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HIPAR DESCRIPTIVE DATA (U)

TRANSMITTER SYSTEM	EFS HIPAR	EFS RETROFIT HIPAR	ATBM HIPAR
PRF	400 to 445 pps (fixed with moving target indicator (MTI) trigger)	Same	Same
Frequency range	1350 to 1450 mc (ten preset crystal-controlled frequencies, selected at battery control console or transmitter control	Same	Same
	cabinet)		
Transmitter Tube type	Broadband Klystron Type	Same	Same
Peak power	7.5 megawatts	5.5 megawatts	10.4 7.5 megawatts
Average power	26 19 kilowatt (.00254 duty cycle)	14 kilowatts (.00254 duty cycle)	19 kilowatts (. 00254 duty cycle)
Pulse width	6 μsec	Same	Same
Transmitter frequency change time	Less than 90 μ sec (During dead time before transmitted pulse)	Same	Same
TR tube Recovery time	Less than 100μsec to 3 db down point	Same	Same
Insertion loss	0.7 db maximum	Same	Same
Duplexer tube Recovery time	105 μs	Same	Same
Insertion loss	0.3 db maximum (transmitting) 0.1 db maximum (receiving)	Same	Same
RECEIVING SYSTEM			
Receiver type	Low-noise broadband para- metric amplifiers of the lower sideband, up- converter type (noise figure limit is 3 db) dual channel (main and auxiliary)	Same	Same
System noise figure (in- cluding front-end loss and sky noise)	5.5 db (maximum - either channel) 4.5 db (typical)	Same	Same
January 1, 1965	HIPAR		15

RECEIVING SYSTEM	EFS HIPAR	EFS RETROFIT HIPAR	ATBM HIPAR
Receiver bandwidth (Target channel)	200 kc	Same	Same
Receiver bandwidth (Strobe channel)	3 mc	Same	Same
Anti-jam features	Clutter gated noncoherent MTI, Dicke-Fix, Stagger PRF, fast automatic gain control (FAGC) electronic frequency selection	Same	Same
MDS	***		
Main receiver	-114 dbm	Same	Same
MTI receiver	-112 dbm	Same	Same
Auxiliary receiver Parametric amplifier dynamic range	-102 dbm	Same	Same
Main parametric amplifier	80 db	Same	Same
Auxiliary parametric amplifier	80 db	Same	Same
Parametric amplifier gain			
Main amplifier	45 ±3 db	Same	Same
Auxiliary amplifier	45 ±3 db	Same	Same
Image rejection	Spurious signal rejector of 60 db or more at ±10 mc from center frequency	Same	Same
FAGC noise level variation	Less than 2 db at the signal detector for a 60-db variation at the input of the narrowband amplifier with a recovery period of not more than 100 μ sec.	Same	Same
STC signal range adjustment	Suppression adjustable from 0 to 80 db (STC time constant adjustable from 100 to 1500 μ s) Range adjustable from zero to 40 nautical miles with a reduction of 12 db per octave.	Same	Same

NIKE-HERCULES, IMPROVED NIKE-HERCULES, AND NIKE-HERCULES ATBM MISSILE TRACKING RADAR

	HANDWHEEL	HANDWHEEL CONSTANTS AND MAXIMUM TRACKING RATES(U)		
		Time of Promotion		
		Type of Operation		
Coordinate	Manual	Aided Manual	Automatic	Slew
ELEVATION	34 mils/turn	0.465 - second time constant; 420 mils/second maximum	700 mils/second maximum	
AZIMUTH				
А Ѕсоре	34 mils/turn	0.313-second time constant; 625 mils/second maximum	700 mils/second maximum	-
RANGE	200 yards/ turn	1.15-second time constant; 1000 yards/second maximum	1600 yards/second maximum	18, 000 yards/ second maximum



MISSILE TRACKING RADAR - DESCRIPTIVE DATA (U)

NIKE-HERCULES

Pulse repetition rate

Frequency range

Power requirements (minimum)

Pulse width

Frequency tuning rate

Antenna type

Antenna diameter

Antenna gain

Azimuth and elevation

Sum

Increase over NIKE-AJAX

Antenna polarization

Antenna efficiency

Beamwidth

Receiver noise figure

System noise figure

IF preamplifier

Gain

Noise figure

500 pps (HERCULES mode) 1600-2400 pps (AJAX mode)

8500-9600 mc

Average power 79.4 watts Peak power 158.9 kw

 $0.25~\mu sec$

50 mc/sec

Double dish cassigranian parabolic reflector consisting of feed, subdish, and

polarizing filter

92 inches

37.5 db (midband)

2.5 db variation over the frequency band

44.1 db (midband)

0.7 db variation over the frequency band

4.8 db (midband, sum)

Vertical

54% (measured/ideal, power gain for uniformly illuminated antenna of same

size)

1 degree azimuth and elevation

11.2 db nominal, with input to converter,

(includes noise source correction)

12.2 db nominal with input to converter

+1 db preconverter losses (includes noise

source correction)

24 db

3 db

MISSIL E TRACKING RADAR - DESCRIPTIVE DATA (U) (continued)

NIKE-HERCULES

Tracking rates

Automatic

Manual aided

Slew

Presentation range

Azimuth and elevation 700 mils/second maximum range 1600 yards/second maximum

Azimuth and elevation 700 mils/second maximum 1000 yards/second maximum

Range 18,000 yards/second

200,000 yards

Improved NIKE-HERCULES

Pulse repetition rate

Frequency range

Power requirements (minimum

Pulse width

Frequency tuning rate

Antenna type

Antenna diameter

Antenna gain

Azimuth and elevation

Sum

Antenna polarization

Beam width

Antenna cross-polarized gain

Receiver noise figure

System noise figure

ATR recovery time (6163 tube)

IF preamplifier

Gain

Noise figure

Receiver dynamic range (including AGC)

Main IF amplifier, gain control range

500 pps (HERCULES mode) 1600-2400 pps (AJAX mode)

8500-9600 mc

Average power 79.4 watts Peak power 158.9 kw

0.25 µsec

50 mc/sec

Double dish cassigranian parabolic reflector consisting of feed, subdish, and

polarizing filter

CONTR SCREEN FILTER d 583311 : (de :) .7db 92 inches

37.5 db (midband) 2.5 db variation over the frequency band

44. 1 db (midband)

0.7 db variation over the frequency band

Vertical

1 degree azimuth and elevation

At least 26 db below nominal sum mode gain over the band

11.2 db nominal with input to converter (includes noise source correction)

12.2 db nominal with input to converter +1 db preconverter losses (includes noise

source correction)

8 μsec maximum

24 db

3 db

Greater than 95 db

Greater than 75 db

Tracking antenna capabilities in high winds (based upon 521 ft-lbs to counterwind torque and 7250 lb antenna weight)



TARGET TRACKING RADAR - DESCRIPTIVE DATA (U)

NIKE-HERCULES

Pulse repetition rate

Frequency range

Power requirements, minimum Power requirements, typical

Pulse width

Frequency tuning rate

Antenna type

Antenna diameter

Antenna gain

Azimuth and elevation

Sum

Increase over NIKE-AJAX

Antenna efficiency

Antenna polarization

Beam width

Receiver noise figure

System noise figure

IF preamplifier

Gain

Noise figure

Tracking rates

Automatic

500 pps

8500-9600 mc

26.9 watts average, 215.3 kilowatts peak

250 kilowatts peak

0.25 μsec

50 mc/sec

Double dish Cassigranian parobolic reflector

consisting of feed, subdish, and polarizing

filter

92 inches

37.5 db (midband)

2.5 db variation over the frequency band

44. 1 db (midband)

0.7 db variation over the frequency band

4.8 db (midband, sum)

54% (measured/ideal, power gain for uniformly

illuminated antenna of same size)

Vertical

1 degree azimuth and elevation

11.2 db nominal with input to converter (in-

cludes noise source correction)

12.2 db nominal with input to converter + 1 db

preconverter losses (includes noise source

correction)

24 db

3 db

Azimuth and elevation 700 mils/second maximum; range 1600 yards/second

maximum.

Manual aided

Slew

Azimuth and elevation 700 mils/second maximum; range 1000 yards/second maximum

Azimuth 700 mils/second maximum; elevation 62 mils/second maximum; range 18,000 yards/second maximum

Handwheel constants

Elevation

Manual 34 mils/turn; manual aided 420 mils/second maximum (0.465 second time constant)

Azimuth

Manual 34 mils/turn; manual aided 625 mils/ second maximum (0.313 second time constant)

Range

Manual 200 yards/turn; manual aided 1000 yards/second maximum (1.15 second time constant)

Presentation range

200,000 yards

TECHNICAL DATA **NIKE-HERCULES**

Improved And ATBM NIKE-HERCULES

Pulse repetition rate

Frequency range

Power requirements, minimum

Power requirements, typical

Pulse width

Frequency tuning rate

Antenna type

Antenna diameter

Antenna gain

Azimuth and elevation

Sum

Beamwidth

Antenna cross-polarization gain

Antenna polarization

Receiver noise figure

System noise figure

Receiver bandwidth

ATR recovery time (6163 tube)

IF preamplifier

Gain

Noise figure

Receiver dynamic range (including AGC

Main IF amplifier, gain control range

400-445 PPS (HIPAR, long and short pulse) 500 PPS (LOPAR, long and short pulse) 8500-9600 mc (X - Band)

Short pulse 25.1 watts average power, 201.1 kw peak power Long pulse 177.8 watts average power, 142.3 kw peak power

Short pulse 250 kw peak; long pulse 200 kw

peak

0.25 and 2.5 μsec

50 mc/sec

Double dish Cassigranian parabolic reflector consisting of feed, subdish, and polarizing

filter

92 inches

37.5 db (midband)

2.5 db variation over the frequency band

44.1 db (midband)

0.7 db variation over the frequency band

1 degree azimuth and elevation

At least 26 db below nominal sum mode gain

over the band

Vertical

10.2 db nominal with input to converter (includes noise source correction)

11.2 db nominal with input to converter + 1 db preconverter losses (includes noise source

correction)

Long pulse, 0.8 mc (bandpass filter) Short pulse, 9.5 mc (main IF amplifier)

8 μsec maximum

Greater than 25 db

2.30 db

Greater than 95 db

Greater than 75 db

Tracking rates

Automatic

Azimuth and elevation 700 mils/second maximum; range 2600 yards/second maximum

Manual aided

Azimuth and elevation 700 mils/second maximum; range 2000 yards/second maximum

Slew

Azimuth 700 mils/second maximum; elevation 65 mils/second maximum; range 18,000

yards/second maximum

Handwheel constants

Elevation

Manual 73 mils/turn;

manual aided 420 mils/second maximum (1-

second time constant)

Azimuth (B Scope)

Manual 440 mils/turn;

manual aided 420 mils/second maximum

(6-second time constant)

Azimuth (A Scope)

Manual 73 mils/turn;

manual aided 420 mils/second maximum

(1-second time constant)

Range (B Scope)

Manual 2100 yards/turn;

manual aided 2000 yards/second maximum

(6-second time constant)

Range (A Scope - long pulse)

Manual 700 yards/turn;

manual aided 2000 yards/second maximum (2-second time constant)

Range (A Scope - short pulse)

Manual 175 yards/turn:

manual aided 2000 yards/second maximum

(0.5-second time constant)

Presentation range

200,000 yards

Tracking antenna capabilities in high winds (based upon 521 ft-lbs to counterwind torque and 7250-lb antenna weight)

With an inflated radome the tracking antenna will safely operate without fairings in winds up to

75 mph (approx.)

