approximately 27 feet long. The gross weight is approximately 5,400 pounds. The maximum body diameter is 31.5 inches. The four main fins are delta-shaped surfaces which give the missile lift and stability while on the trajectory. Mounted to the rear or trailing edge of each main fin are the missile control surfaces called elevons. These elevons provide roll control and directional control. The four forward fins are rigidly attached to the missile body and are designed to assure adequate response to steering commands when the missile speed is above Mach 3 (2,625 m.p.h.).

5-2.3. ROCKET MOTOR CLUSTER. The rocket motor cluster consists of a cluster of four rocket motors, thrust ring, and four rocket motor cluster fins. The overall length of the cluster is approximately 14 feet. The gross weight is approximately 5,300 pounds. When joined to the missile body, the rocket motor cluster fits over the rear 2 feet of the missile body. When the missile is fired, the rocket motor cluster is ignited; it burns for about 3 seconds, furnishing the thrust to accelerate the missile to a speed of approximately Mach 2. When the rocket motor cluster stops burning, aerodynamic drag pulls it from the missile body, causing the rocket motor to ignite. The missile rocket motor then further accelerates the missile and propels it to the kill point.

5-3. ORIENTATION. When the missile is on the launcher-handling rail or along its trajectory, fin number 1 is positioned 45 degrees left of 12 o'clock as viewed from the rear end (figure 3). The fins are then numbered consecutively in a clockwise direction. Elevons 1 and 3 are called "Y" elevons; 2 and 4 are called "P" elevons. The wiring is contained under main fins 3 and 4. In flight, this arrangement permits corrections for yaw, pitch, and roll.

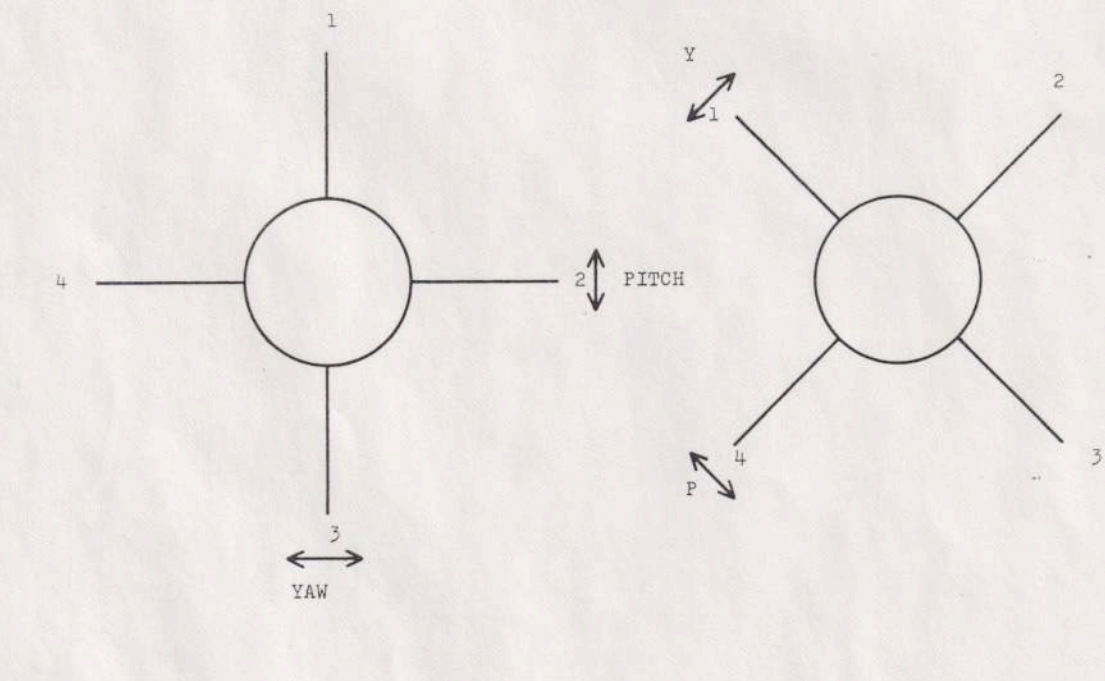


Figure 4. --Fin Orientation.

5-4. SECTIONS.

5-4.1 GENERAL. The missile body is divided into three sections: forward body, warhead body, and rear body. All of these sections are constructed of cast magnesium alloy forming rings with an aluminum skin attached. Forming rings of adjacent sections are bolted together to join the missile body. Measurements in length are expressed as stations.

5-4.2 FORWARD BODY SECTION (Station 0 to 87.5). This section houses the transponder-control group. Forward fins are mounted on the exterior of the forward body section. An antenna and a ram-pressure probe are mounted on each forward fin. The electronic guidance components of the missile guidance set are mounted within the housing of the transponder-control group. This system controls the missile while on trajectory and transfers the burst command to detonate the warhead. This is accomplished by correct response to commands received from the missile-tracking radar.

5-4.3 WARHEAD SECTION.

5-4.3.1 STATIONS 87.5 TO 150. The warhead and associated equipment are housed in this section. The forward main fins are attached to the exterior of the warhead body section. On the belly of the warhead body section is the T-hook adapter which is used to secure the missile to the launcher-handling rail. The warhead system consists of the warhead, appropriate adaption components, warhead body section, and safety and arming devices. The M17 HE Warhead uses an explosive harness assembly. The warhead section is shipped and stored in an M409 Container until mated to a missile.

5-4.3.2 M409 CONTAINER. The M409 Container is a rugged, rolled steel container equipped with one cover on front of the container. The M409 Container weighs approximately 1,900 pounds empty and has a spring-supported movable track arrangement to facilitate removal of the warhead section from the container. The M409 Container is airtight and is packaged with desiccant to maintain a moisture-free weapon.

