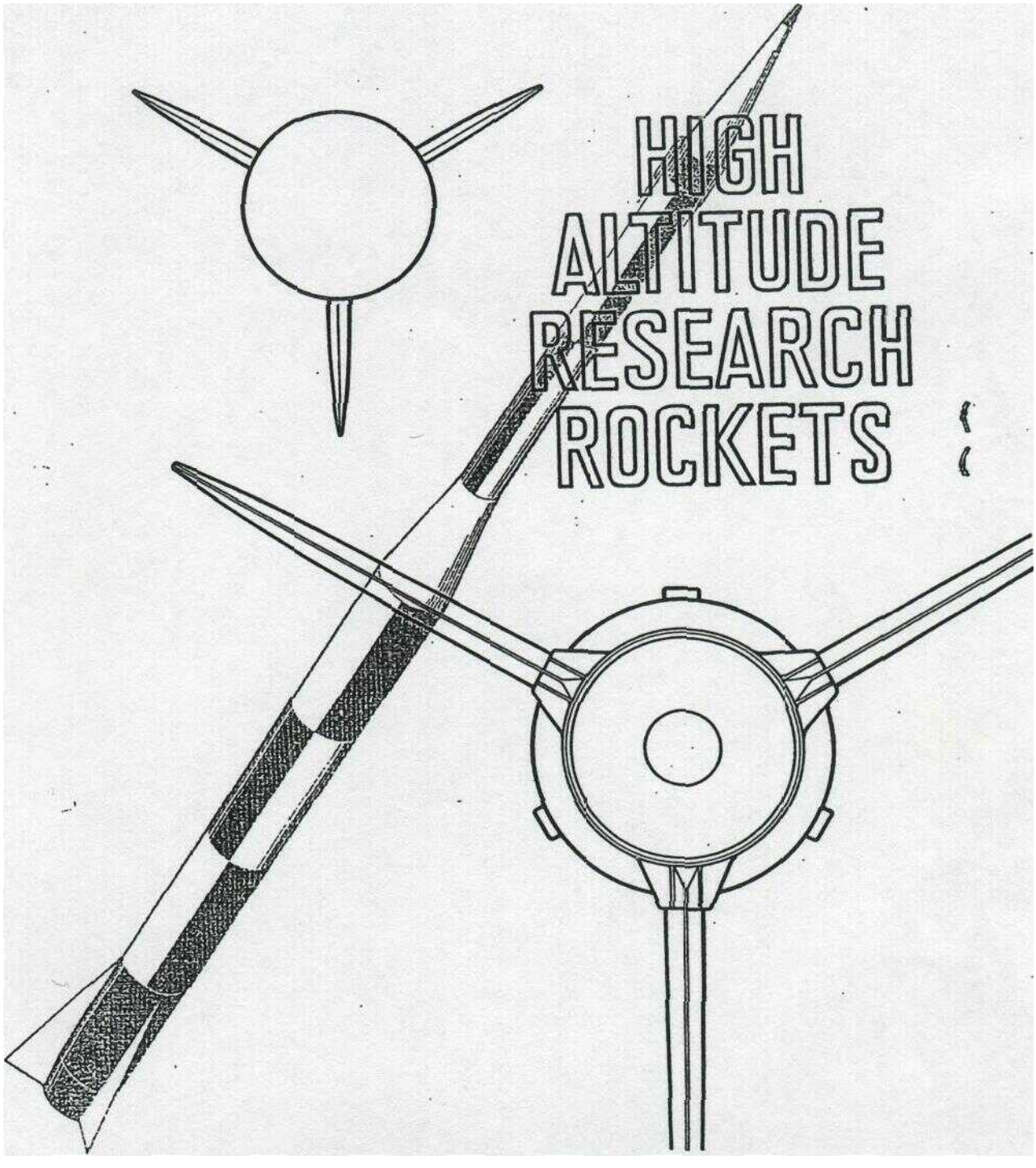
BLACK BRANT



CANADIAN BRISTOL AEROJET

WINNIPEG CANADA

PROPRIETARY INFORMATION

REVISION 1 , JUNE. 1962

For experiments at greater altitudes, the Black Brant IV-A is currently being developed. This is a two stage rocket with the Black Brant I motor boosting a Black Brant III vehicle to an altitude of 600 miles with a 40 pound payload.

A further development of the 17" Black Brant II will be known as the Black Brant V. It is expected to have an altitude capability of 240 miles with 150 pounds of payload.

A complete range of telemetry is being developed for this family of rockets together with appropriate launchers and other ground handling equipment.

Figure 1.1 illustrates the various ranges of altitude of the Black Brant High Altitude Rockets together with the positions of some of the interesting areas of space, and experiments that can be achieved, with this series.

NOTE:

Propellant temperature range of —20°F to +120°F is listed in this brochure for the various Black 'Brant vehicles as being the Canadian Bristol Aerojet design objective.

At present the solid propellant used in all of the Black Brant vehicles is cleared for storage and use from +30°F to +100°F. An evaluation program is currently underway to clear the propellant for storage and use from 10°F to +125°P and Canadian Bristol Aerojet intend to verify performance down to —20°F.

TABLE OF CONTENTS

Section 1

INTRODUCTION

1 INTRODUCTION

The Black Brant Series of High Altitude Research Rockets is being developed specifically for the varied requirements of scientific and defence space research as a joint Canadian Government-Canadian Industry Program. This series of utility vehicles will initially cover an altitude range of between 100 miles and 600 miles with payloads of from 25 pounds to 300 pounds. Launching can be carried out over a wide temperature range and simple launching facilities are required.

The team developing these vehicles is made up of the Canadian Department of Defence Production (DDP), The Defence Research Board (DRB). and Canadian Bristol-Aerojet Limited (CBA). The Canadian National Research Council (NRC), is also assisting in the design and development phases of the program. User agencies are monitoring the program and providing information to ensure the development of a product most suited to the requirements of all users. The solid propellant motor development including development of propellant, internal insulants, igniter and nozzle is being carried out by the Canadian Armament Research and Development Establishment (CARDE) of DRB. Process design, propellant filling and static testing is conducted by CARDE. Dynamic testing is conducted jointly by CBA and CARDE.

The family of rockets known as the Black Brant series consists of a single stage 17" diameter rocket, one of 10" diameter, and a 2 stage vehicle which utilizes the 10" diameter rocket with a 17" diameter booster. The altitude range covered by these is the region above the limit of balloons and into the zone of satellites.

The initial Black Brant vehicle was designed to a CARDE specification in 1956 to enable evaluation of the solid propellant motor to be carried out under dynamic conditions. The success of the dynamic test vehicle, known as the Black Brant I, led to its acceptance in Canada as a high altitude research rocket. A high degree of reliability has been experienced with the Black Brant I motor.

The performance potential of the Black Brant I motor led to the development of a high altitude research vehicle with improved structural design, nose cone, and fins. This vehicle is known as the Black Brant II. The basic Black Brant II, referred to as the Black Brant 11-A, will carry a 150 pound payload to an altitude of 125 miles.

Black Brant III, a 10" diameter rocket, provides a more economical approach to High Altitude Research. The design performance is an altitude of 120 miles with a 40 pound payload.