With an inflated radome the tracking antenna will safely operate with fairings in winds up to

90 mph (approx.)

With uninflated radome the tracking antenna is subject to damage in winds exceeding

70 mph

With the radome inflated no damage is sustained in winds up to

100 mph

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TTR

January 1, 1965

CHRONOLOGY OF THE NIKE-HERCULES RESEARCH AND DEVELOPMENT PROGRAM

July (5)

Office Chief of Ordnance (OCO) requested feasibility study on the defense against formations of aircraft by use of Corporal in conjunction with T33 or Nike-Ajax system.

July (30)

Conclusions were reached by Bell Telephone Laboratories (BTL) that neither T33 nor Nike-Ajax were feasible to mate with Corporal.

- - - - - 1952 - - - -

October (9)

Feasibility study requested by OCO for integration of an atomic warhead into the Nike-Ajax missile system. This proposal was considered feasible, with reservations, both for the Nike-Ajax missile and for a larger-diameter missile that would make more efficient use of fissionable materials.

- - - - 1953 - - - - -

February

Nike-Hercules missile study begun under Nike-Ajax Research and Development (R & D) contract.

March (16)

BTL-OCO conference held to discuss Nike-Hercules Development Program.

R & D Board and the Joint Chiefs of Staff had approved the Army requirements for Nike-Hercules.

June (19)

Nike-Hercules program reviewed by Army General Staff G-3 and G-4, Office Chief of Army Field Forces, OCO, Western Electric Co., and Bell Telephone Laboratories at Washington, D. C. Objectives of the Nike-Hercules program were defined as:

- Development of a new missile to carry a large warhead for use with Nike-Ajax ground guidance and control equipment essentially unmodified.
- Study of the possibilities of extended range of the Nike-Ajax ground guidance and control equipment to utilize fully the range capabilities of the new missile (including a possible secondary role as a surface-to-surface system).

July (16)

The Nike-Hercules project was authorized by OCO.

October (20 and 21)

Contractor representatives made an oral presentation of the results of Nike-Hercules system studies. Principle topics discussed were:

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- 1. Possible configurations for the Nike-Hercules missile.
- Ground equipment changes for the 25-mile version of the missile. It was
 estimated that these changes would cost about 9-1/2 per cent of the original Nike-Ajax ground equipment investment.
- 3. A long-range (50-mile) version of Nike-Hercules. A cost estimate for the program was given as 21 per cent of the original Nike-Ajax investment.
- 4. Possibilities of incorporating surface-to-surface capabilities.

- - - - - 1954 - - - - -

First Quarter

Authorization given to:

- Develop a Nike-Hercules missile capable of carrying a 30-inch diameter, 1200-pound payload.
- 2. Modify a production Nike-Ajax system for testing the 25-mile Nike-Hercules missile at White Sands Missile Range.
- 3. Continue study on a long-range version of the Nike-Hercules missile.

February (26)

Oral survey of the Nike-Hercules system given by the contractor at the Pentagon Building, Washington, D.C. at the request of the Committee on Guided Missiles of the Department of Defense.

March (23)

A meeting was held at Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland, for the purpose of coordinating the efforts and fixing the responsibilities of the various agencies concerned with the development of the Nike-Hercules cluster warhead.

April (23)

Oral report on surface-to-surface role of Nike-Hercules given to Sergeant Steering Committee.

Second Quarter

Authorization given to:

- 1. Develop ground equipment models for extended-range (50-mile) version of Nike-Hercules.
- 2. Continue study of a single-stage solid propellant missile.
- 3. Investigate the problem of increased accuracy against ground targets.

August (17-20)

Second Nike-Hercules planning conference was held at White Sands Missile Range.

Third Quarter

Authorization given to contractor to construct a second experimental model of the Nike-Hercules ground guidance and control equipment for development use at Bell Telephone Laboratories, Whippany, N.J.

- - - - 1955 - - - - -

January

First R & D firing test.

April (29)

Authorization for five prototype systems.

April (29)

Authorization for Charlotte missile production.

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November (30)

Authorization for production of Nike-Hercules ground equipment.

December

Completed preparation of manufacturing information.

White Sands Missile Range Firing Summary

Twenty Nike-Hercules rounds fired with modified Nike-Ajax ground guidance equipment using Bathtub guidance sections.

- - - - 1956 - - - -

January

First Nike-Hercules missile fired from modified Nike-Ajax R & D system at White Sands Missile Range.

March

Delivery of Nike-Hercules model #1 to White Sands Missile Range.

July (25)

First Nike-Hercules missile fired using a Nike-Hercules missile system.

Third Quarter

First prototype (Santa Monica) missile delivered.

November (30)

First Nike-Hercules prototype system (#1) delivered to BTL.

White Sands Missile Range Firing Summary

Eight firings with modified Nike-Ajax ground equipment.

Four firings with internal programmer.

Fifteen firings with Nike-Hercules ground equipment.

(All firings with Bathtub guidance sections, except two firings with Stovepipe guidance sections. All system test rounds in surface-to-air mode.)

- - - - - 1957 - - - - -

January

First prototype (#2) Nike-Hercules system delivered to the Army.

June

Installation of prototype system at White Sands Missile Range.

June (30)

First production system delivered to the Army.

White Sands Missile Range Firing Summary

QB-17 drone kill, 2/6/57, 9000-foot altitude MSL, 20,000-yard range.

QF-80 drone kill, 4/25/57, 9000-foot altitude MSL, 25,000-yard range.

QB-17 drone kill, 9/11/57, 6300-foot altitude MSL, 50,000-yard range.

First solid propellant missile, 3/13/57.

First production-type missile fired, 7/12/57, with Nike-Hercules prototype system #1.

First successful surface-to-surface round, 8/21/57.

First low altitude round, 9/11/57.
(Drone destroyed by direct contact.)

First article inspection round, 11/27/57.

Four surface-to-surface rounds (three successful).

Four low-altitude rounds (two successful).

Five T45 warhead rounds.

Six cellular launcher tests.

- - - - - 1958 - - - - -

January

Delivery of first production (Charlotte) missile.

June

First tactical deployment.

White Sands Missile Range Firing Summary

Three surface-to-surface rounds (all successful).

First flight test of Charlotte production missile successful (also first article inspection round), 4/30/58.

First T46 warhead round, 4/2/58.

First live T46 warhead round, 6/25/58.

Project Ammo demonstration round successful, 7/1/58.

Series of eight rounds to demonstrate in-flight reliability — five fired from White Sands Missile Range, three fired from McGregor range, (seven successful) 7/58.

First Mushroom guidance section flight, 8/8/58, (successful).

Army Ordnance Association demonstration round, 10/9/58.

First flight against POGO drone successful, 11/6/58, 109,000-foot altitude MSL, 58,000-yard range, T45 warhead (drone killed).

First flight against Q-5 drone successful, 11/19/58, 60,000-foot altitude, 50,000-yard range, T45 warhead (drone killed).

1959 - - -

January

HIPAR model at Whippany operational.

Snowjet cold weather operational tests (Fort Churchill, Manitoba).

February

Experimental Dicke-Fix receivers (ECCM devices) installed in Washington-

Baltimore Defense Area.

April

Ordnance Design Characteristics Inspection of the Improved NIKE-HERCULES

System.

May

Testing of Mobile Launcher model begun at White Sands Missile Range.

June

Quick Reaction Capability Program initiated to introduce electronic counter-

countermeasure devices into NIKE systems on an expedited basis.

July

Analysis of Weapons System Evaluation Group Test No. 3 to evaluate NIKE

performance in a heavy ECM environment presented to ARGMA.

October

Complete Improved NIKE-HERCULES System model at Whippany operational.

November

Development started as part of the HERCULES program on a multichannel

ECCM receiver known as the Anti-Jam Display (AJD).

White Sands Missile Range Firing Summary

Two low-altitude rounds successfully fired at a grounded B-17 aircraft carcass for evaluation of the T-46 warhead, 1/7/59.

First flight against Matador drone successful, 2/6/59, 42,500-foot altitude, 48,000-yard ground range, T-45 warhead (drone killed).

QF-80 drone successfully intercepted at an altitude of less than 1000 feet, 2/18/59, 25,900 yard ground range, T-45 warhead (drone killed).

Flight against POGO-Hi target successful, 3/11/59, 156,000-foot altitude, 19,000-yard ground range, T-45 warhead (target killed).

Four rounds fired to demonstrate T-46 warhead tactical capability, 5/59 to 9/59 (all successful).

First firing from cellular launcher, 6/24/59 (successful).

Series of 16 successful rounds to demonstrate surface-to-surface capability — 9 fired from White Sands Missile Range, 7 fired from McGregor range, 7/59 to 9/59.

First round fired to test Transponder Control Group parachute recovery system, 8/28/59 (successful).

Q-5 drone flying at Mach 2.2 successfully intercepted, 10/16/59, 38,000-foot altitude, 47,000-yard ground range.



- - - - - 1960 - - - - -

February	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW I.
March	Proposed concept of mobility for the High Power Acquisition Radar (HIPAR) of
	the Improved NIKE-HERCULES System was prepared.
March	Anti-Jam Display (AJD) equipment installed in the S-band Acquisition Radar
	(LOPAR) at Whippany and tested in an ECM environment.
March	Whippany Improved NIKE-HERCULES Model operated as a Basic NIKE-
	HERCULES System participated in SIOUX ARROW II.
March	Prototype HIPAR accepted with the Improved NIKE-HERCULES Ground
	Guidance System by Army Ordnance $(3/31/60)$.
April	Study on Cross-Country NIKE-HERCULES indicated feasibility to mount the
	Improved NIKE-HERCULES System on self-propelled, Goer-type vehicles.
April	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW III.
April	Study completed which investigated the capabilities of the Basic and Improved
	NIKE-HERCULES System with certain modifications against attack by certain
	short-range ballistic missiles. (4/8/60).
April	First firings made from the prototype Improved NIKE-HERCULES System at
	White Sands Missile Range (4/14/60).
May	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW IV.
June	Study made of an abbreviated NIKE-HERCULES System limited only to the
	surface-to-surface mode of operation.
June	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW V.
July	Installation and checkout of the Manual Anti-Jam Display (AJD) for the Whippany
	Improved NIKE-HERCULES Model and the White Sands Missile Range Prototype
	HIPAR concluded.
November	Study concerning the feasibility of using a single HIPAR to supply acquisition
	data to a dual NIKE-HERCULES site completed.
December	Model kit for experimental installation of the MARK XII. IFF Interrogation
	System to selected NIKE-AJAX and NIKE-HERCULES Systems completed.

White Sands Missile Range Firing Summary

HERCULES Missile (B-281) cold condition to -40° F. successfully intercepted a POGO Target. (2/5/60).

Four rounds (B-284, 285, 286, 293) fired in evaluation tests of the new low-altitude functions which were installed in the C-Station Computer. Three rounds were successful. One unsuccessful. (2/26/60, 2/26/60, 3/2/60, 4/26/60).