5-4.3.3 WARHEAD BODY SECTION. The warhead body section is a rolled aluminum skin riveted to magnesium structural rings. When assembled to a guided missile, it is located between stations 87.5 and 150. To facilitate assembly of a warhead section, the body section is in two pieces: the forward warhead body section and the rear warhead body section. The assembly of these two sections takes place at station 136. The body section houses the warhead, adaption kit components (less static tube), fail-safe device, sequential timer, and M30A1 Safety-Arming devices. It mechanically and electrically mates the warhead section to the guided missile.

5-4.3.4 ADAPTION KIT. The purpose of the adaption kit is to electrically and mechanically adapt the warhead to the warhead body section. When issued as a separate major component, it is packaged and shipped in four containers. The adaption kit for the Nike-Hercules consists of the cartridge assembly, the self-aligning static tube, the adapter ring, and the one-point self-destruct system.

5-4.3.4.1 Cartridge Assembly. The cartridge assembly is a sealed unit consisting of two baroswitches used for performing safing and arming functions. Two arming-safing devices are used to complete a portion of arming circuits, and a wiring harness-relay

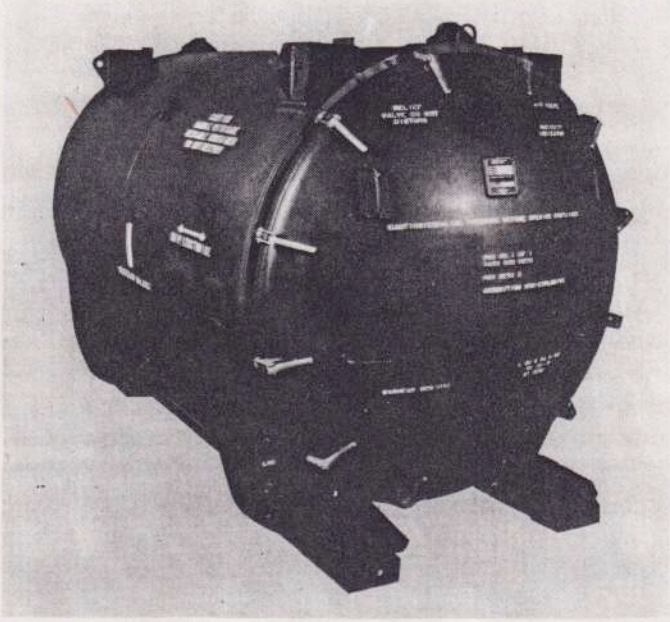


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Figure 5. --M409 Container.

assembly to electrically connect the cartridge assembly components to the warhead components. These components are housed in a metal structural cartridge shell. Also furnished with the cartridge assembly are the necessary cables and plugs needed to complete electrical routings and circuits.

5-4.3.4.2 Self-Aligning Static Tube. The self-aligning static tube is assembled to the forward tip of the forward body section. While the missile is in flight, the static tube obtains static pressures which are transmitted through hose assemblies to the cartridge assembly.

5-4.3.4.3 Adapter Ring. The adapter ring is a rolled aluminum construction. Mechanically it secures the aft end of the warhead to the rear warhead body section at station 136.

5-4.3.4.4 One-Point Self-Destruct System. The one-point self-destruct system consists of two M30A1 safety-arming devices and the one-point self-destruct components (the destructor load assembly, destructor lead assembly, and mounting plate). The one-point self-destruct assembly is used on War Reserve warheads. This system functions to destroy the missile if guidance is lost, or in a surface-to-air mission if the warhead fails to detonate on command.

5-4.4 REAR BODY SECTIONS (Stations 150 to 325).

NOTE

The rear body section is made up of three sections.

5-4.4.1 MISSILE MOTOR SECTION. The motor section contains the missile rocket motor, two initiators, safety and arming switch (S31), and a heater blanket. The safety and arming switch (S31) prevents the propellant from being ignited until after lift-off. The heater blanket is built into the motor section and is used in cold weather to keep the propellant warmed to operating temperature. The solid propellant is a single grain of cast double-base propellant. The grain is perforated in the form of three concentric hollow rings supported by grain structures of the same thickness. The ring configuration provides a burning surface area that will burn evenly and produce a relatively constant thrust. The burning of propellant grain is unrestricted. The solid propellant is wrapped in a cellulose acetate inhibitor, which serves to insulate the combustion chamber walls. Resonance rods that extend the full length of the grain are placed in the perforations of the grain. The resonance rods absorb shock waves created by propellant burning, resulting in a more even burning and consequently a more constant thrust. The weight of the propellant in the rocket motor is approximately 750 pounds. Ignition of this motor is accomplished by the propulsion-arming lanyard, which is attached to the thrust ring assembly, a part of rocket motor cluster, which is pulled when the first stage separates from the missile. This lanyard activates the rocket motor igniter.

5-4.4.2 EQUIPMENT SECTION. The blast tube, which carries the motor gases to the rear, passes through the center of the equipment section. The hydraulic pumping unit is on the right side of the section and the battery rack is on the left side. One missile battery in this rack provides power for the guidance system. If this missile is equipped with a nuclear warhead, two additional batteries must be used. Also, on the left side of the equipment section is a power distribution box. Associated with this box, on the bottom of the section, is the umbilical cable by which the electrical connection is made from the missile to the launcher-handling rail. The rear main fins are attached to the motor and equipment sections. The hydraulic pumping unit is mechanically attached to the elevons and provides for movement of the elevons when they respond to corrections being sent to the missile from the computer.

5-4.4.3 ACTUATOR SECTION. The elevon actuator assemblies are located in the actuator section. The elevons are attached to universal joints on the ends of torque rods. They are also attached to the trailing edges of the rear main fins by means of hinged eyebolts. Also contained in this section is the remainder of the blast tube and the blast tube nozzle. The propulsion-arming lanyard and the thermal battery assembly used to ignite the missile rocket motor are also housed in the actuator section.