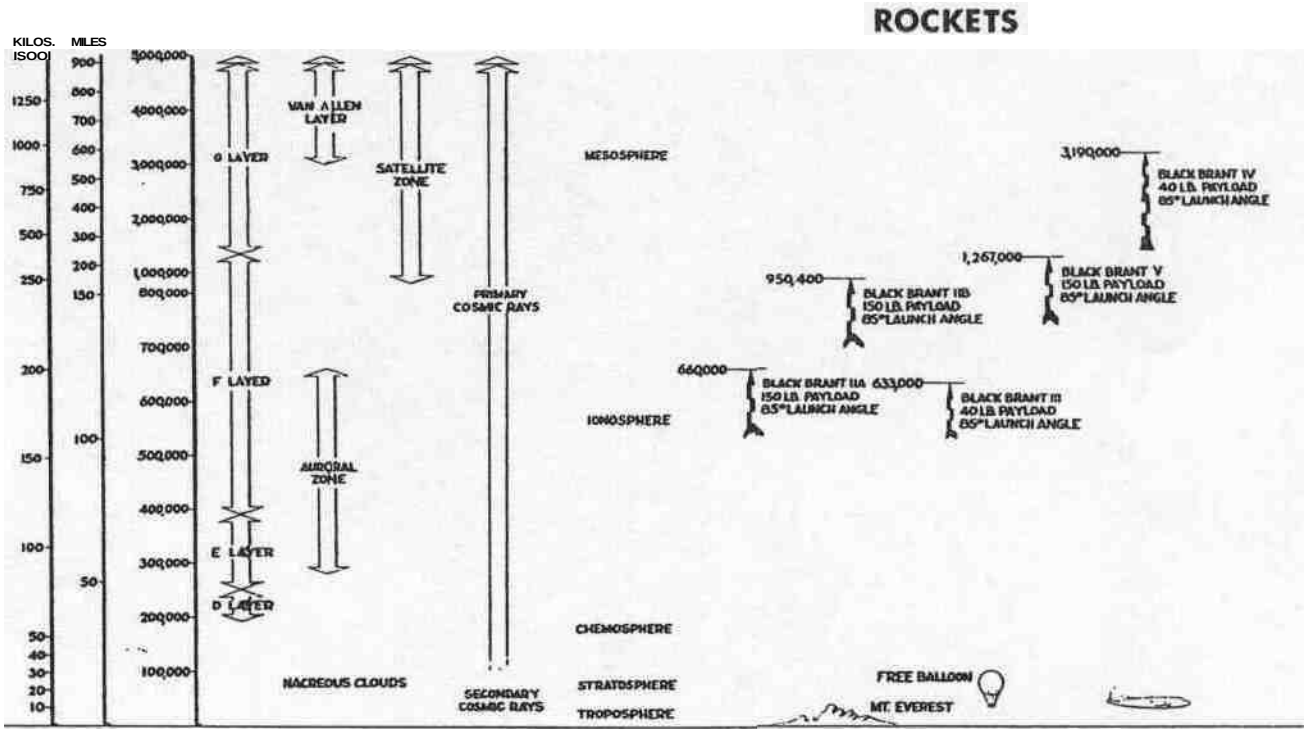
For experiments at greater altitudes, the Black Brant IV-A is currently being developed. This is a two stage rocket with the Black Brant I motor boosting a Black Brant III vehicle to an altitude of 600 miles with a 40 pound payload.

A further development of the 17" Black Brant II will be known as the Black Brant V. It is expected to have an altitude capability of 240 miles with 150 pounds of payload.

A complete range of telemetry is being developed for this family of rockets together with appropriate launchers and other ground handling equipment.

Figure 1.1 illustrates the various ranges of altitude of the Black Brant High Altitude Rockets together with the positions of some of the interesting **areas of** space, and experiments that can be achieved, with this series.

BLACK BRANT HIGH ALTITUDE RESEARCH ROCKETS



SOME EXPERIMENTS PERFORMED WITH SOUNDING ROCKETS

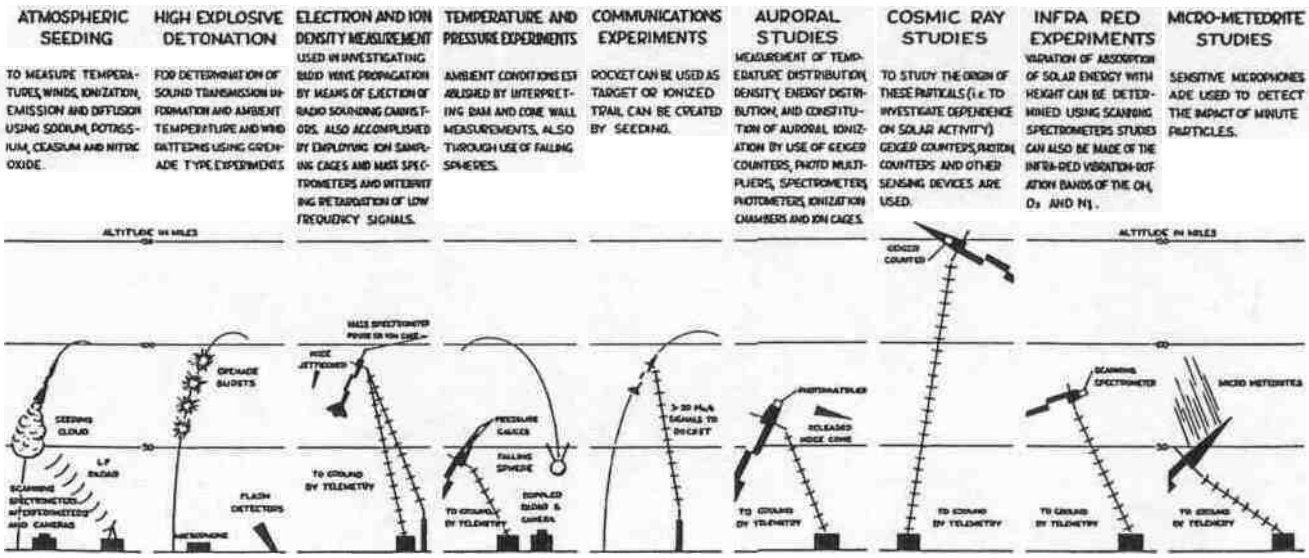


Figure 1-1

CANADIAN BRISTOL AEROJET LIMITED

WINNIPEG CANADA

REVISION 1, JUNE, 1962

Section 2

GENERAL

DESIGN PHILOSOPHY

2 GENERAL DESIGN PHILOSOPHY

A wide choice of motor sizes, methods of launching, attitude control, and coupling. etc. is available to the rocket designer. Any of the many combinations of these, results in a vehicle differing from the others in cost, complexity of construction, performance, reliability, etc.

The basic vehicle characteristics that were chosen to govern the design of the Black Brant Rockets are the following, not necessarily in order of preference:

(1) Performance

(2) Availability and Utility

(3) Reliability

(4) Cost Effectiveness

(5) Simplicity of Design and Launch Procedure

(6) Launch Capability Over a Wide Range of Environmental Conditions.

2.1 PERFORMANCE

Although there is a general requirement to cover the altitude zone from 30 kilometers (100,000 ft.) to 1500 kilometers (5,000.000 ft.), the main interest appears to be in the region up to about 1.000 kilometers (3,300,000 ft.) The initial design aim therefore, was to produce a family of vehicles to carry 40 pounds of payload up to 1,000 kilometers in altitude.

2.2 AVAILABILITY AND UTILITY

The success of the CARDE propellant test vehicle suggested that this general design concept and the CARDE solid propellant should be the basis for the Black Brant family of research rockets.

The 10" rocket was conceived for use as a single stage vehicle for requirements up to 650,000 feet. and as the second stage of the high altitude vehicle.

Both basic rockets, therefore, have been designed for use either singly or with the minimum of modification as components of multi-stage vehicles. This increased the utility and usefulness of both.

2.3 RELIABILITY

A high order of reliability is achieved by the combination of a proven motor and simplicity of design in staging and separation.

2.4 COST EFFECTIVENESS

The purpose of the design was to produce the maximum performance with a minimum of **cost.**

2.5 SIMPLICITY OF DESIGN

Although improved performance is possible by the use of some form of auto" mafic flight control system, it was considered that this would add to the complexity and cost. Since the requirement can be met without the use of this control, it was not included in the design approach.

2.6 LAUNCH CAPABILITY OVER A WIDE RANGE OF ENVIRONMENTAL CONDITIONS

Simplicity of launching, coupled with the proven performance of the CARDE solid propellant engine over a wide range of environmental conditions, insures reliability and ease of launching.

Section 3

BLACK BRANT II

3 BLACK BRANT II

3.1 GENERAL

Although this vehicle was developed from the Black Brant I under the overall design authority of CARDE. the marketing responsibility for the Black Brant II rests with CBA. It is a solid propellant, three finned, unguided sounding rocket designed for zero roll rate. The original Black Brant II vehicle is identified as the Black Brant 11-A. When equipped with a more recently developed CARDE solid propellant engine, the vehicle will be known as the Black Brant 11-B.

3.2 BLACK BRANT II.A DETAILS

3.2.1 CONFIGURATION

The basic configuration as detailed in Figure 3-1 consists of:

(1) Nose — conical followed by cylindrical section.

(2) Motor — solid fuel, fixed nozzle.

(3) Stabilizers — fixed fin.

3.2.2 NOSE

The 86.0" long conical portion is followed by a 24.6" long cylindrical section. Approximately 6 cubic feet of volume is available for a maximum payload weight of 300 pounds.

3.2.3 ROCKET MOTOR

The Black Brant II-A motor section is comprised of a solid propellant 15KS25000 rocket motor.

3.2.4 STABILIZERS

Three fixed fins are used. Each fin has a leading edge sweepback of approximately 55°, a trailing edge sweepback of 30°, with a semi-span of 30.4" and a root chord of 51.5". Total individual fin area is 1050 square inches.