First firings from ZURF occurred; one AJAX Missile (660) fired in a successful system test of ZURF. (3/8/60). One HERCULES round (ZURF) also fired. (4/8/60)

Two firings (B-294, ZURF-6) made using cold-conditioned missiles. One successful intercept of a simulated target was made at 130,000 yards range, 64,000 feet altitude MSL. The other round unsuccessful. (5/17/60, 7/15/60).

AJAX missile successfully fired to evaluate miss distance indicator to be used in the HIGHBALL target program. (5/21/60)

First intercept by HERCULES missile (INH-2), equipped with a conventional T-45 warhead, of a CORPORAL missile at 26,500 feet MSL and a range of 52,000 yards. (6/3/60)

HERCULES (INH-4) intercepted a POGO-HT Target at an altitude of 101,000 feet MSL and a ground range of 52,000 yards. (6/15/60)

Six separate HERCULES missiles (INH-3,6,8,9,11,12) fired against six target HERCULES missiles. (6/15/60, 8/12/60, 8/17/60, 9/14/60, 10/6/60, 11/17/60) Three HERCULES rounds (B-299, B-303, B-305) fired for the T-46 firing program. (7/6/60, 7/27/60, 10/12/60)

HERCULES missile (INH-5) successfully intercepted a Q-5 drone at 63,000 feet MSL and 72,000 yards ground range. (7/11/60)

HERCULES missile (INH-7) fired at a surface target 115,000 yards up-range. (8/17/60)

HERCULES missile (INH-10) successfully destroyed an XM-21 drone at the low altitude of 4500 feet above ground level. Ground range was 60,000 feet. (9/14/60)

---- 1961 ----

First quarter Strategic Air Command (SAC) developed a Radar Bomb Scoring field kit for use in NIKE Systems.

January

HIPAR operating frequency band shifted from 1435 - 1535 MCS to 1427 - 1527 MCS.

January

The design of Electronic Shop 3 (GS-58679) for the Improved NIKE-HERCULES Battery Type IV was placed into production.

February

Whippany Model HIPAR modified to incorporate automatic Anti-Jam Display (HAJD) capability.

May

Army Rocket and Guided Missile Agency requested that Bell Telephone
Laboratories develop an Anti-tactical Ballistic Missile (ATBM) system.

June

Feasibility study for operating one HIPAR with two NIKE-HERCULES Systems resulted in a modification kit to provide facilities for integrating a HIPAR into NY-49, a dual Improved NIKE-HERCULES site.

MOV - FINALIZED ECP'S - TM'S

November

The "A" Frame Derick for use with the NIKE-HERCULES Field Army System mounted and tested.

November

Testing of the Improved NIKE-HERCULES HIPAR Anti-Jam Display (HAJD) successfully completed.

White Sands Missile Range Firing Summary

Six HERCULES missiles (SS-1 thru SS-6) fired in support of a surface-to-surface evaluation. (2/28/61 to 4/27/61)

HERCULES (INH-15) successfully intercepted Q2A drone at 4500 feet above terrain, 52,000 yards range. (3/10/61)

HERCULES round (INH-16) fired in the surface-to-surface mode to 100,000 yards ground range (3/21/61).

First GOER launch (B-314) at simulated ASM. (3/30/61)

HERCULES (INH-17) with T-45 successfully intercepted ECM-equipped Q2A drone at 27,000 feet above terrain, 96,000 yards range. (4/31/61)

Simulated radar-seeking missile target successfully intercepted by a HERCULES Missile (B-316) at 52,000 feet MSL and 58,000 yards ground range. (5/20/61)

Round (B-317) fired at a space point, 15,000 feet MSL and 30,000 yards ground range during verification that failsafe switches at station 136 would operate correctly. (6/14/61)

First firings from a GOER launcher in the surface-to-surface mode. Two missiles (B-320, 321) fired to a ground range of 154,000 yards. (9/20/61, 10/6/61).

HERCULES (INH-13) launched and successfully intercepted an ECM-Equipped XM-21 Drone at 22,000 feet MSL and 60,000 yards ground range. (11/17/61)

HERCULES round (INH-18) equipped with a Miss Distance Indicator (MDI) successfully intercepted a ballistic HIGHBALL II Rocket nose section at an altitude of 20,000 feet (MSL) and ground range of 54,000 yards. (11/20/61)

HERCULES round (INH-19) with T45 warhead fired against a Redstone missile under "Operation HARDNOSE." Intercept of the REDSTONE nose cone not accomplished. (12/5/61) LOST BEAGEN

System Test Division (STD) Round 84HE successfully fired at a 66-foot diameter polyethylene balloon. (12/6/61)

ATBM Two HERCULES missiles (ZURF-13, 14) fired at space points as high altitude ballistic targets for NIKE-ZEUS System Demonstrations (12/12/61, 12/14/61)

- - - - 1962 - - - -

March

AOMC authorized the development of the Cross-Country NIKE-HERCULES HIPAR Program (3/6/62).

March

The HIPAR staggered PRF modification concluded.

January 1, 1965

FEB- GE ROIL-OUT AT PLANT 40 SNOW

April General Electric began development of mobile HIPAR.

April Static ECCM tests for the TRR completed and documented. (4/16/62)

June Prototype Evaluation of the Improved NIKE-HERCULES System completed and

documented.

June Criteria established for an acceptable Cross-Country NIKE-HERCULES power

distribution system. (6/26/62)

June The Improved NIKE-HERCULES System implemented with the "Sync-loop"

successfully beacon-tracked ZEUS missiles. (6/28/62, 7/31/62, 8/28/62)

July The EFS modification installed in the prototype NIKE-HERCULES System at

WSMR.

August Two brassboard kits of the lin-log receivers installed in the Prototype Improved

NIKE-HERCULES System at WSMR for dynamic testing.

September Ordnance documentation for ATBM System completed and approved by AMICOM.

(9/28/62)

September Production model of the ATBM modification (less HIPAR) installed in the

improved NIKE-HERCULES Prototype System at WSMR. (9/22/62) 457 K 17 1

November Installation of ATBM HIPAR Antenna into the Improved NIKE-HERCULES

Prototype System at WSMR complete. LC-37 2066

December Development effort to provide Cross-Country capability to the NIKE-HERCULES

System discontinued. (12/13/62).

December Interim Mobile HIPAR proposed. (12/15/62)

White Sands Missile Range Firing Summary

Two HERCULES cold rounds (B-324, 325) successfully fired at space points. (1/12/62, 2/9/62)

System Test Division (STD) round 85HE successfully fired in the SS mode. (1/29/62)

STD round (FS-4) successfully fired at a 36-foot metalized parachute. (3/15/62) HERCULES missile (ZURF-15) fired as high altitude ballistic targets from

ZURF for NIKE-ZEUS System demonstrations. (3/28/62)

HERCULES missile (B-326) successfully fired in the SS mode at a target 154,000 yards distant. (5/12/62)

For evaluation of a new guidance section two HERCULES rounds (B-327, 328) fired on special "roller coaster" trajectories. The rounds were successfully fired at a test point 20,070 yards in range and zero altitude. (6/28/62, 8/16/62)

A HERCULES missile (B-330) and two special missiles successfully fired at a space point. Maximum altitudes attained were 280,000, 228,000, and 320,000 feet MSL respectively. (9/10/62, 8/28/62, 8/29/62)

- - - - - 1963 - - - - -

February

Advanced HERCULES study program begun by BTL at the request of AMICOM.

February

Effort terminated on development of the NIKE-HERCULES GOER solid state

power converter. (2/15/63)

March

NIKE-HERCULES participated in Project DOMINIC.

April

BTL study on the NIKE-HERCULES Proposed Improvement Program was

documented. (4/17/63)

April

Design requirements on Interim Mobile HIPAR finalized. (4/19/63)

April-May

Flight Tests conducted to evaluate HIPAR MTI Performance.

May

Design of vans for use with Mobile HIPAR completed.

June

Contractor directed by HERCULES Project Office at RSA to develop specific improvements to TTR, TRR, and HIPAR and conduct feasibility studies on an improved Battery Control Console and use of scan conversion.

July

R and D model of "Random/Program Frequency Selector" installed in the HIPAR

at WSMR.

August

HIPAR Electronic Frequency Selection (EFS) modification kit installed in the

WSMR HIPAR.

November

Design requirements for the Interim Mobile HIPAR finalized and released.

White Sands Missile Range Firing Summary

Instrumented HERCULES cold round (B-331) successfully fired at two space points 80,000 feet MSL, 130,000 yards ground range and 43,000 feet MSL, 167,000 yards ground range. (1/18/63)

A HERCULES round (B-332) fired at a surface target of 154,000 yards ground range to evaluate new missile guidance section components. Missile fail-safe at 123 seconds. (2/7/63)

The first missile (ATBM-1) of the NIKE-HERCULES ATBM Prototype System fired at a NIKE-HERCULES missile launched from the ZURF site. Event recorder miss distance was 738 feet. (4/3/63)

The nose section of a Pershing missile tracked after being released from a B-47. (5/17/63)

The second missile (ATBM-2) of the Prototype NIKE-HERCULES ATBM System intercepted a POGO target at an altitude of 101,000 feet MSL and a ground range of 30,000 yards. (5/11/63)

Four HERCULES missiles (ATBM-3, -4, -5, -8) fired from the HERCULES ATBM Prototype System against HERCULES target missiles. (5/17/63, 5/28/63, 6/5/63, 6/5/63)

Two HERCULES missiles (ATBM-6, -7) fired from the HERCULES ATBM

Prototype System successfully intercepted a space point at a ground range of

80,000 yards and an altitude of 120,000 feet MSL. (6/26/63, 7/19/63)

A HERCULES missile (ATBM-9) with a T-45 warhead fired from the HERCULES ATBM site and successfully intercepted a HERCULES target missile at a ground range of 56,000 yards and an altitude of 65,000 feet. This was an Engineering/Service tactical firing test and was conducted by a military operating crew. (9/5/63)

HERCULES missile (ATBM-11) with a T-45 warhead successfully fired from the ATBM site against a REDSTONE missile. Intercept occurred at 45,000 yards ground range and an altitude of 40,000 feet MSL. (10/5/63)

Two HERCULES missiles (ATBM 42 and 13) successfully fired from a mobile launcher located 1000 yards from the MTR. (10/11/63 and 10/24/63)
First SERGEANT intercept by HERCULES (ATBM-14). (12/9/63)
HERCULES missile (ATBM-15) with a T-45 warhead fired against SERGEANT target missile. (12/18/63)

- - - - - 1964 - - - - -

March

The HIPAR portion of the ATBM Prototype Test Program at WSMR completed.

April

Douglas report prepared which described the technical and economic aspect of

converting to a single-stage missile.

May

Development phase of the Mobile HIPAR program completed.

June

HIPAR MTI performance investigation completed and documented.

March

Contractor testing of Interim Mobile HIPAR System completed.

April

Implementation of AJD into WSMR EFS/ATBM HIPAR begun.

A pril

Modifications begun to increase radiated power of HIPAR transmitter.