SECTION VI

ASSEMBLY AND SERVICE AREA

6-1. GENERAL. The equipment and facilities located in the assembly and service area, though not actually required to complete the engagement, are necessary to test and service missile components before they are moved to the launching area.

6-2. ASSEMBLY AREA.

6-2.1 The assembly area is comprised of the assembly building and the associated hardstand.

6-2.2 Preparation of the Nike-Hercules missile for firing (less its explosive components) is begun in the assembly area. The rear body section and forward body section are unpackaged. An initial inspection of the containers and the contents is made. Handling rings are affixed, and these items are installed on their respective dolly trucks. Rear main fins and elevons are unpackaged, inspected, and installed. Air and oil servicing of the Hydraulic Pumping Unit (HPU) is accomplished. A complete electrical check is made of the missile guidance set to assure that it is in proper operating condition. The missile radiofrequency (RF) test set, electrical test set, and other associated equipment are used to perform these tests. Upon satisfactory completion of these tests, the missile is transported to the service area.

6-3. SERVICE AREA.

6-3.1 The service area is comprised of the service building and associated hardstand, surrounded by earthen revetments to restrict the effects of an accidental explosion in this area. The majority of potentially hazardous operations are performed here. There must be an ample water supply, first-aid equipment, and firefighting equipment within this area.

6-3.2 The main operations accomplished in the service area are unpackaging of the missile rocket motor, inspecting the propellant grain for cracks, and installation of the motor into the rear body section. Rocket motor initiators are installed onto the missile motor, and all internal mechanical and electrical connections are completed within the missile motor and actuator sections of the rear body section. Unpackaging, inspecting, and mating the warhead body section to the rear body section are accomplished as well as the installation of the fail-safe device, sequential timer, and forward fins. The forward body section is mated to the warhead body section. All electrical and mechanical connections are made between the forward body section and the warhead body section. Batteries are installed in the equipment section. Premating and postmating assembly tests are accomplished, using appropriate test sets.

6-3.3 The rocket motor cluster is unpackaged and inspected, fins and thrust rings installed, and then this cluster is positioned on its dolly truck. In general, this completes the operations performed within the assembly and service area.

6-3.4 Throughout all explosives and electrical operations performed within the service area, grounding of all missile components is mandatory.

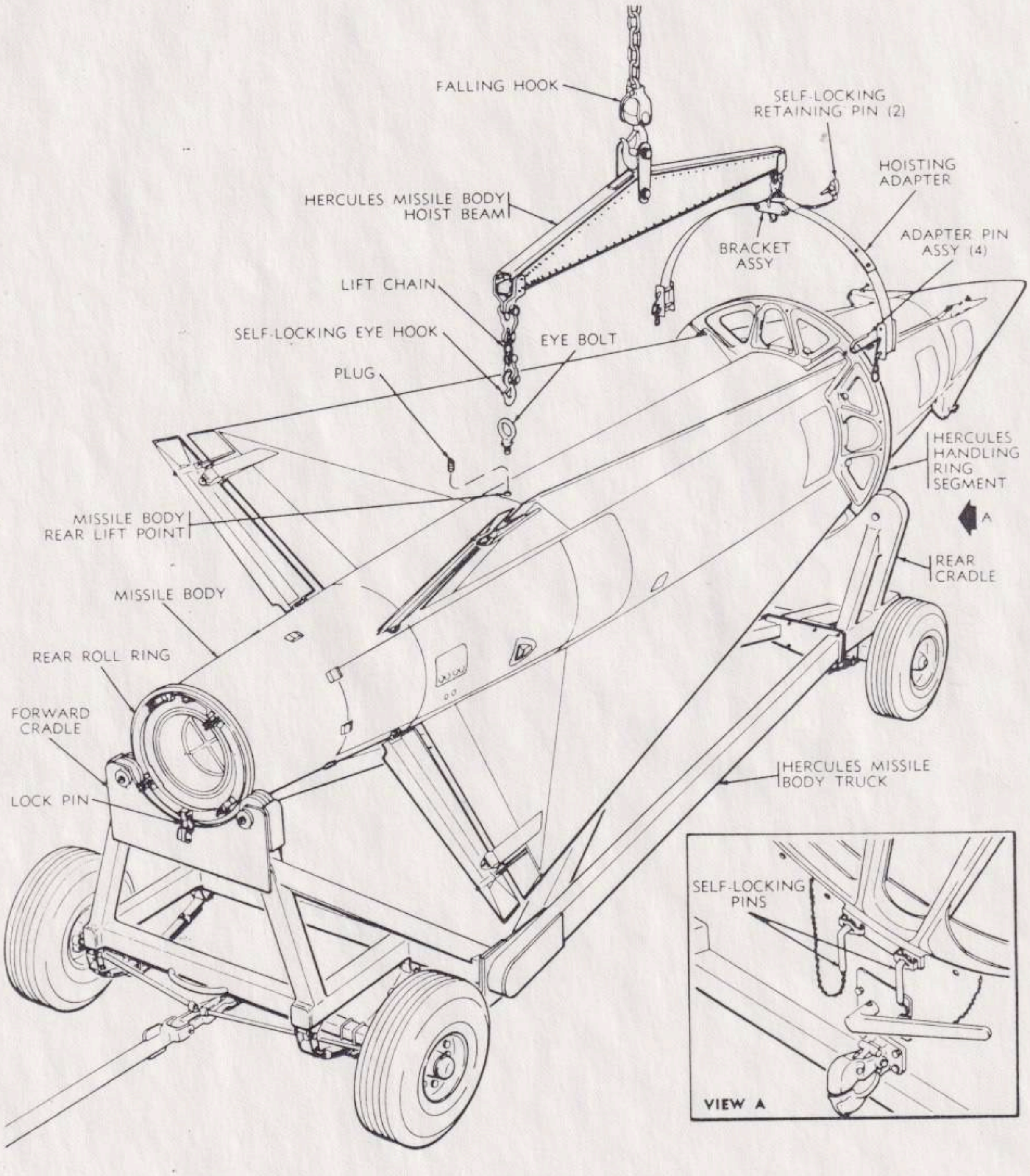

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Figure 6. --Missile Body On Dolly Truck .