3.2.5 COMPLETE VEHICLE

The complete vehicle has an outside diameter of 17.2" and an overall length of 332.5".

3.2.6 WEIGHTS

Weight of Loaded Rocket Motor. Inc. nozzle, pounds	2.264
kilograms	1.027
Total Rocket Weight (less payload). pounds	2.550
kilograms	1.156

3.2.7 PERFORMANCE (85° LAUNCH ANGLE)

Payload, pounds	75	150	300
Payload, kilograms	34	68	136
Maximum Acceleration "G"	17	16	14
Launch velocity with 15 foot launcher, ft./sec.	98	95	90
Maximum velocity, ft./sec.	6.550	6.070	5.200
, meters/sec.	2.000	1,840	1.580
Altitude at burnout, feet		62.000	
Peak Altitude, feet	735,000	660,000	455.000
, miles	139	125	86
, kilometers	224	201	138
Time to peak altitude, seconds		205	
Range, feet		260.000	
Propellant Temp. Range, °F		—20 to 120	(Objective)
. °C		—29 to 49	(Objective)

3.2.8 BALLISTIC DATA (70° F. AMBIENT)

Square Wave Burning Time. seconds	15.5
Actual Burning Time (to zero thrust), seconds	18.8
Square Wave Thrust (sea level), pounds	24.700
kilograms	11.174
Total Impulse (sea level), pounds - seconds	383,200

3.3 BLACK BRANT II-B DESIGN DETAILS

3.3.1 GENERAL

The Black Brant II-B will be identical in configuration and dimensions to the Black Brant II-A except for propellant configuration and nozzle.

3.3.2 ROCKET MOTOR

The motor section will be composed of a solid propellent 23KS20000 rocket motor with a nozzle exit diameter of 14".

3.3.3 WEIGHTS

Weight of Loaded Rocket Motor, pounds	2.537
, kilograms	1.151
Total Rocket Weight (less payload), pounds	2.817
, kilograms	1.300

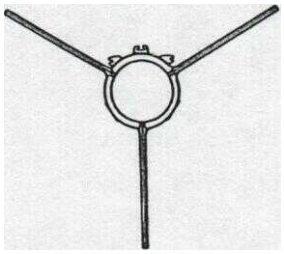
3.3.4 PERFORMANCE (85° LAUNCH ANGLE)

Payload, pounds	75	150	300
Payload, kilograms	34	68	136
Maximum acceleration "G"	14.5	13.5	11.7
Launch velocity with 15 foot launcher, ft/sec.		79	
Maximum velocity, ft./sec.	7.470	7.077	6.370
, meters/sec.	2.280	2.160	1.820
Altitude at burnout, feet		97.200	
Peak Altitude, feet	1.056,000	950.400	765.600
, miles.	200	180	145
, kilometers	322	290	133
Time to Peak Altitude, seconds		258	
Range, feet			
Propellent Temp. Range. °F		-20 to 120 (Objective)	
. °C		-29 to 49 (Objective)	

3.3.5 BALLISTIC DATA (70°F)

Square Wave Burning Time, seconds	23.5
Actual Burning Time (to zero thrust), seconds	28.5
Square Wave Thrust (sea level), pounds	19.200
, kilograms	8,609
Total Impulse (sea level), pounds - seconds	.452.000

BLACK BRANT II ROCKET



View On
Arrow "A"

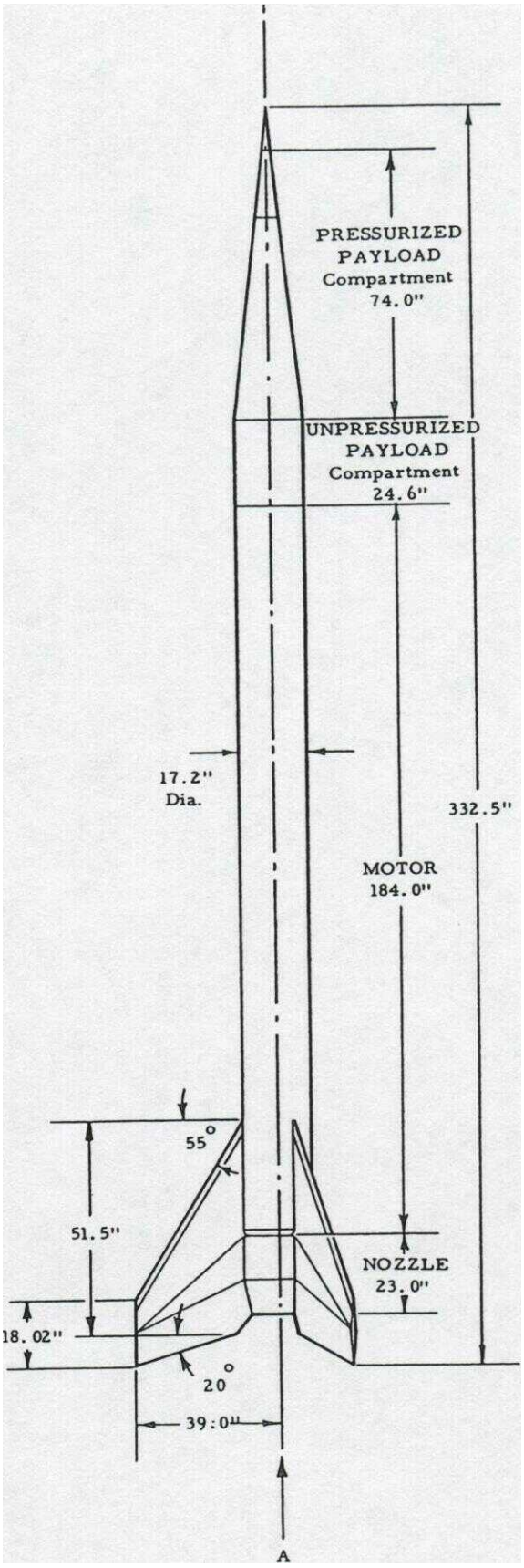


Figure 3-1

TYPICAL OGIVE NOSE CONE

BLACK BRANT II

(17" forward body shown)