White Sands Missile Range Firing Summary

First TECOM tactical SERGEANT intercept by HERCULES (ATBM-17). Intercept occurred at an altitude of 40,600 feet (MSL) and a ground range of 60,000 yards. (1/15/64)

First intercept of HONEST JOHN by HERCULES (ATBM-18)
Intercept at 23,000 yards ground range, altitude 20,700 feet (MSL) (1/21/64)
First TECOM tactical HONEST JOHN intercept by HERCULES (ATBM-19).
Intercept at 21,000 yards ground range, altitude 24,000 feet (MSL). (1/30/64)



NIKE-HERCULES PROPELLANT CHARACTERISTICS

LETTER REPORT RD-PR-87-40

ROBERT R. RADKE

JULY 1987

PROPULSION DIRECTORATE

RESEARCH, DEVELOPMENT, AND ENGINEERING CENTER

U. S. ARMY MISSILE COMMAND

REDSTONE ARSENAL, ALABAMA

M5/M88 Propellant Properties.

- Booster Propellant. 750.5 666.
 - Designation: OIO

2.	Composition.	
	Nitocellulose (12.6% N)	59.1
	Nitroglycerin	25.3
	Glycerol Triacetate	9.5
	Dimethyl Phthalate	2.6
	Lead Stearate	1.9
	2-Nitro Diphenyl Amine	1.6

З.	Combustion Properties.		
	Molecular Weight	22.84	
	Pressure	14.70	ngia
	Temperature		F
20	Ratio of Specific Heats	1.24	-

M30

- B. Sustainer Propellant.
 - 1. Designation: TP-E-8082

2.	Composition.	
	Ammonium Perchlorate	62.98
	Ethyl Formal Polysulfide	33.17
	Para Benzoquinone Dioxime	2.32
	1,3-Diphenyl Guanidine	1.16
	Polymeric Amide	0.33
	Sulfur	0.04
		100

Combustion Properties. Molecular Weight 24.23 Pressure 14.70 psia Temperature 3245.0 F Ratio of Specific Heats 1.19

II. Exhaust Species.

A. The theoretical booster exhaust products that were considered are expressed in mole fraction.

1. Free elements.

- a. Greater than 0.000005 mole fraction. H 0.00102 PB 0.00055
- b. Less than 0.000005 mole fraction.

2. Gasses.

- a. Greater than 0.000005 mole fraction.

 CO 0.44667

 CO2 0.08782

 H2 0.18835

 H2O 0.17488

 N2 0.10060

 OH 0.00010

 PBO 0.00001
- b. Less than 0.000005 mole fraction. CH C2H2 HCN NO CH2 C2H4 HCO NO2 CH20 C2H6 HNCO N2H4 CH3 C2N HNO N20 CH4 C2N2 HO2 N204 CNC20 H202 ΝЗ CNN C3 NCO 02 CN2 C302 NH 03 C2 C 4 NH2 C2H C5 кни

3. Liquids.

- a. Greater than 0.000005 mole fraction. None
- b. Less than 0.000005 mole fraction. H20

4. Solids.

- a. Greater than 0.000005 mole fraction. None
- b. Less than 0.000005 mole fraction. C H20

- B. The theoretical sustainer exhaust products that were considered are expressed in mole fraction.
 - 1. Free elements.
 - a. Greater than 0.000005 mole fraction. CL 0.00052 H 0.00105 S 0.00077
 - b. Less than 0.000005 mole fraction. C

2. Gasses.

Greater than 0.000005 mole fraction. CO 0.22652 COS 0.00073 CO2 0.06038 CS 0.00001 HCL 0.12936 H2 0.19540 H20 0.24612 H2S 0.01714 N2 0.07135 \circ H 0.00014 SH 0.00451 SO 0.00559 S02 0.01259 \$2 0.02782

	b. Less	than	0.000005	mole fractio	n.
CCL	CN	C2H2	CLCN	H202	N20
CCL2	CNN	C2H4	CLO	NCO	
CCL3	CN2	C2H6	CLO2		N204
CCL4	COCL	C2N		NH	ИЗ
CH	COCL2		CL2	NH2	02
CH2		C2N2	CL20	инз	03
CH2O	CS2	C20	HCN	NO	SN
	C2	C3	HCO	NOCL	SO2CL2
СНЗ	C2CL2	C302	HNCO	NO2	S03
CH4	C2H	C4	HNO	NO2CL	
•	•	C5	H02	N2H4	

- 3. Liquids.
 - a. Greater than 0.000005 mole fraction. None
 - b. Less than 0.000005 mole fraction.

4. Solids.

- a. Greater than 0.000005 mole fraction. None
- b. Less than 0.000005 mole fraction. C H2O S

MISSILE (continued)

Control Fins. (Delta planform, 2.78% thick, double-wedge airfoil, maximum thickness at 59.2% chord, hinge lines of both pairs of fins are same distance aft of body nose.)

Over-all span	24.598 in
Span at trailing edge, one fin	7. 576 in
Root chord (theoretical at body centerline)	28.975 in
Tip chord	0.000 in
Chord at fin-fuselage intersection	20.307 in
Hinge line location, distance forward of trailing edge	8.076 in
Theoretical vertex angle at body centerline	46.000 deg
Gross area, two fins	2.475 ft ²
Mean aerodynamic chord of gross area	19. 317 in
Exposed area, two fins	1.068 ft ²
Mean aerodynamic chord of exposed area	13.538 in
Maximum deflection	±15.0 deg
adar Antenna Fairings. (Four triangular-shaped fairings located at	

Ra Station 72.000 in the planes of the main fins.)

Span (measured from tip to fuselage)	3.000 in
Chord at antenna-fuselage intersection	
6	10.350 in

Conduit Fairings. (Four approximately semicircular fairings extending from Station 17.272 to Station 230.750, equally spaced around the circumference of the missile between the fins.)

Width at base	3.625 in
Maximum extension above fuselage	
ontoubton above luserage	1.250 in

XA ZA BOOSTER

Fins. (Trapezoidal, 6.13% thick root and 6.57% thick tip, double-wedge airfoil, maximum thickness at 50.0% chord.)

Circular span	86.325 in
Span at trailing edge, one fin	34.688 in
Root chord (intersection with skin)	
Tip chord	37. 125 in
• *************************************	10.500 in
Angle of sweepback of leading edge	20.996 deg
Angle of sweepback of trailing edge	
Exposed area, one fin	-20.996 deg
	5.736 ft ²
Mean aerodynamic chord of exposed area	26.306 in

BOOSTER (continued)				
Motor				
Beginning of head assembly		Sta	257.437	
Beginning of cylindrical section		Sta	262.037 (12	4.688 V
Centerline of fins		Sta	373.562	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
End of nozzle exit		Sta	392.125	
Diameter at end of head pad			18.760 in	
Diameter of cylindrical section			16.400 in	
Diameter of end of nozzle			16.626 in	
Internal diameter of nozzle exit (approximate)			16.636 in	
Thrust Structure				
Forward end of structure		Sta	233.187	,
Aft end of structure			257.437	
Aft end of missile			251.000	
Diameter of structure (forward external)			15.250 in	
Diameter of structure (forward internal)			12.031 in	
Diameter of structure (aft internal)			9.031 in	, e
Circular span of structure			19.187 in	į
Booster impact cushion		Sta	251.218	
THRUST				
Booster M5				
Rated vacuum thrust (approximate)			59,000 lb 🛩	
Duration (approximate)			3.5 sec -	- "
Total impulse (approximate)			147,500 lb sec	-
Missile				
Nominal thrust (sea level)	•		2600 lb	
Duration (approximate)			20.8 sec	
3				
WEIGHT				
Missile ATAX				
Constant				

W

Gross weight	1193.3	lb
Expendable load: Oxidizer (red fuming nitric acid) Starting propellant Fuel (83% JP4 gasoline and 17% UDMH) Air	241.8 1.9 50.5 17.1	lb lb lb

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MISSILE

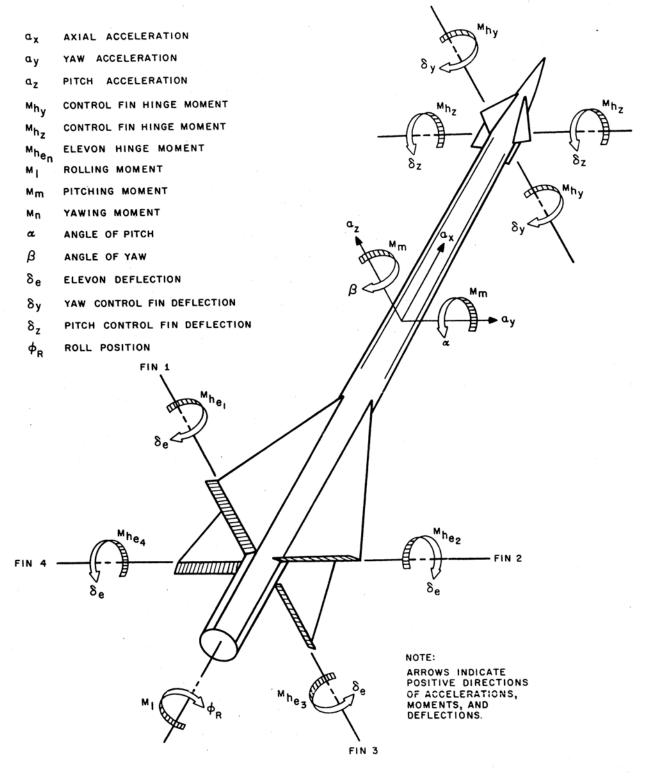
August 1, 1960

WEIGHT (continued)

CG at end of boost

M5 Booster.		
Gross weight	1306	lb 🗠
Propellant	750.5	lb ∽
Igniter and disk assembly	4.0	lb
CG loaded	Sta 316.5	
CG empty	Sta 322.0	
AJAX Missile-Booster Combination.		
Gross weight	2499.3	lb
Missile gross weight plus empty booster	1744.8	lb
CG at firing	Sta 231.54	

Sta 196.54



NIKE-AJAX SIGN CONVENTIONS (Accelerations, Moments, and Deflections)



DESCRIPTION OF NIKE-HERCULES MISSILE

The NIKE-HERCULES configuration is a two-stage, ground-to-air vehicle consisting of a solid propellant, computer-controlled missile connected through a thrust structure to a cluster of four solid propellant boosters. The missile was designed to carry a payload of 1200 pounds.

The missile body has an over-all length of 322.5 inches and a maximum diameter of 31.5 inches. The nose section is of ogival shape, fairing to a constant section at Station 136. The tapered section begins at Station 247.5 and tapers to a diameter of 21.2 inches at the base. The missile contains four wings of delta planform having root chords of 182.64 inches and a gross span of 88.0 inches. Linearizer fins of delta shape and exposed semispans of 8.496 inches are attached to the body immediately forward of its intersection with the leading edge of each wing. Elevons for controlling both steering and roll are hinged to the trailing edge of each wing, separated from the wings by an air gap. The elevons have trapezium planforms and chords which average 8.230 inches. Four radar antenna fairings are located at the aft edge of the forward fins at approximately Station 87 and are an integral part of the linearizer. This installation also incorporates the ram pressure tubes.