SECTION VII

LAUNCHING AREA

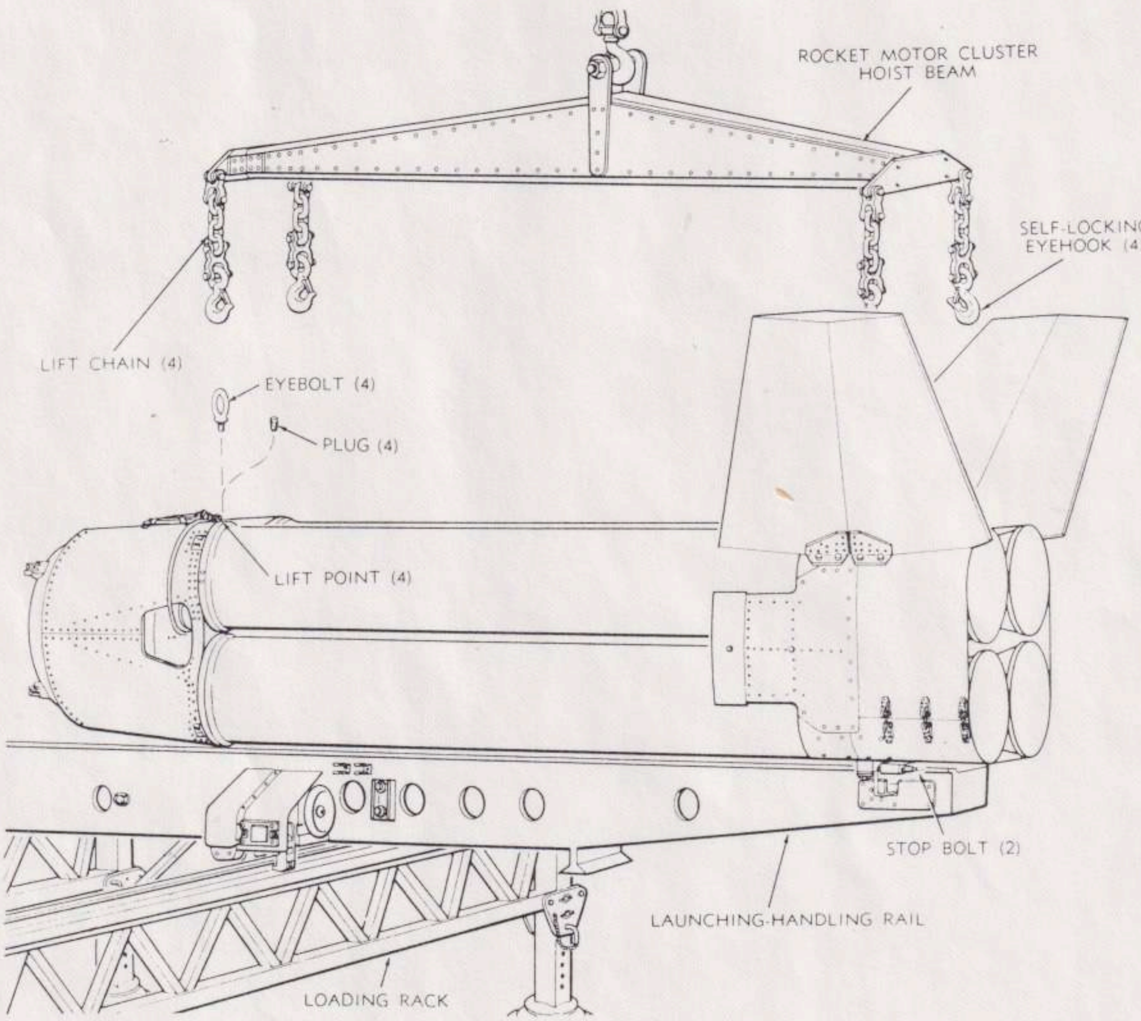
7-1. GENERAL. Within the launching area, there will be between two and four launching sections. A launching section will have three or four launchers depending on site construction. The launching area contains the equipment and facilities necessary to store, maintain, and launch the Nike-Hercules guided missile. No repairs to the Nike-Hercules guided missile are permitted within the launching area. The missile must be dejoined and returned to the service area.

7-2. LAUNCHER-HANDLING RAIL. This rail is first inspected to insure that it is in good operating condition. It is then positioned to join the guided missile previously prepared in the service area. The missile body and rocket motor cluster are transported to the launching area on their respective handling dollies. The rocket motor cluster is placed on the launcher-handling rail first, and positioned so that the cluster comes to rest against the cluster stop bolts. The missile body is then positioned by aligning index pins found on the missile body and cluster. After the missile actuator section is completely fitted into the rocket motor cluster, it is then lowered to engage the T-hook adapter on the belly of the warhead section, to the T-hook adapter fitting on the rail. Final preparation of the Nike-Hercules missile is now performed. The umbilical cables are connected to the rail. The lower cluster fins are installed. The batteries found in the equipment section are connected. The initiator wiring harness and propulsion-arming lanyard are connected. The missile away switch is adjusted. The rocket motor igniters and M30A1 safety-arming devices are visually and electrically checked for safe condition and then installed. The static tube and static-tube protector are installed. All open access doors are secured.

7-3. LAUNCHING CONTROL-INDICATOR (LCI). This LCI has the capability of testing and monitoring up to four missiles. The LCI may be mounted on a mobile dolly for field displacement. Final preparation of the missile also includes a monitoring check by the LCI. All missiles stored are tested daily by the LCI to assure missile serviceability.