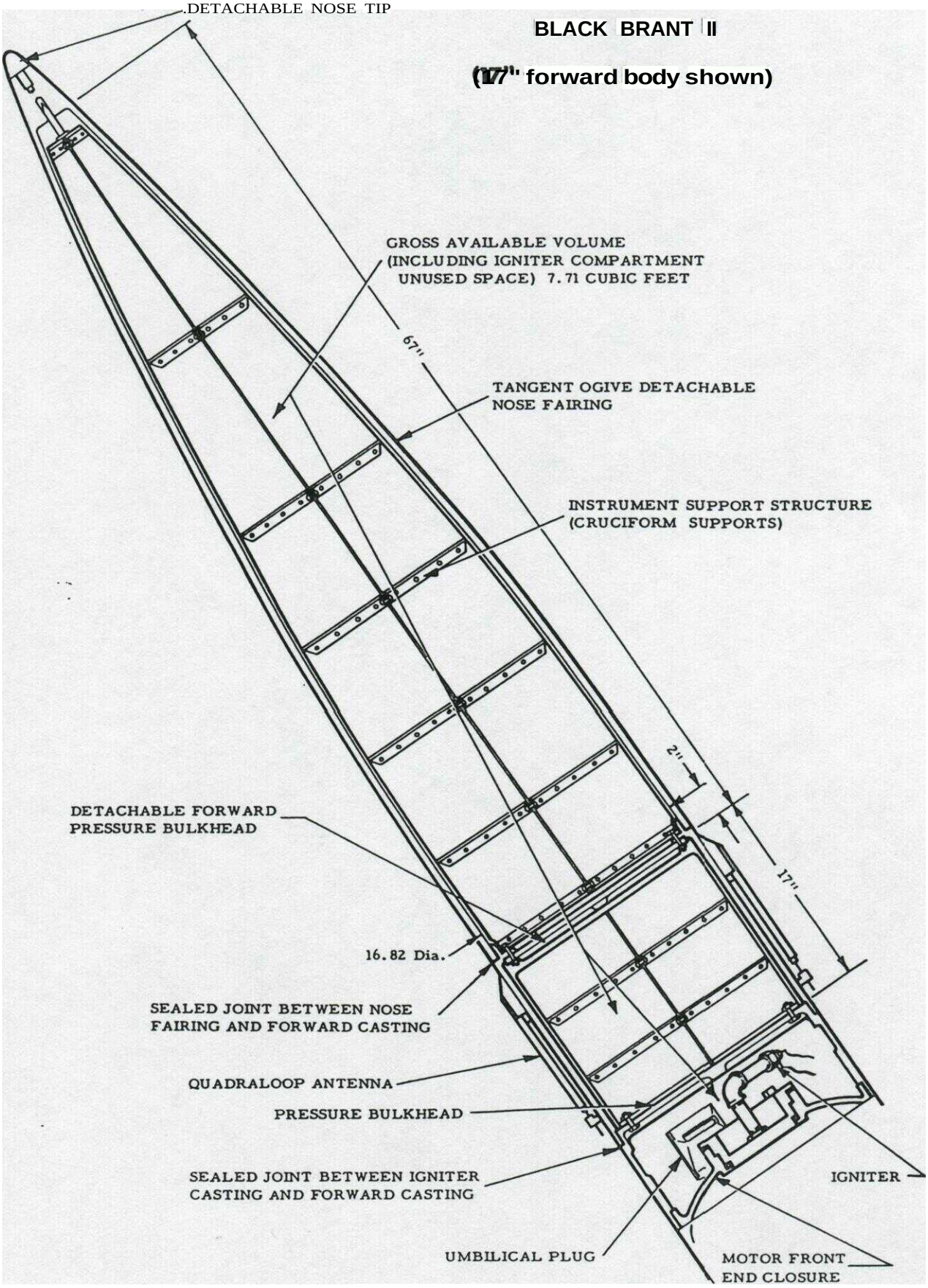


Figure 3-2

Section 4

BLACK BRANT Ⅲ

4 BLACK BRANT III

4.1 GENERAL

The Black Brant III is a three finned, unguided sounding rocket, utilizing solid rocket propellent and designed for zero roll rate. It is basically a single stage vehicle, however, the 10" motor can also be used as a stage for multi-stage rockets.

4.2 REQUIREMENT

Typical potential uses are: cosmic ray and auroral investigations, — meteorological observations above balloon altitudes, — as a basis for a communication device.

4.3 DESIGN DETAILS

4.3.1 CONFIGURATION

The basic configuration as detailed in Figure 4-1, consists of:

(1) NOSE — conical followed by a cylindrical section.

(2) MOTOR — This will be identical for all roles except for nozzles which will be optimized for each of the operations.

(3) STABILIZERS — These will take two forms; one for single stage, and another for multi-stage operation.

The static margin provided by the stabilizers are as follows:

(1) Two-Stage Operation — At M = 1 3 with 40 lb. payload — 2 calibres.

(21 Single Stage Operation — At M = 7.0 with 40 lb. payload — 1 calibre.

4.3.2 NOSE

With a 49.3" cone section and a 16.9" cylindrical section, approximately 1.4 cubic feet of space is available for instrumentation. It has been found that this configuration is suitable for all roles. However, this may be changed somewhat to meet individual requirements.

4.3.3 ROCKET MOTOR

The basis of this motor is a tube of 131.2" in length, 10.2" outside diameter and .057" wall thickness.

4.4 WEIGHTS

Weight of loaded Rocket Motor, pounds..... 583

, kilograms..... 265

Total Rocket Weight (less payload), pounds..... 621

, kilograms..... 282

4.5 PERFORMANCE (85° LAUNCH ANGLE)

Payload, pounds	**25**	**40**	**75**
Payload, kilograms	**11**	**18**	**34**
Maximum acceleration, "G"	**31**	**30**	**27**
Launch velocity with 10.5 foot launcher, ft./sec.	**122**	**119**	**115**
Maximum velocity, ft./sec.	**7,055**	**6.782**	**6.266**
, meters/sec.	**2,140**	**2,060**	**1,900**
Altitude at burnout, feet	**50.100**	**48,500**	**45,300**
Peak Altitude, feet	**685.000**	**633.000**	**528,000**
, miles	**130**	**120**	**100**
. kilometers	**208**	**193**	**161**
Time to Peak Altitude, seconds	**215**	**212**	**196**
Range, feet	**145,000**	**137.000**	**118.000**
Propellant Temp. Range, °F		**-20 to 120 (Objective)**	
. °C		**-29 to 49 (Objective)**	

NOTE:

(1) Single Stage — As a single stage vehicle, the 10" Rocket will carry 40 pounds up to approx. 630,000 feet. A 25 pound payload can be carried up to 685.000 feet.

(2) Second Stage — With the same general characteristics when coupled with the Black Brant I and a second stage commencing burning after first stage burnout (which occurs at approximately 50,000 feet) the 10" Rocket will carry 40 pounds of payload a further 3.050,000 feet for a total height of 3.100.000 feet.

4.6 BALLISTIC DATA (70° P)

Square Wave Burning Time. seconds	9.0
Actual Burning Time (to zero thrust), seconds . . . . . 1 2 . 1	
Square Wave Thrust (sea level), pounds.... . .	10,800
, kilograms	4.899
Total Impulse (sea level), pounds - seconds .. - . .	97,500