The booster cluster is attached to the missile through a thrust structure 33.187 inches in length and having a circular span of 43.3 inches at its aft end. The base of the missile rests in the structure 7.312 inches forward of its aft end. The over-all length of the booster cluster, including the thrust structure, is 170.845 inches; each individual booster has a constant outside diameter of 16.4 inches. The booster cluster is enclosed at its aft end by a shroud 28.3 inches long, having a cross-sectional width of 34.8 inches. Four fairing plates extend from the forward end of the shroud to the fin leading edge and body intersection. Four fins of trapezoidal planform are attached at the aft end of the booster cluster. These fins have root chords of 45.0 inches, tip chords of 23.4 inches, and a gross span of 137.9 inches.

The missile-booster combination is connected to the launcher by means of two sets of lugs located on the booster cluster, one at Station 333 and the other at Station 447, and one lug located on the missile at Station 150.

The four M-5 boosters have a total nominal rated thrust of 173,600 pounds and have a nominal duration of 3.4 seconds at 77°F. The XM30 solid propellant motor is actuated by an ignitor engine which produces a 1000-pound thrust for 0.3 second. The ignitor engine is actuated by a thermal battery which provides a delay of 0.7 second to prevent motor start from occurring before the missile clears the booster thrust structure at separation. The propellant consists of an ethyl rubber fuel and an ammonium perchlorate oxidizer. The power plant produces a nominal thrust of approximately 13,750 pounds for 29 seconds at 70°F.

1 = 43,400 LBS THRUST 3.4 Sec



DESCRIPTIVE DATA, NIKE-HERCULES

MISSILE

Fuselage		
Over-all length	322.500	in
Distance from nose tip to: Linearizer fin leading edge-body intersection Linearizer fin trailing edge End of ogival nose section Start of boattail section Trailing edge of wing tip Hinge line of elevon Trailing edge of elevon	133.50 245.00	in in in in in
Diameter of cylindrical section	31.50	
Maximum cross-sectional area	779.31	in ²
Diameter of base	21.19	in
Cross-sectional area of base	352.59	in^2
Wings. (Delta planform, 2.20% thick at root chord, modified double-wedge airfoil, maximum thickness at 83.2% of root chord, aspect ratio 0.604.)		
Gross span	88.00	in
Chord at fin, maximum body intersection	182.64	in
Tip chord	0.00	in
Semiapex angle of body centerline	8.60	deg
Angle of trailing edge sweepback	8.33	deg
Exposed area of two panels outboard of chord at fin-maximum body intersection	5159.30	in ²
Mean aerodynamic chord (MAC) of exposed area	121.76	in
Maximum thickness	5.00 i	in
Leading edge radius	0.63	in
Trailing edge thickness	0.20	in
Elevons. (Trapezium planform, modified double-wedge airfoil section, 5.83% thick at average chord line, aspect ratio 4.04.)		
Gross span at trailing edge	90.453 i	in
Exposed semispan	32.364 i	in
Average chord	8.230 i	in
Root chord	9.911	in
Sweepback angle of leading edge	6.31	deg

MISSILE (continued)

Elevons (continued)		
Area of one elevon	259.272	in^2
Area aft of hinge line	183.682	in ²
Leading edge radius	0.015	in
Maximum thickness of average chord	0.480	in
Linearizer Fins and Antenna Fairings. (Delta planform, aspect ratio of exposed fin 0.45, modified double-wedge airfoil section, maximum thickness line swept 45°.)		
Gross span	41.838	in
Exposed semispan	8.496	in
Length of fin-body intersection	37.959	in
Theoretical semiapex angle at body centerline	18.92	deg
Exposed area (one panel)	160.150	in^2
M42A1 - 1337-00-891-5470 (9020717) M42E2 1337-00-646-7324 (8525883)		
Booster Body. (Cluster of four Radford M-5 boosters.)		
Over-all length (including thrust structure)	170.845	in
Length of shroud	28.25	in
Distance from base of thrust structure to: Leading edge of shroud Trailing edge of fins	106.50 137.66	
Cross-sectional width of shroud	34.75	in
Thrust Structure		
Distance from forward end of structure to base of missile	25.875	in
Length of structure	33.187	in
Outside diameter at forward end of structure	33.06	in
Circular span at aft end of structure	43.25	in
Thickness of impact cushion	0.50	in
Booster Fins. (Trapezoidal planform, 6.18% thick at root chord, double-wedge airfoil, maximum thickness at 49.4% of root chord, taper ratio 52%, aspect ratio 0.7.)		
Gross span (including body)	137.88	in
Fin-body intersection chord	45.00	
Tip chord	23.40	
Exposed area (one panel)	1641.60	in ²
Mean aerodynamic chord of exposed area	35.34	
Leading edge sweepback angle	24.23	
		-

BOOSTER (continued)

Booster Fins (continued)

Trailing edge sweepback angle	0.00	deg
Exposed semispan	48.00	in
Maximum thickness	3.06	in

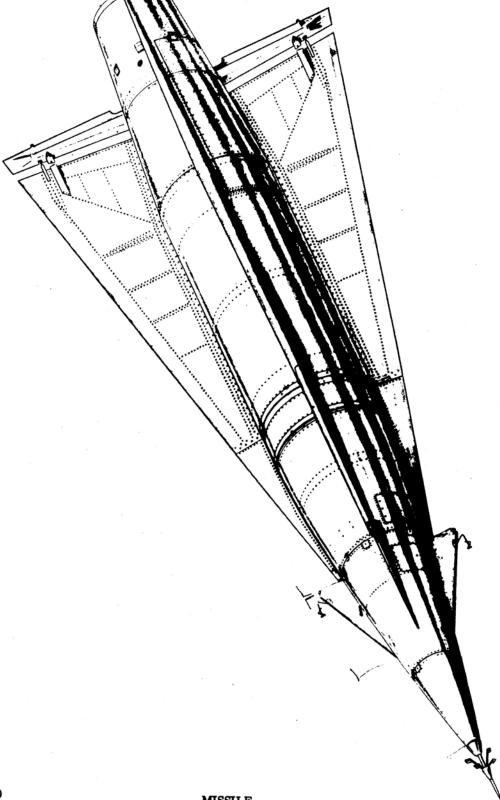
THRUST

Booster. (Cluster of four Radford M-5 boosters.)

Rated vacuum thrust (nominal) at 77° F	43,400	173,600 lb
Duration (nominal) at 77°F		3.4 sec
Total impulse (nominal) at 77° F	1500	600,000 lb sec

Missile. (JATO XM-30.)	M30 A2	1337-00-832-5102	
Rated thrust (sea level) at 70° F	A	1337-00-965-0830	13,750 lb
Duration (nominal) at 70°F			29 sec
Total impulse (nominal) at 70° F			388 500 lb sec

MISSILE



NIKE-HERCULES MISSILE, ILLUSTRATED LIST

August 1, 1960

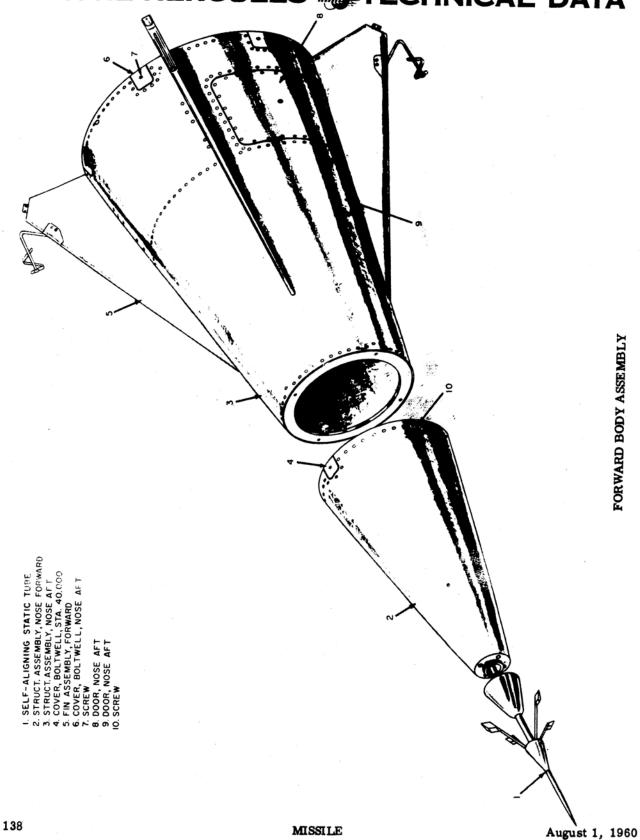
MISSILE

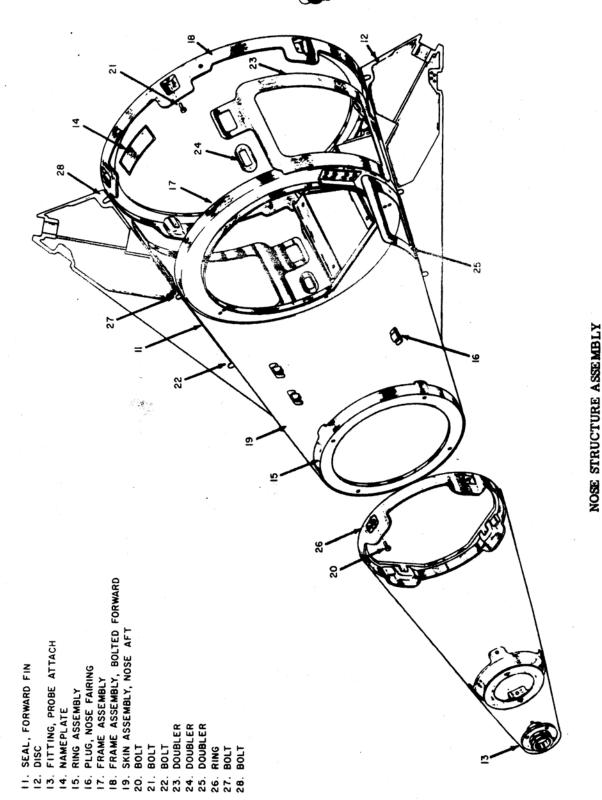
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COMPLETE MISSILE