7-4. NIKE-HERCULES LAUNCHERS. For a Nike-Hercules missile to obtain the most efficient trajectory, it must be erected to a near vertical position for launching. The launcher consists of a base frame, erecting beam, erecting strut assembly, and necessary components to furnish electrical and hydraulic power. The launcher is 8 feet wide by 23 feet long and weighs 12,000 pounds.

7-5. LOADING RACK SECTIONS. The loading rack sections are utilized to interconnect the launchers within a launching section and the loading rack sections in the storage building that maintains the launcher-handling rails with missiles installed. This rack is a parallel pair of rails that are assembled in 15-foot sections with leveling float jacks in the corners of each section.



F0208 Figure 7.--Launcher-Handling Rail With Rocket Motor Cluster.

SECTION VIII

BATTERY CONTROL AREA

8-1. GENERAL. Within the battery area are several major functional items of equipment employed by the Nike-Hercules battery in accomplishing its mission. The radars and two trailers that house their controls are located in this area. The director station contains the controls for the acquisition radar, computer, part of the tactical control facilities, communications switchboard, and also serves as the command post for the battery control officer. The tracking station trailer houses the controls for the tracking radars, radar receivers, built-in test equipment, communications equipment, fire distribution equipment, and generators to provide the operating power for this area.

8-2. NIKE-HERCULES RADARS. Integral to the Nike-Hercules battery are three to five radars: the acquisition radar; target-tracking radar; missile-tracking radar; for modified sites, the addition of the high-power acquisition radar; and the target-ranging radar. These radars, in conjunction with other components of the battery, accomplish that part of the air defense mission, beginning with the presentation of early warning information and culminating in the destruction of hostile aircraft. These radars operate on the pulse-modulated principle. This principle has a series or string of pulses transmitted. During the interval between transmitted pulses, the radar will "listen" for the reflected echo. Since (RF) energy travels at a constant speed (186, 000 miles per second), a definite time is required for the pulse of (RF) energy to travel to the target and return. By measuring the time lapses between the time the pulse is transmitted and the time the reflected echo is received, range to the target can be accurately determined. Reducing this to more practical terms, RF energy will travel to and from the target at the rate of 328 yards per microsecond (one-millionth part of a second). To determine one-way distance, 164 yards per microsecond is used; i. e., if the time lapse is 1, 000 microseconds, the actual distance to the target will be 1, 000 microseconds times 164 yards or, 164, 000 yards.

8-2. 1 ACQUISITION RADAR. The acquisition radar provides the means for rapid target acquisition by the target-tracking radar. In so doing, it fills the gap between the supply of early warning information and actual tracking of the target by the target-tracking radar. It gives the battery the capability of independent operation. The acquisition radar performs three essential functions. It scans the area around the battery and detects targets in azimuth and range, aids in identification of these targets by permitting correlation of target position with early warning or other information, and provides a means of designating targets to the target-tracking radar. This radar is capable of searching continuously through 6, 400 mils of asimuth and to ranges greater than 125 miles. Targets detected are displayed on a plain position indicator (PPI) at the battery control console in the director station trailer.

8-2. 2 TARGET-TRACKING RADAR (TTR). The target-tracking radar, using azimuth and range information supplied by the acquisition radar, locates the target in elevation and then locks on and continuously tracks the hostile target until it is destroyed. During this time, it supplies smooth, continuous, and precise target-position information to the computer in terms of spherical coordinates. This radar can track targets to ranges of more than 100 miles.