BLACK BRANT III

10" ROCKET

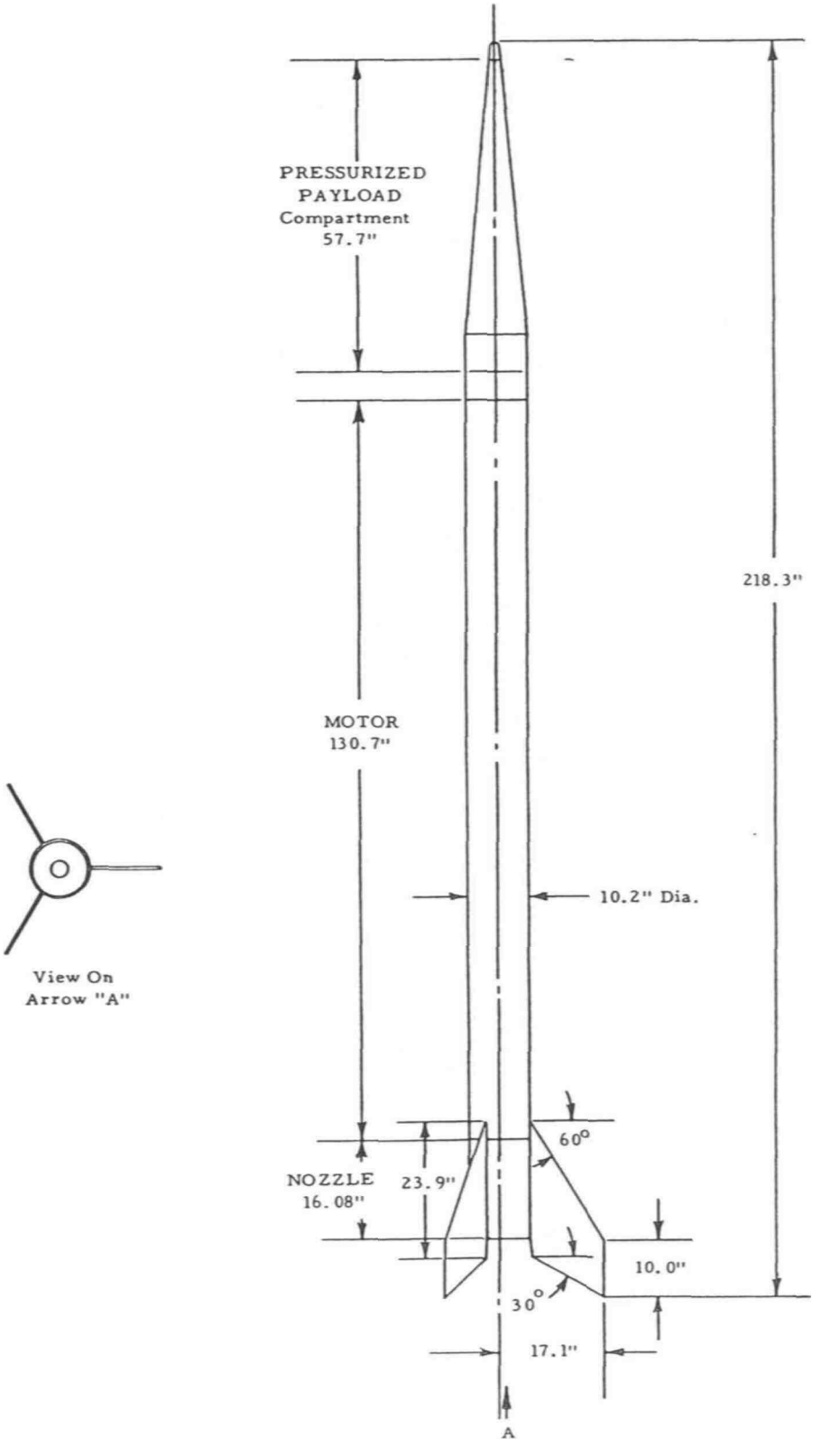


Figure 4 - 1

EFFECT OF PAYLOAD ON PEAK ALTITUDE

BLACK BRANT III

TOTAL VEHICLE WEIGHT (Without Payload) **621 LBS.**

LAUNCH ANGLE 85°
NO DISPERSION

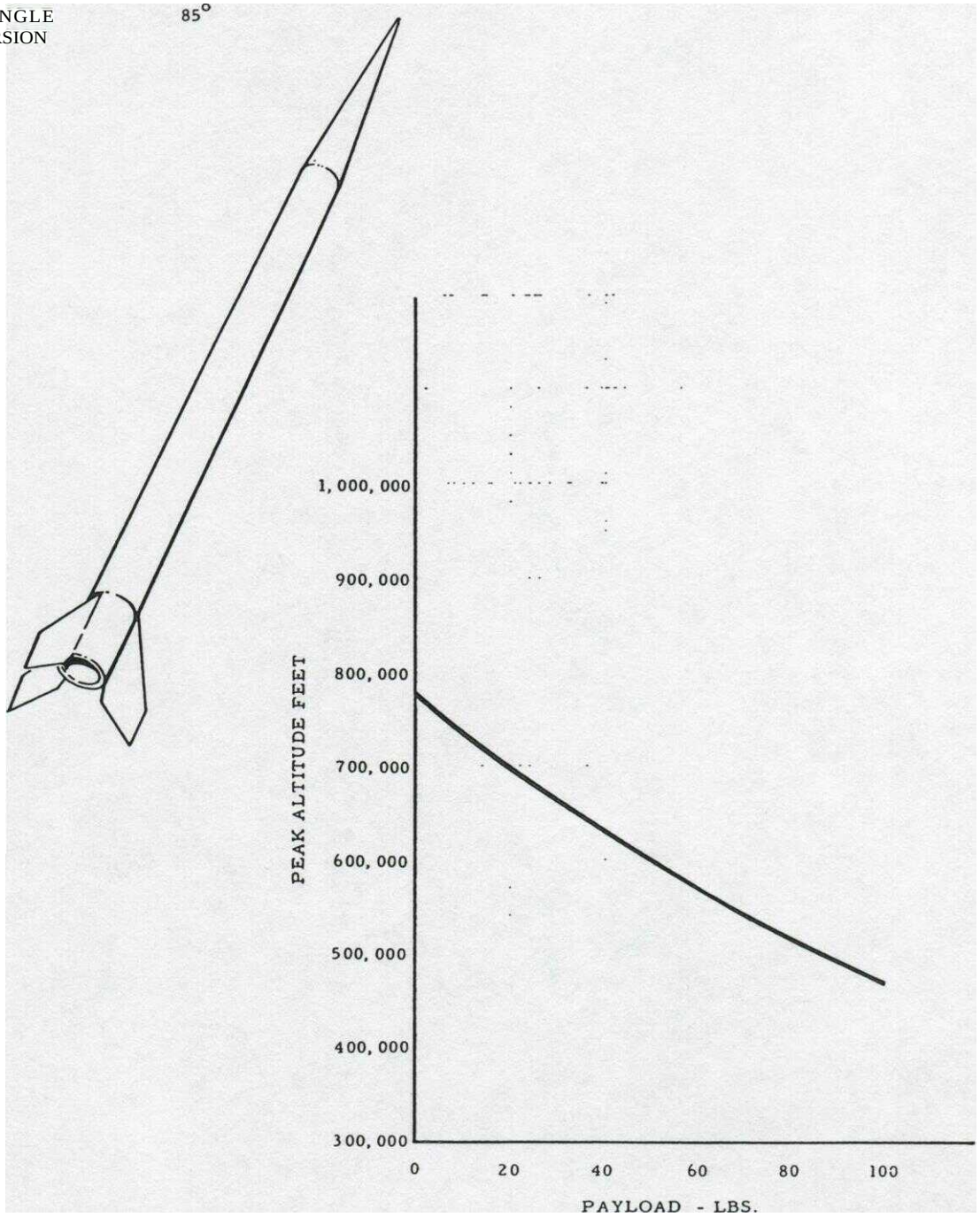


Figure 4- 2

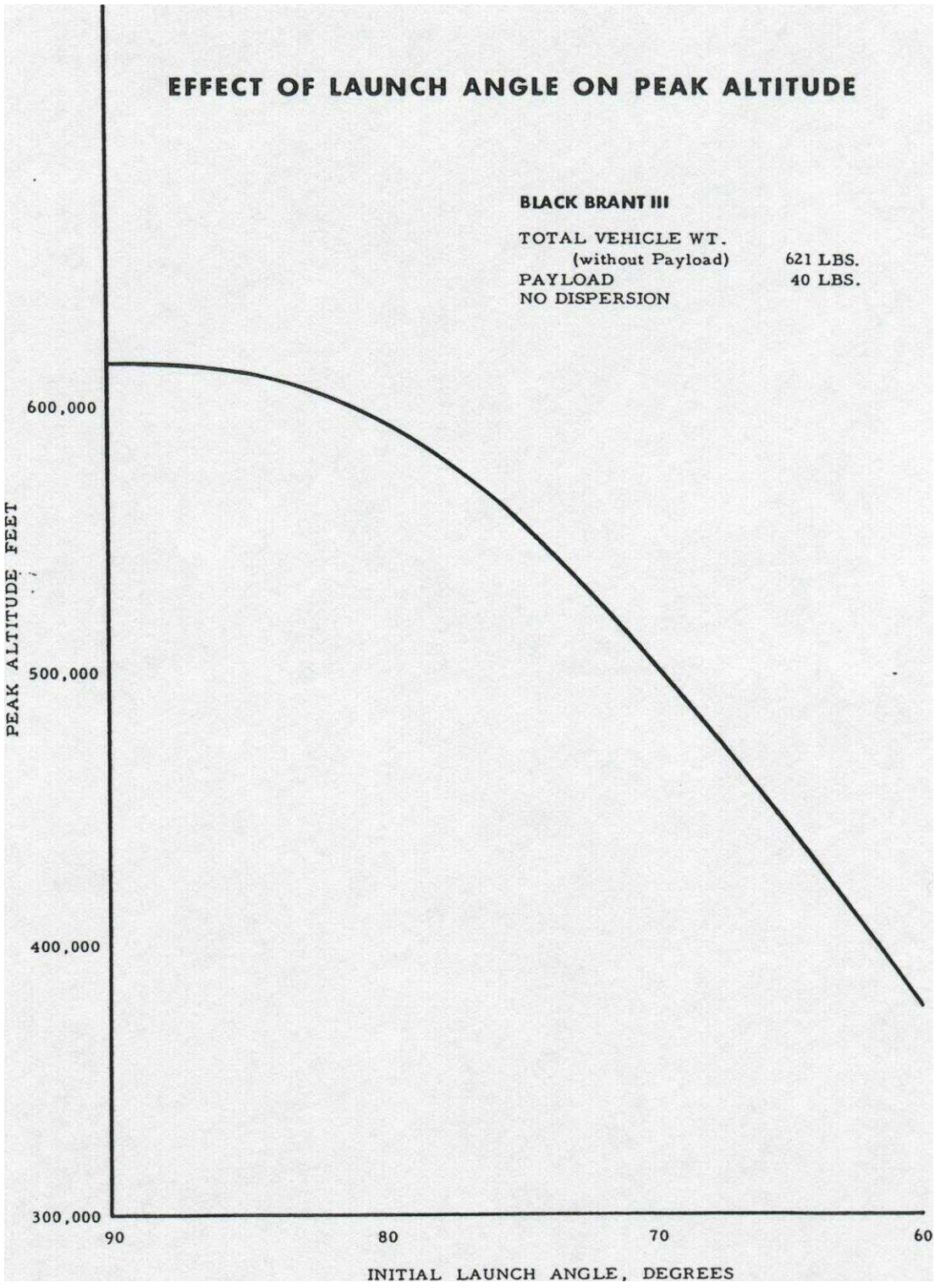

EFFECT OF LAUNCH ANGLE ON PEAK ALTITUDE
BLACK BRANT III
TOTAL VEHICLE WT.
(without Payload) 621 LBS.
PAYLOAD 40 LBS.
NO DISPERSION
600,000
500,000
400,000
300,000
PEAK ALTITUDE FEET
90
80
70
60
INITIAL LAUNCH ANGLE, DEGREES