9028313 8524287 9034849 8521061

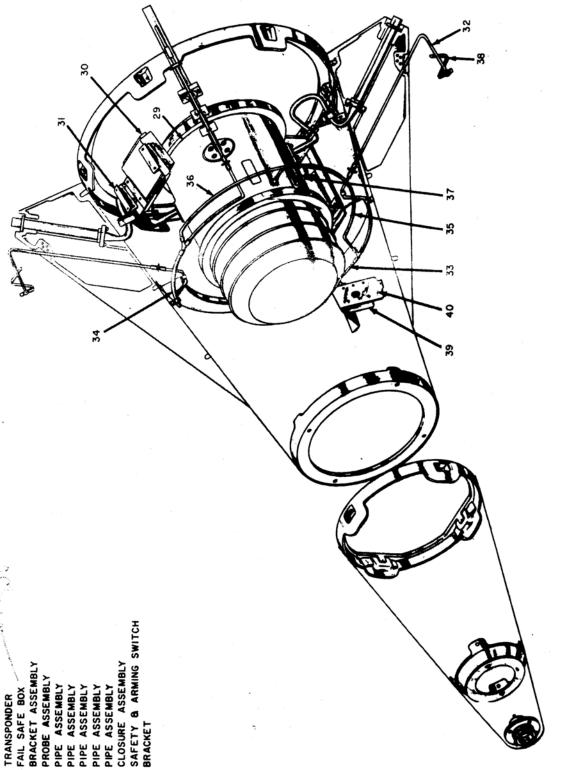
NIKE-HERCULES TECHNICAL DATA



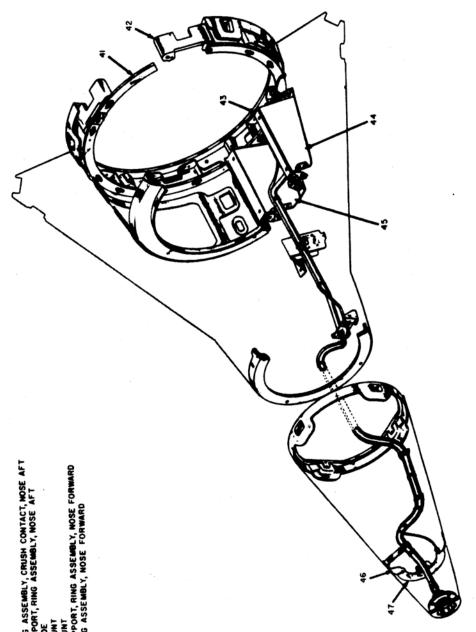


August 1, 1960

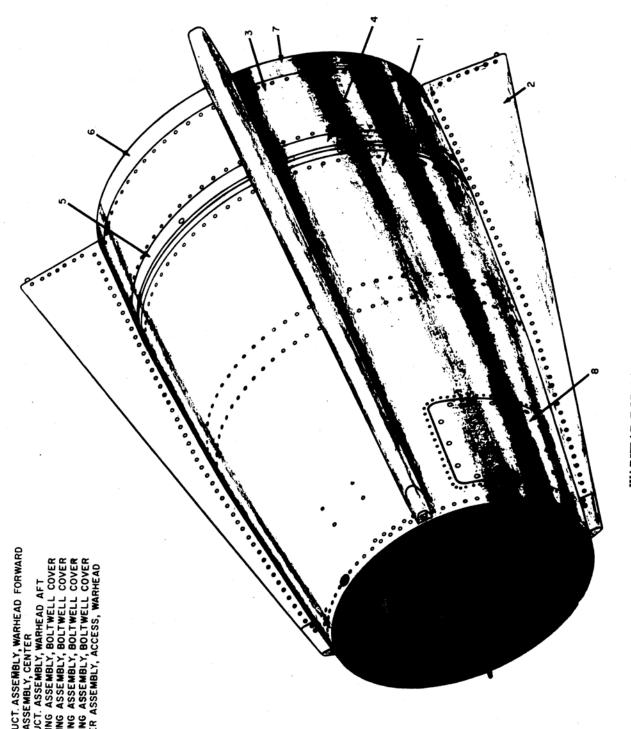
MISSILE



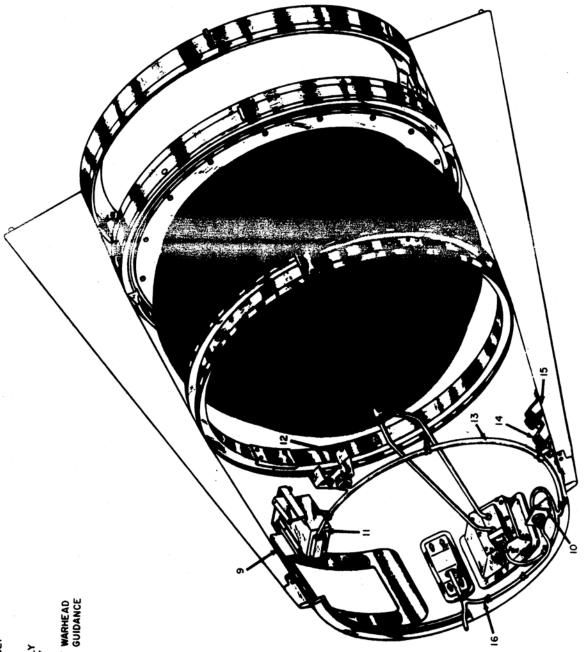
GUIDANCE SET EQUIPMENT INSTALLATION



CRUSH RING AND PRESSURE HOSE INSTALLATION



WARHEAD BODY ASSEMBLY

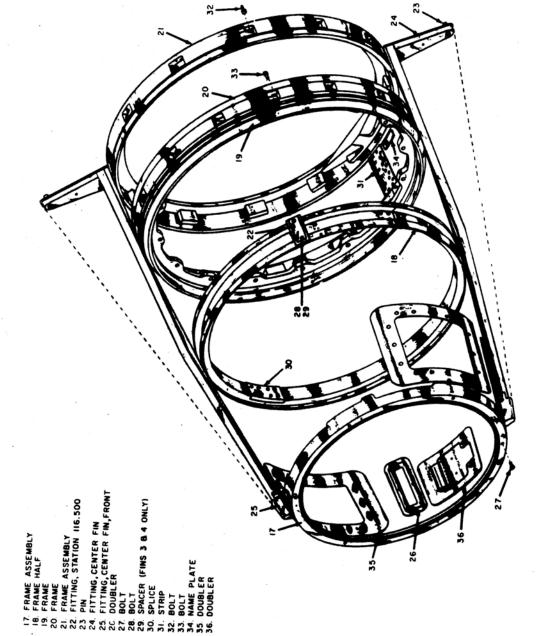


WARHEAD EQUIPMENT INSTALLATION

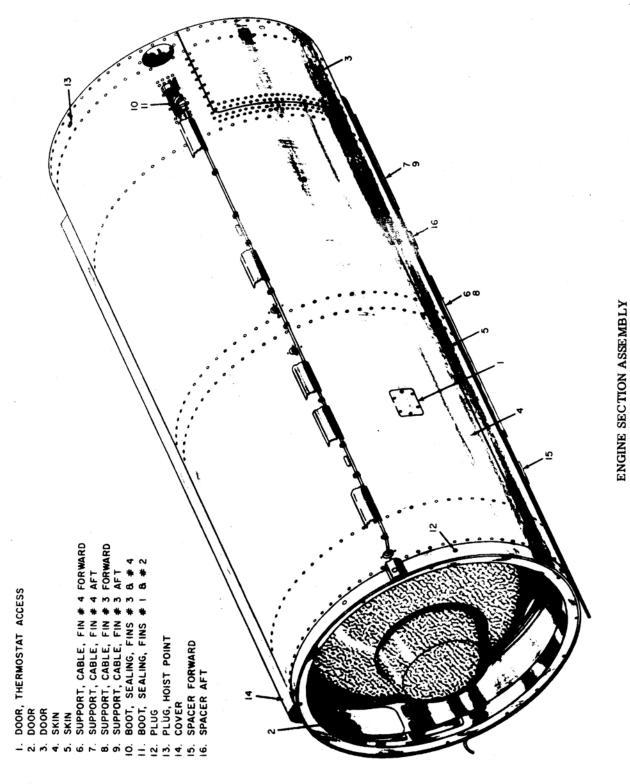
9. BRACKET ASSEMBLY
D. BRACKET
I. FAIL SAFE BOX
Z. JUMPER ASSEMBLY
S. CABLE ASSEMBLY
F. BRACKET
CABLE ASSEMBLY
CABLE ASSEMBLY
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CABLE ASSEMBLY