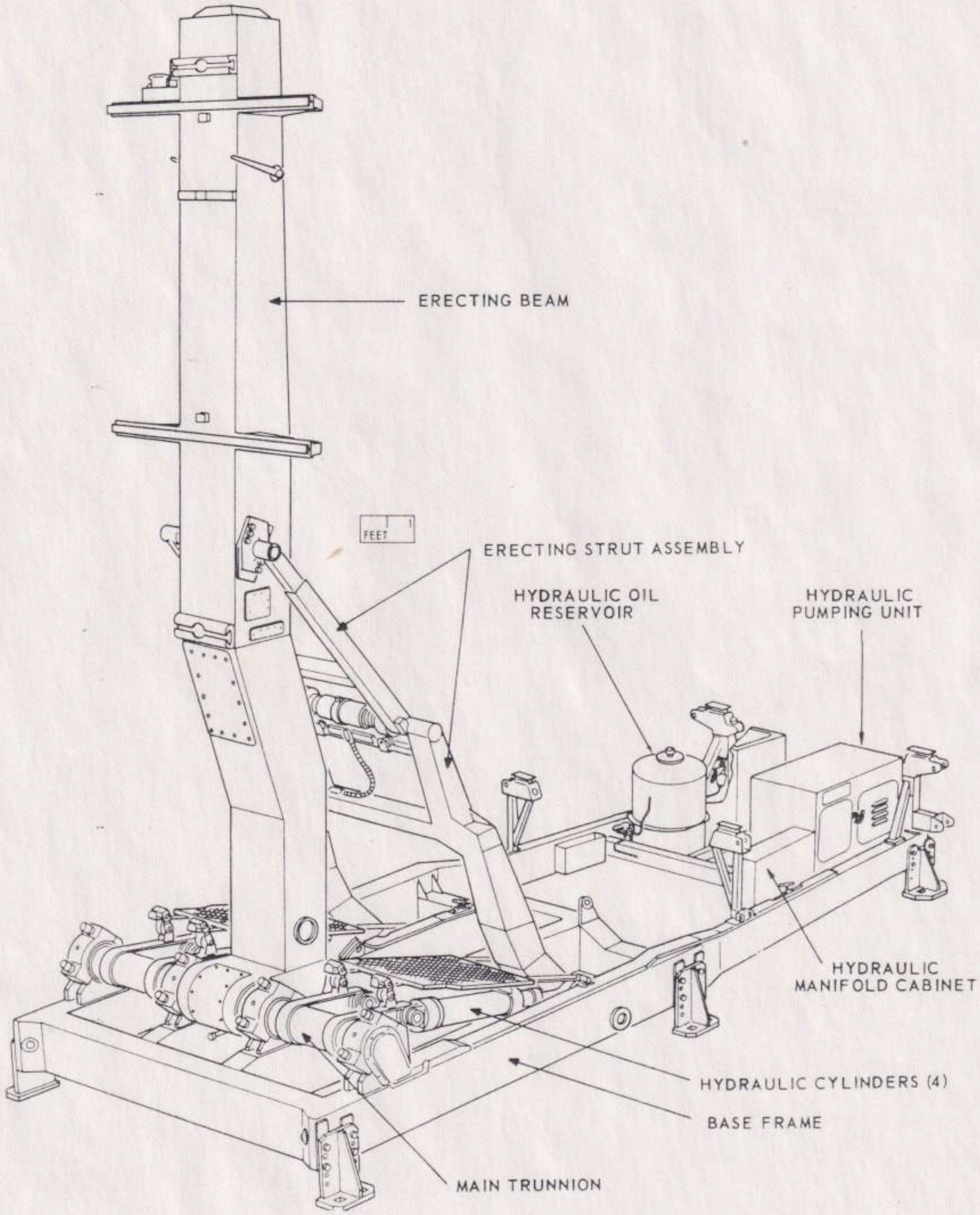


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Figure 8. --Nike-Hercules Launcher.

8-2.3 MISSILE-TRACKING RADAR (MTR). The missile-tracking radar, using predetermined information set on the launcher position controls, automatically locks on and tracks a designated missile on its launcher. From this time on, the MTR will continuously track the missile on its launcher and, after fire, along its trajectory. While tracking the missile, the MTR will supply the computer with missile present-position information and transmit steering commands to the missile from computer determinations. It transmits the burst command to the missile when the battery control officer depresses the burst command switch in the director station. The missile-tracking radar has a maximum range capability of more than 100 miles.

8-2.4 HIGH-POWER ACQUISITION RADAR (HIPAR). This radar has been added to most Continental United States Installations. It provides long-range detection of targets having small radar reflective size. The majority of HIPAR components are installed in a separate building with the antenna reflector and motors on the roof. Although separate power and system circuitry enable independent operation of these different acquisition radars, they share a common presentation system. The choice of using either radar is a tactical decision.

8-2.5 TARGET-RANGING RADAR (TRR). To most modified sites, this target-ranging radar has been added. In tracking aircraft in an electronic countermeasure (ECM) environment, range information could be denied. Therefore, this radar was included to provide range data in such an environment. This target-ranging radar (TRR) is slaved to the target-tracking radar (TTR) for angle pointing.

8-3. COMPUTER.

8-3.1 Events take place too fast for the human brain to record, plot, correct, and coordinate all the events necessary to launch and intercept an enemy target. The computer receives the present-position data of the target and missile from the tracking radars. With this information, it continuously computes the predicted kill point and steering orders necessary to guide the missile to the kill point. As can be seen, the computer has three primary purposes: to compute a kill point, to originate commands to direct the missile to the kill point, and to display this information on servo dials, meters, plotting boards, the multichannel data recorder, and by lighting of lamps.

8-3.2 The computer used in the Nike-Hercules missile is an electromechanical d.c. analog computer to give continuous outputs directly related to the input, which may be varying continuously. Its major advantage is its continuous solution. This type of computer solves problems by using voltages, shaft positions, and time delays to represent problem data input. These quantities are caused to vary in a manner analogous to the way in which the input variables are changing in the problems to be solved.

8-3.3 To achieve a kill, the computer operates in three phases.

8-3.3.1 PRELAUNCH PHASE. Most of the computations during prelaunch are obtained before the missile is launched. The prelaunch problem is basically the old gun problem. It answers the question, "If the missile were launched now, where would target and missile meet in space?"