Figure 4-3

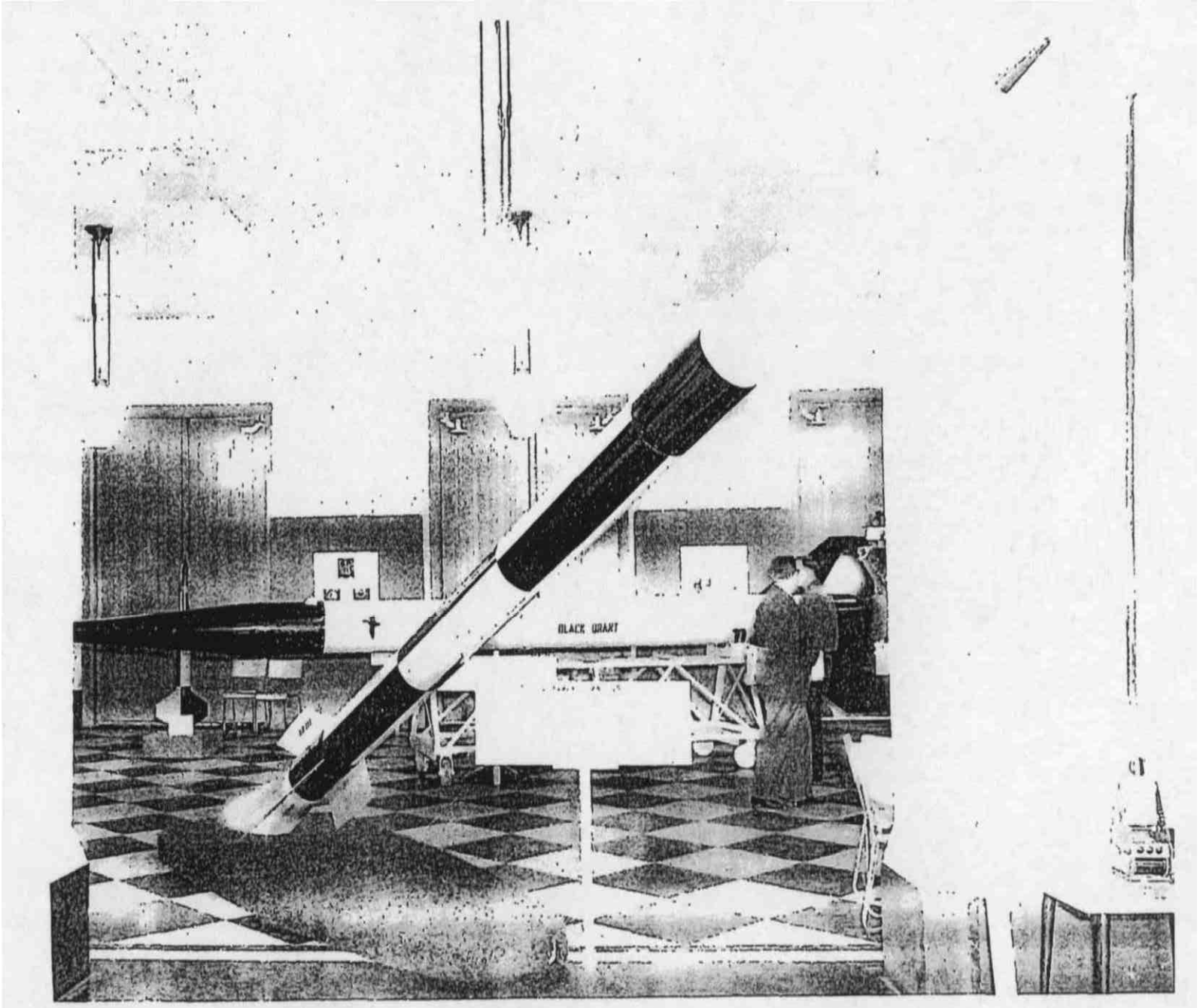


Figure 4-4 BLACK BRANT III MODEL MOUNTED ON DISPLAY STAND

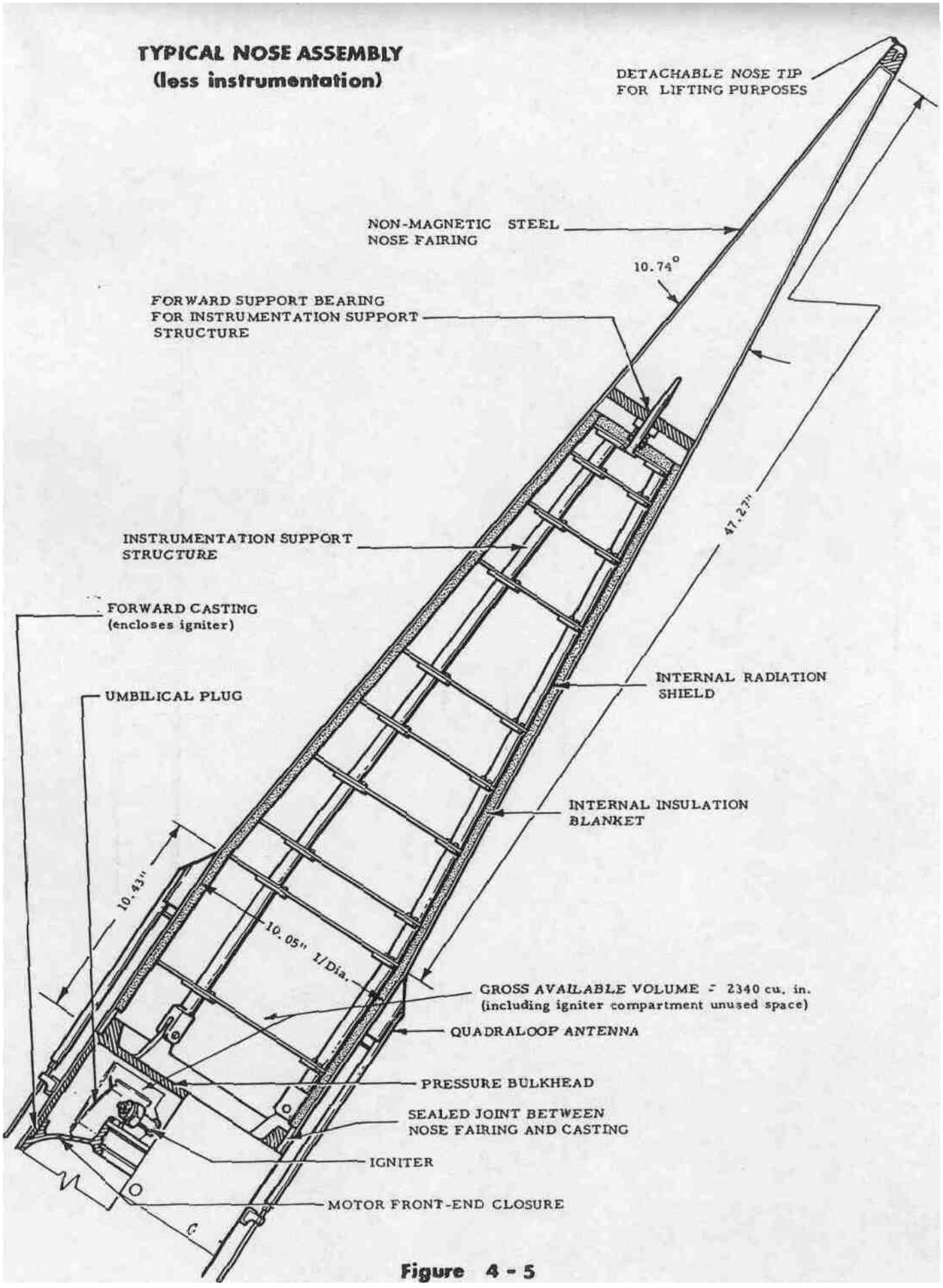

TYPICAL NOSE ASSEMBLY
(less instrumentation)
DETACHABLE NOSE TIP
FOR LIFTING PURPOSES
NON-MAGNETIC STEEL
NOSE FAIRING
10.74°
FORWARD SUPPORT BEARING
FOR INSTRUMENTATION SUPPORT
STRUCTURE
47.27"
INSTRUMENTATION SUPPORT
STRUCTURE
FORWARD CASTING
(encloses igniter)
UMBILICAL PLUG
INTERNAL RADIATION
SHIELD
INTERNAL INSULATION
BLANKET
10.43"
10.05" I/Dia.
GROSS AVAILABLE VOLUME = 2340 cu. in.
(including igniter compartment unused space)
QUADRALOOP ANTENNA
PRESSURE BULKHEAD
SEALED JOINT BETWEEN
NOSE FAIRING AND CASTING
IGNITER
MOTOR FRONT-END CLOSURE
C

Figure 4 - 5

Section 5

BLACK BRANT IV

5 BLACK BRANT IV

5.1 GENERAL

This rocket is a two-stage fixed finned vehicle using solid propellant in both stages. The initial Black Brant IV will be known as the Black Brant IV-A. Future development of the Black Brant IV-B is planned.