August 1, 1960

MISSILE

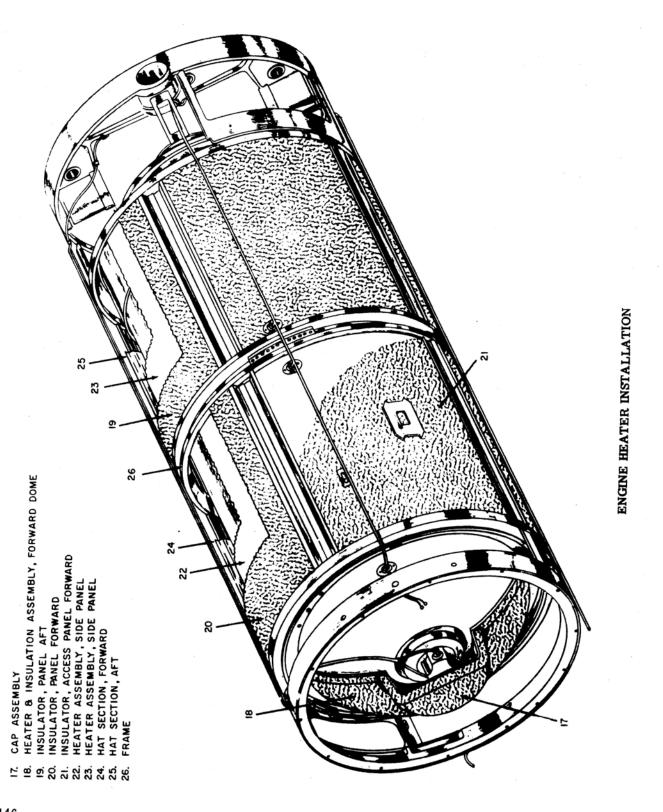


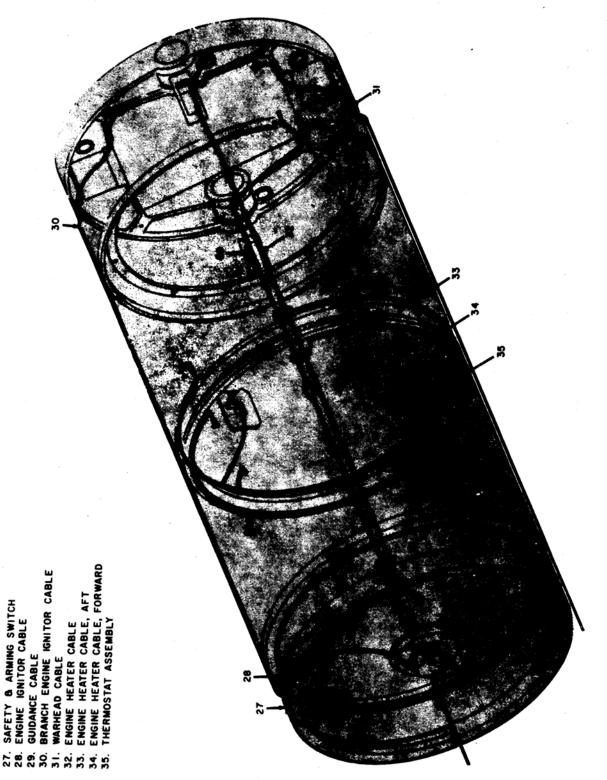
WARHEAD STRUCTURE ASSEMBLY



August 1, 1960

MISSILE



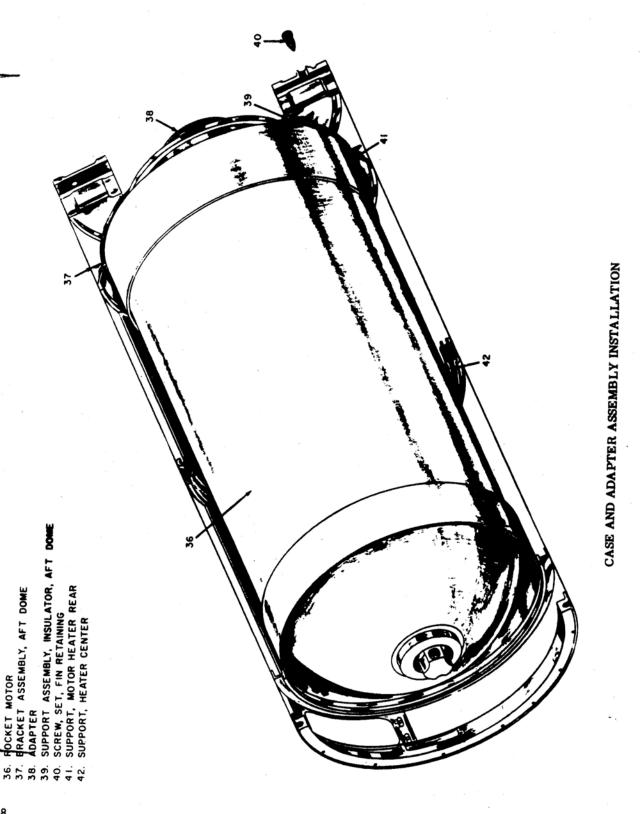


August 1, 1960

MISSILE

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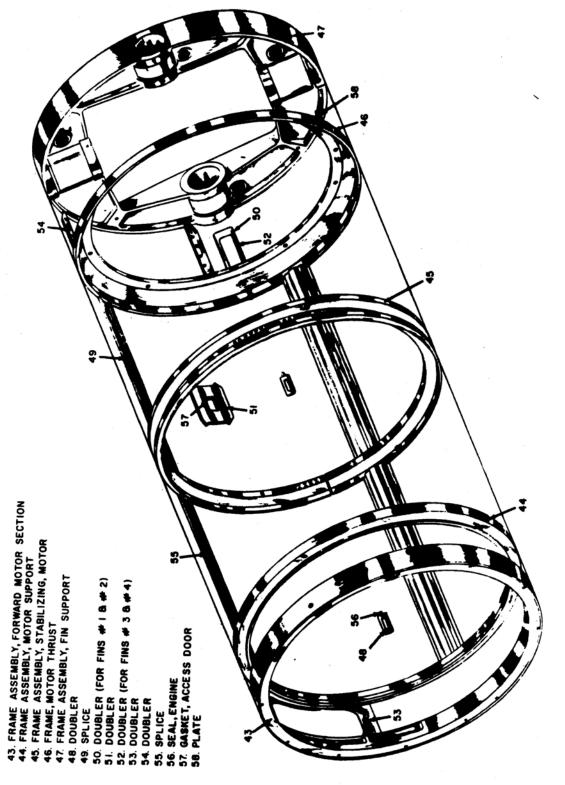
ENGINE EQUIPMENT INSTALLATION



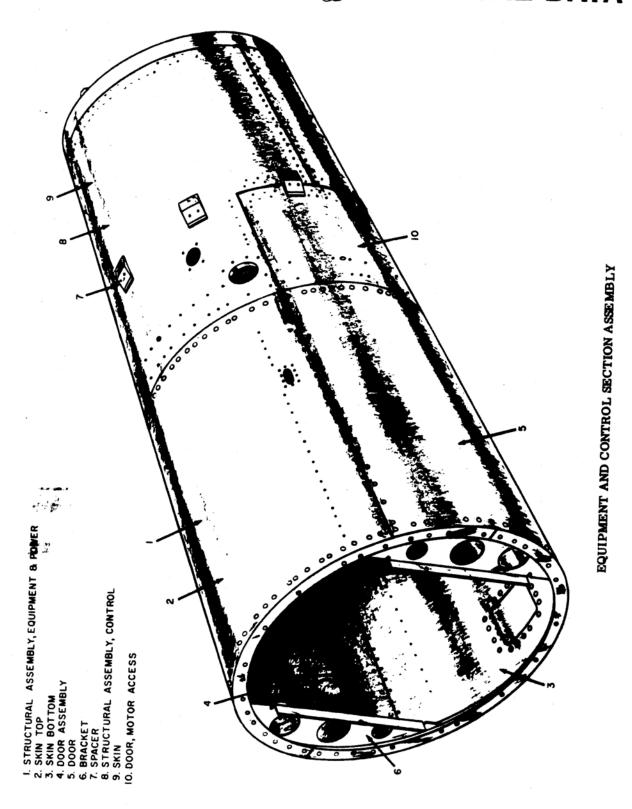
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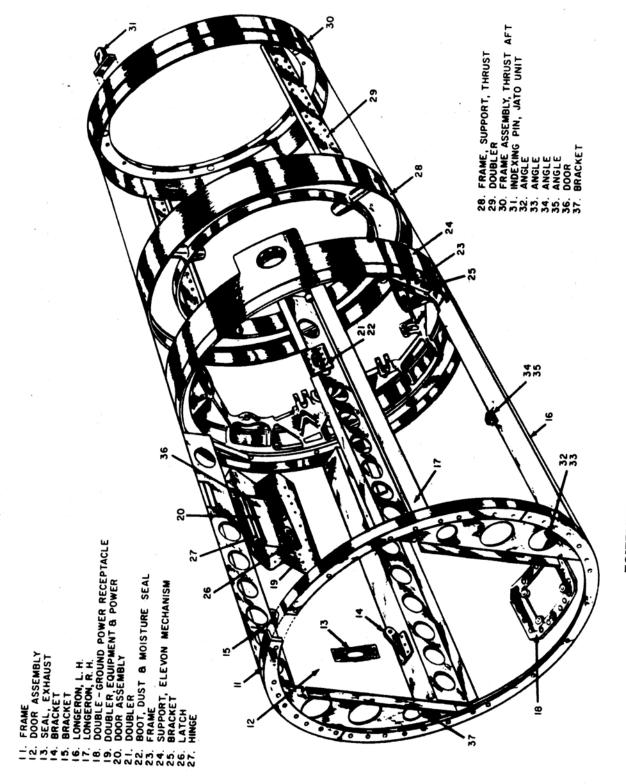
MISSILE

August 1, 1960

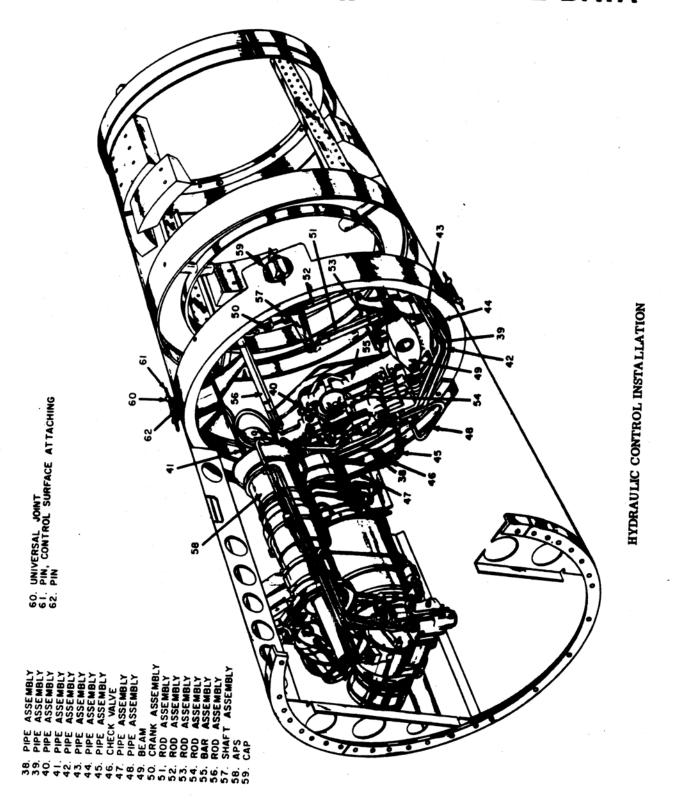


ENGINE STRUCTURE ASSEMBLY





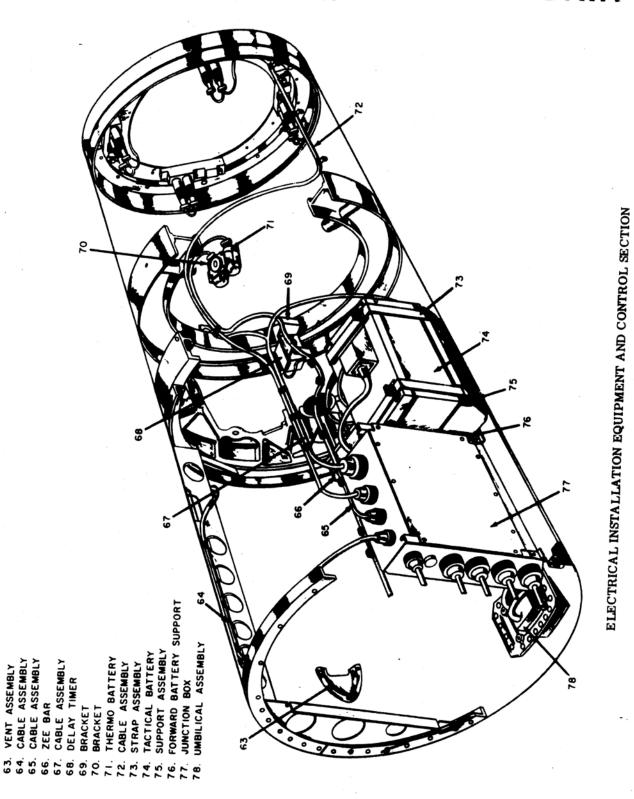
EQUIPMENT AND CONTROL STRUCTURE ASSEMBLY



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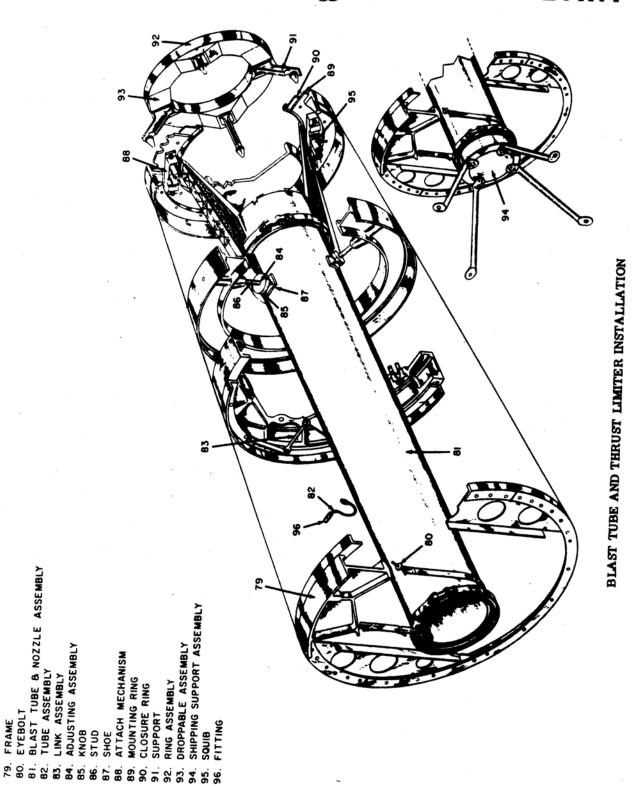
MISSILE