ACQUISITION RADAR

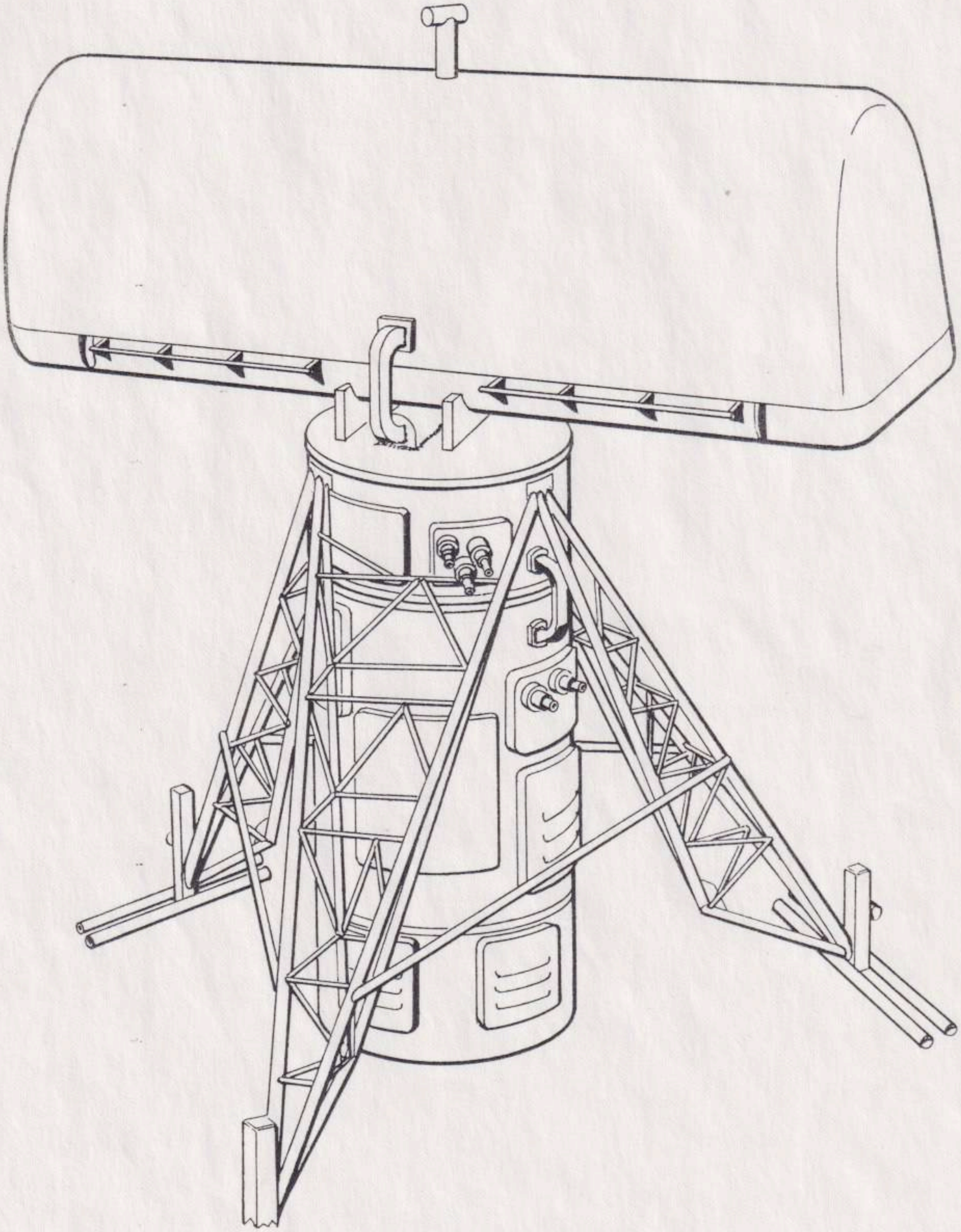

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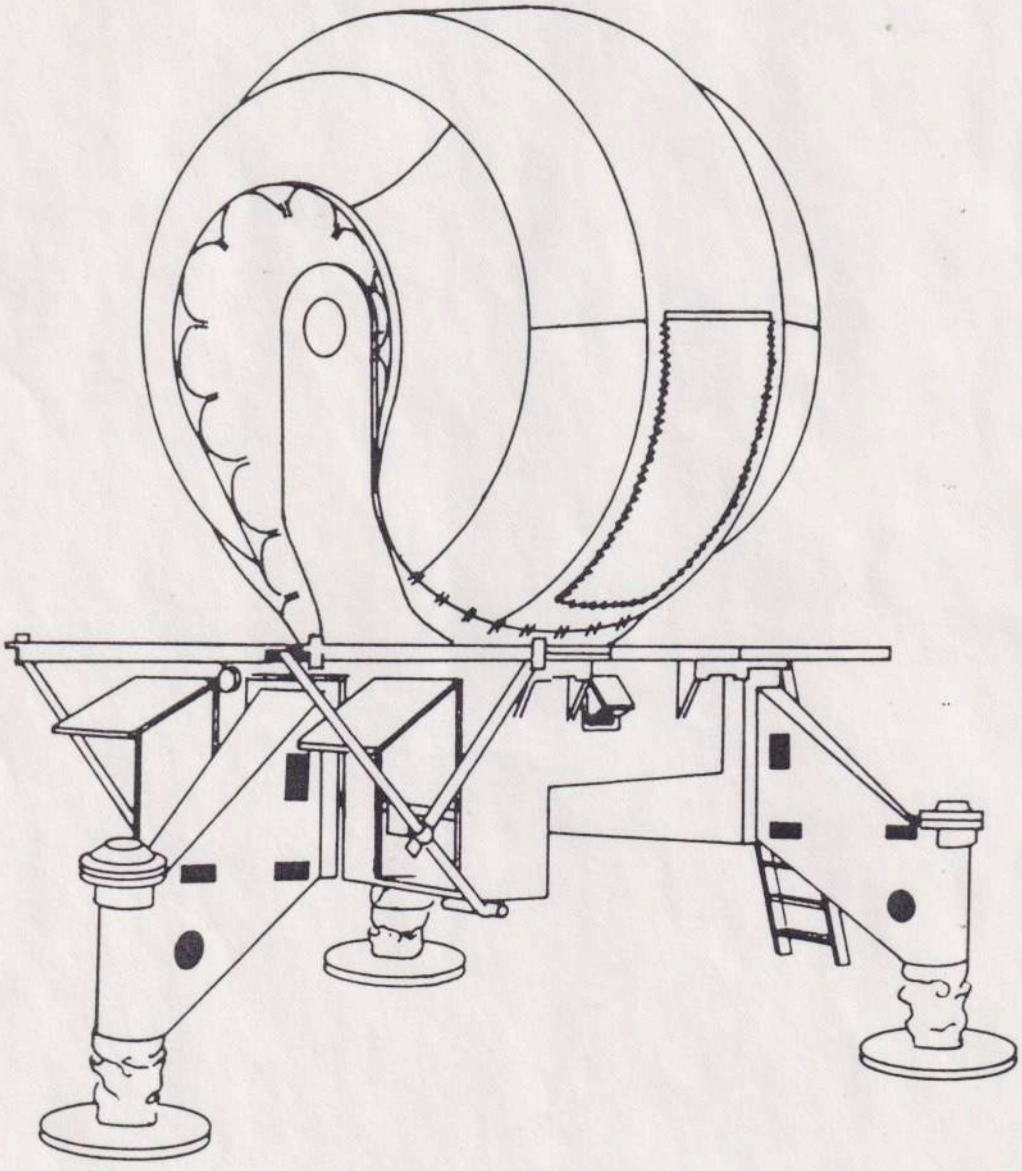
Figure 9. --Acquisition Radar .



F0211 Figure 10. --Tracking Radars .