5.2 BLACK BRANT IV-A DETAILS

The vehicle Black Brant IV-A was designed around the Black Brant I motor and the Black Brant III vehicle.

5.2.1 10" ROCKET — SECOND STAGE

Body Diameter	10.2	inches
Body length (without nose cone)	147.3	inches
Body cross-sectional area	.565	sq.ft.
Payload compartment length	63.3	inches

5.2.2 17" ROCKET — FIRST STAGE

Body diameter	17.2	inches
Body length (without nose cone)	184.0	inches
Body cross-sectional area	1.615	sq. ft.

5.2.3 CONFIGURATION

The configuration as shown" in Figure 5-1, consists of 4 major sections:

SECTION 1 — The 10" Rocket attached and faired to the first stage.

SECTION 2 — Attachment and separation devices.

SECTION 3 — The 17" Black Brant I motor casing.

SECTION 4 — Stabilizing fins for the combined vehicle.

5.2.4 STABILIZING FINS

The fins being developed are of delta shape with a semi-span of 13.0 inches, a root chord of 44.3 inches and a leading edge sweepback of 71°.

5.2.5 WEIGHTS

Weight of loaded rocket motor (Inc. noxile), pounds	....594 & 2,300
, kilograms	275 & 1.040
Total Rocket Weight (minus payload), pounds...	3.104
, kilograms . .	**1,410**

5.2.6 PERFORMANCE (85° LAUNCH ANGLE)

Payload. pounds	25	**40**	**75**
Payload, kilograms	11	**18**	**34**
Maximum acceleration, "G"	**38**	**36**	**33**
Launch velocity with 15 foot launcher, ft./sec.			
Maximum velocity, ft./sec.	**13,460**	13.230	12.700
. meters/sec.	**4,100**	4.060	3,870
Altitude at burnout, feet	—	113,000	—
Peak Altitude, feet	3.400.000	3.190,000	2.870.000
. miles	643	604	543
, kilometers	1.035	972	874
Time to Peak Altitude, seconds	—	446	—
Range, feet			
Propellant Temp. Range, °F		**—20 to 120 (Objective)**	
. °C		—29 to 49 (Objective)	

NOTE:

The altitude and speed of the two-stage vehicle at the time of first stage motor burnout with a 40 lb. payload is of the order of 50.000 feet at Mach. 4.9. With the second stage firing with zero delay after the end of burning of the first stage the approximate maximum altitude of the configuration is calculated to be 3.100.000 feet with a 40 pound payload.

The time for commencement of burning of the second stage appears to be optimized in relation to aerodynamic heating, dispersion, loading, maximum altitude and drag if 0 seconds delay is allowed.

5.2.7 BALLISTIC DATA (70° F)

	1st Stage	**2nd Stage**
Square Wave Burning Time, seconds	**15.5**	**9.0**
Actual Burning Time (to zero thrust), seconds .	**18.8**	**12.t**
Nominal Thrust (sea level and 60,000 ft.), pounds .	**24.500**	**12,650**
. kilograms	**11,100**	**5.750**
Total Impulse (sea level and 60.000 ft.). pounds - seconds	383.200	113.700

5.2.8 STAGE ATTACHMENT AND SEPARATION

(a) ATTACHMENT

The upper and lower stages are attached by an arrangement which utilizes the upper stage nozzle as the structural joint. The aft end of this nozzle registers in a circumferential groove, cut in a heavy ring located at the forward end of a short parallel body section mounted ahead of the first stage motor. Integral with this end-ring is a long spigot, which passes up inside the second stage nozzle to locate against the inside face of the expansion cone.

The upper stage nozzle remains firmly registered in the end-ring due to the downward inertia force present when the first stage is burning. Any lateral moments are reacted by side thrusts on the forward end of the spigot, and on the sides of the end-ring circumferential slot.

Longitudinal webs are used as stiffeners between the nozzle and the conical stabilizer.

(b) SEPARATION

The two stages remain in positive contact only as long as an upward acceleration exists. With burnout of the first stage motor, the greater drag of the booster creates a differential force to separate the stages. Firing of the second stage motor then commences.

5.3 BLACK BRANT IV-B

Ultimately it is Intended to replace the 17" Black Brant I first stage with the motor being developed for the Black Brant V. The resulting vehicle will be known as the Black Brant IV.B.

BLACK BRANT IVA - TWO STAGE VEHICLE

(10" AND 17" COMBINED)