August 1, 1960



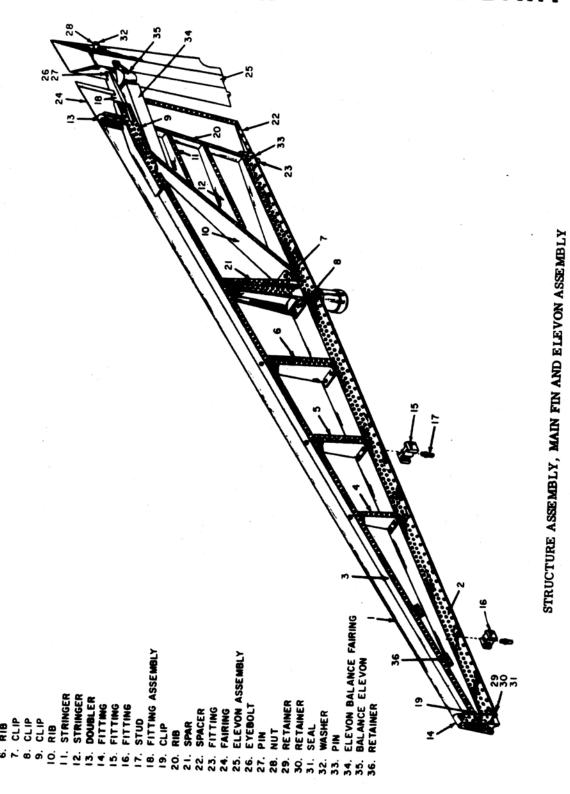
August 1, 1960

MISSILE



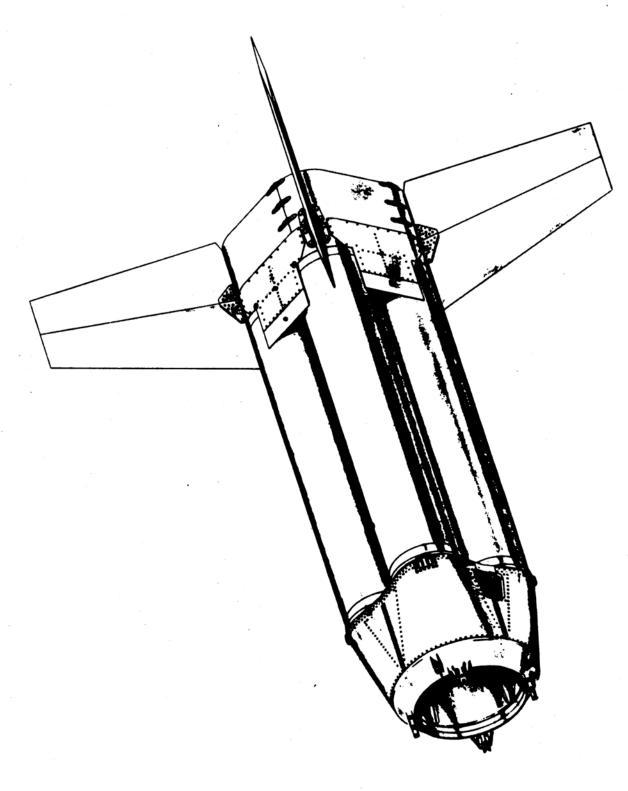
154

EYEBOLT

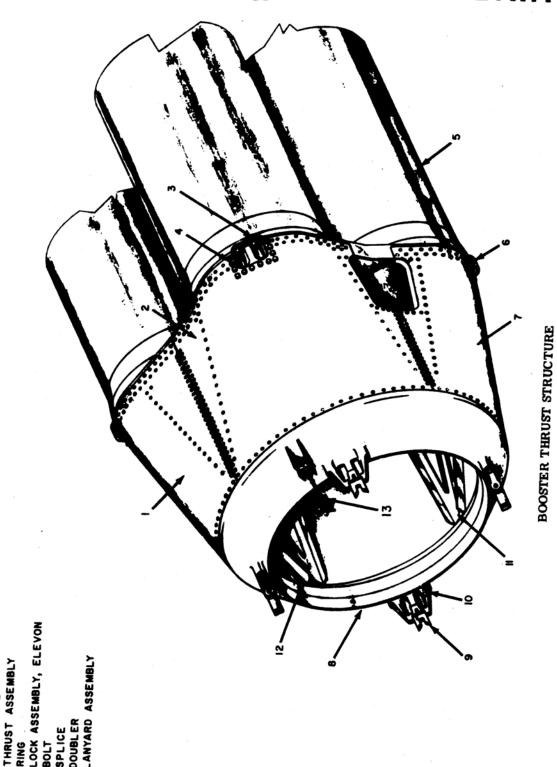


August 1, 1960

MISSILE



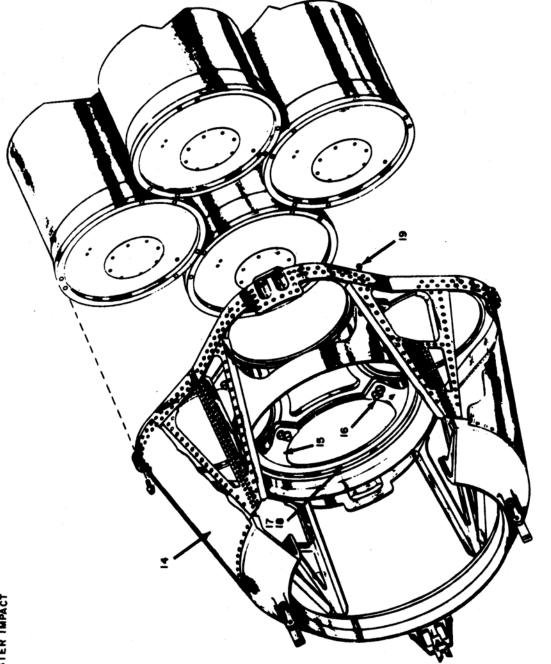
BOOSTER GENERAL ASSEMBLY



I. SKIN, BOOSTER THRUST
2. SKIN
3. BOLT
4. BOLT
5. JATO M5EI, LOADING ASSEMBLY
6. BASE PLATE

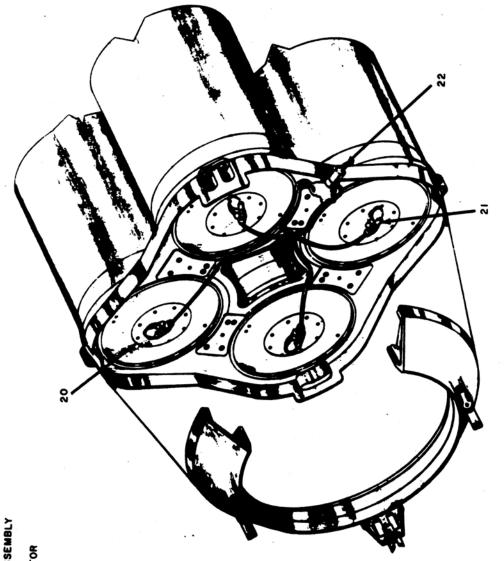
August 1, 1960

MISSILE



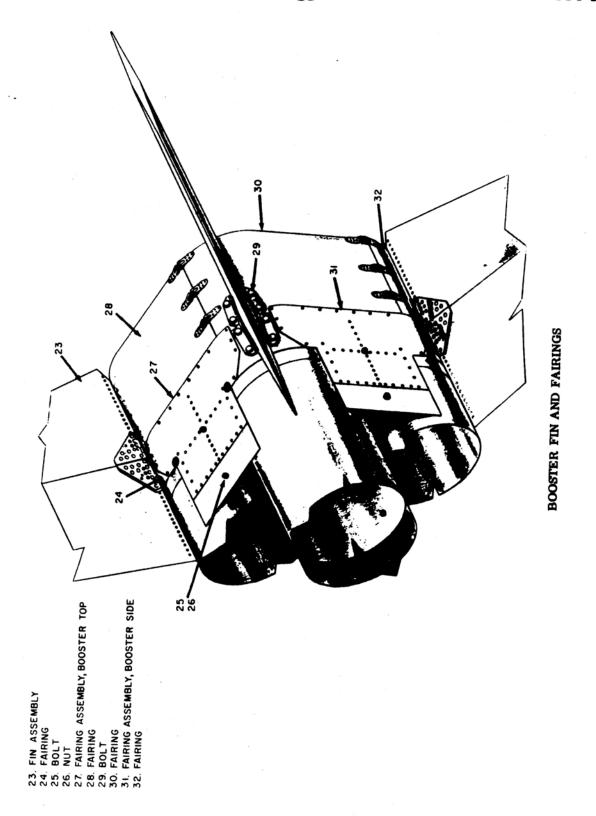
BOOSTER THRUST STRUCTURE CUTAWAY

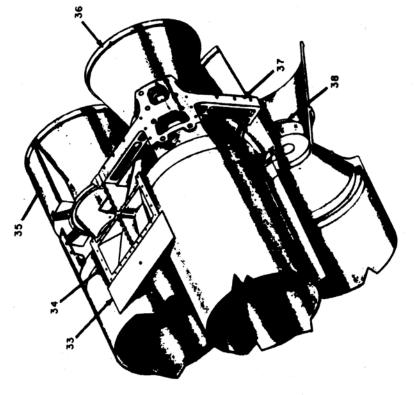
14. FITTING ASSEMBLY
15. PEDESTAL
16. BOLT
17. CUSHION, BOOSTER IMPACT
18. CUSHION, BOOSTER IMPACT
19. BOLT



BOOSTER IGNITOR HARNESS

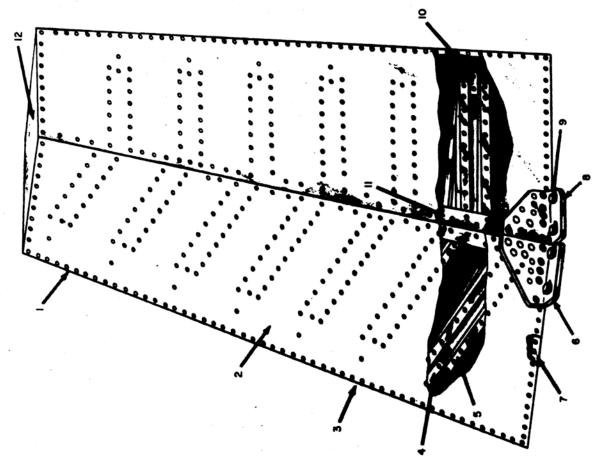
20. IGNITOR, JATO, ELECTRIC, M24 ASSEMBLY 21. HARNESS ASSEMBLY 22. CABLE ASSEMBLY, BOOSTER IGNITOR





BOOSTER FAIRING AND NOZZLE CUTAWAY

35. FILLER BLOCK 36. JATO M5E1, LOADING ASSEMBLY 37. FITTING ASSEMBLY 38. CLOSURE, NOZZLE ASSEMBLY



BOOSTER FIN ASSEMBLY

1. FIN ASSEMBLY
2. SKIN (LEFT SIDE)
3. SKIN (RIGHT SIDE)
4. SPACER
5. RIB
6. ANGLE AND OPPOSITE HAND PART
7. RIB (CLOSING, INBOARD)
8. ANGLE AND OPPOSITE HAND PART
10. SPACER
11. SPAR
2. RIB (CLOSING, OUTBOARD)
3. RIB (CLOSING, OUTBOARD)