8-3.3.2 INITIAL TURN PHASE. The initial turn section of the computer orders the missile to dive and turn toward the computed kill point. It orders the missile on the optimum trajectory to the computed kill point as rapidly as possible. In addition, if necessary, the initial turn section orders the missile to skirt the missile-tracking radar to prevent the missile from causing the tracking radar to exceed its maximum tracking rates. These orders are applied to the missile and held until it has cleared the missile-tracking radar and is on trajectory. What is meant by skirting is: the missile speed is so great that the tracking rate limit of the MTR will be exceeded if the missile is allowed to come too close to the MTR. The critical zone is an area around the MTR in which the missile may not proceed without exceeding the maximum tracking rate of the MTR nearest the kill point direction. Also considered in this phase is the method of launch and booster disposal. The best method of getting the missile on the proper trajectory quickly is to dive it toward the kill point. The missile is fired from the launcher in a nearly vertical direction. If the missile is rising vertically, it can then dive toward a kill point in any direction. If the missile were not fired vertically and had to be directed toward a kill point not in the direction of launch, a great amount of thrust, range, and time would be lost. As stated, the missile is launched in an almost vertical direction. This slight angle allows the booster to fall into the booster-disposal area. The selection of this area normally finds a region of low population and low property values. This slight tilt of the launcher minimizes the possibility of a falling booster that will cause damage in the battery area.

8-3.3.3 STEERING PHASE. Once the missile is launched, programed, and orders of dive and turn have been applied, the computer must generate orders to maneuver the missile continuously toward a constantly changing kill point. To accomplish this guidance, the computer compares target and missile position and determines the errors. These errors are ultimately converted to corrective steering orders to the missile and time correction to the computer. The computer will determine whether the missile is traveling too fast or too slow. Since there is no way to correct the speed of the missile, the computation (time correction) will be applied to the time servo in the computer. The time servo had been setup during prelaunch phase based on how long it would take an average missile to reach the kill point if it were launched at that instant.

8-3.4 SPECIAL EVENTS.

8-3.4.1 LAUNCHING (FIRING). The battery control officer may fire after the ready-to-fire indication from the computer has been received. When the battery control officer depresses the fire switch, the fire command is sent to the missile. Missile launching takes place approximately 2 seconds after depression of the fire switch.

8-3.4.2 BURST ORDER. This order may be originated by the battery control officer or the computer dependent on the option selected by the battery control officer. In either case, the burst command is transmitted to the missile through the MTR.

8-3.4.3 COMPUTER RESET. The computer begins its reset cycle after the burst command is sent. The computer resets to prelaunch phase or standby dependent on whether the target-tracking signal was removed or not.

8-3.4.4 GYRO LIMIT. A built-in circuit prevents the missile from receiving too great a turn angle command preventing the roll-gyro slopes in the missile from going into Gimbal lock which, if this happened, would cause the missile to continuously roll and become unguidable.

8-3.4.5 ORDER LIMIT. The orders sent to the missile as the missile increases in altitude must be limited. This is necessary because as altitude increases, the air density decreases. In this less dense air, the missile does not need as large a command to execute the steering commands. Circuitry built into the computer automatically limits these commands.

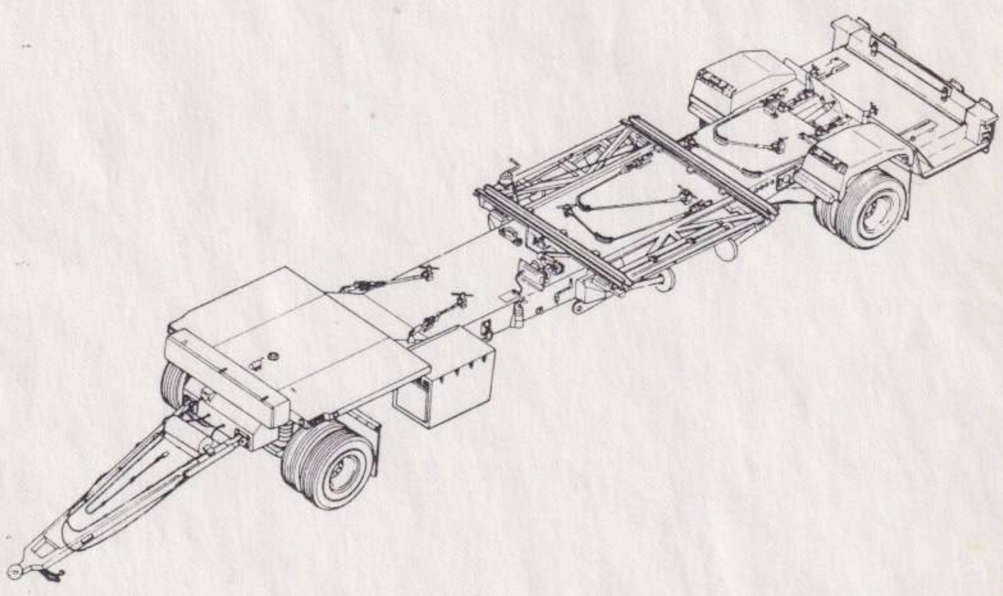
8-3.4.6 PLOTTING BOARDS. The critical elements of an engagement are displayed on several plotting boards available for view to the battery control officer. There is an early warning plotting board to present information on distant aircraft by means of manual plots. The horizontal plotting board plots range and azimuth of kill point, target, and missile during an engagement. This board displays information by a pen tracing on paper. The right pen will trace the missile at launch. The left pen will mark the predicted kill point, then will trace the target when the TTR is activated. There is also a pen tracing plotting board to display the altitude of target and missile.

8-3.4.7 MULTICHANNEL DATA RECORDER. This item of equipment provides a permanent record of an engagement, and of selected tests and checks. From this record, crew performance, equipment performance, and missile performance information can be obtained.

SECTION IX

FIELD DISPLACEMENT

As indicated in previous sections, the Nike-Hercules is capable of being displaced from its permanent firing locations to field firing emplacement.



F0212 Figure 11. --Ready-Round Transporter for Field Firing.