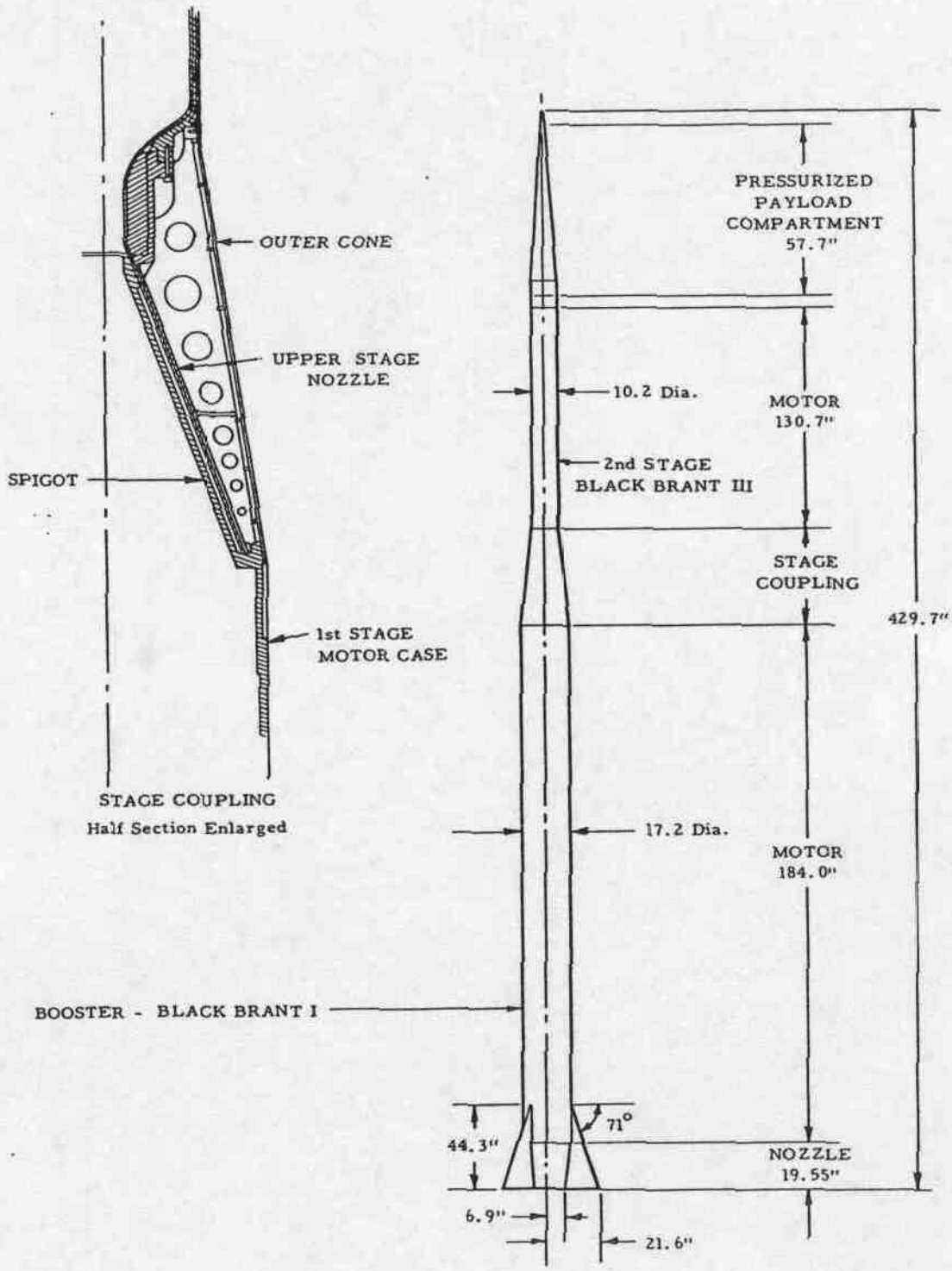


Figure 5 - 1

EFFECT OF PAYLOAD ON PEAK ALTITUDE

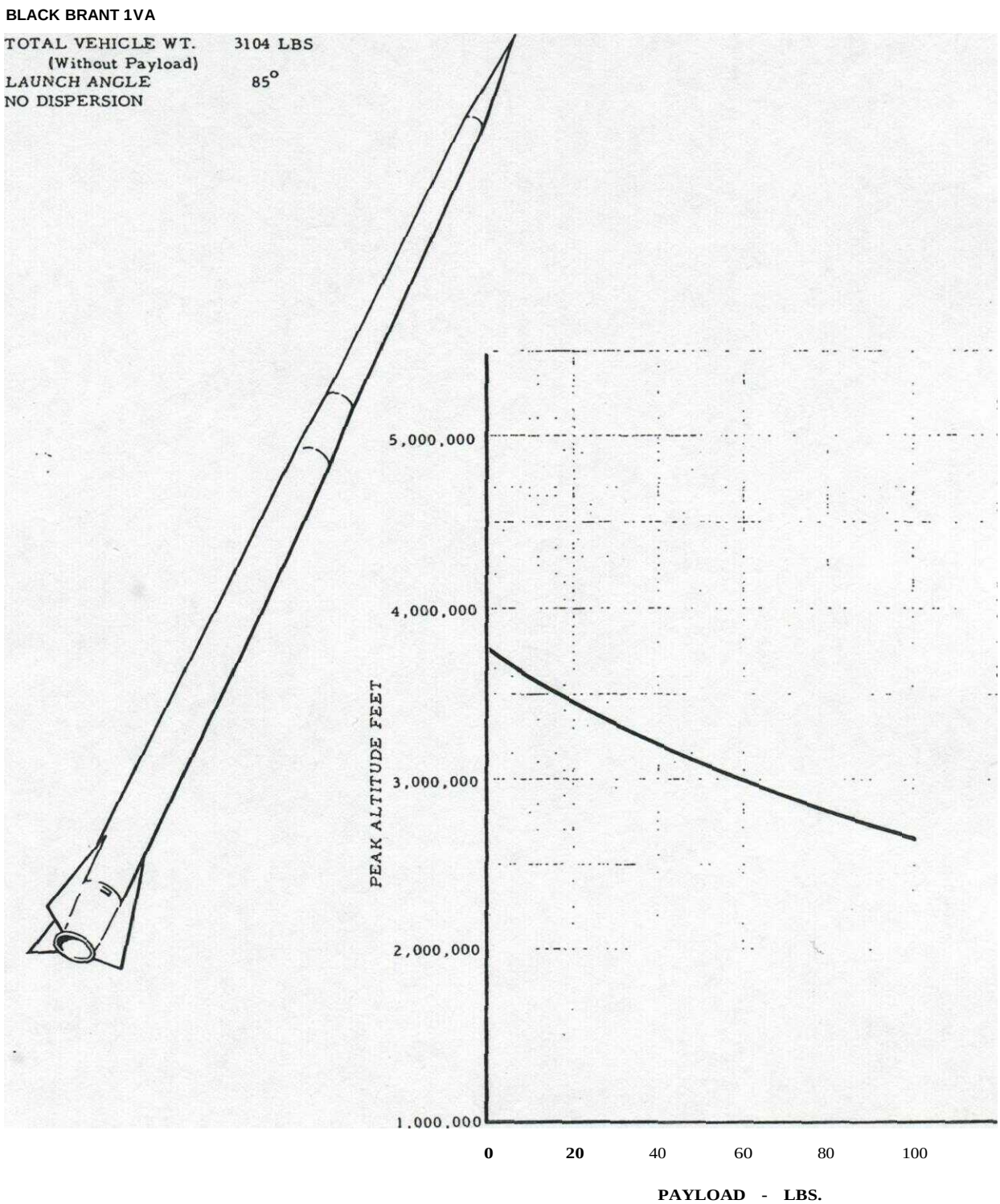


Figure 5-2

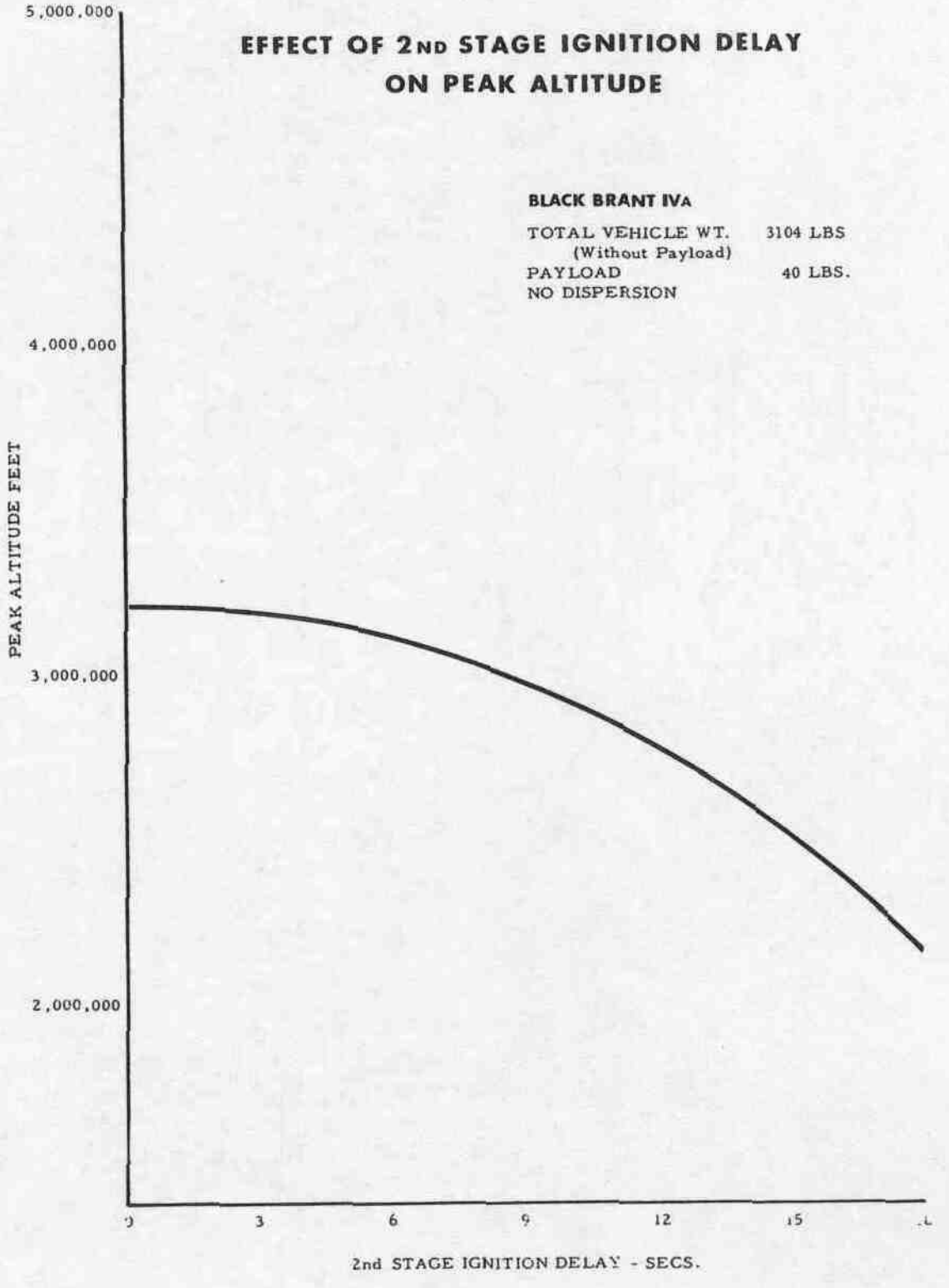

EFFECT OF 2ND STAGE IGNITION DELAY
ON PEAK ALTITUDE
BLACK BRANT IVA
TOTAL VEHICLE WT. 3104 LBS
(Without Payload)
PAYLOAD 40 LBS.
NO DISPERSION
5,000,000
4,000,000
3,000,000
2,000,000
PEAK ALTITUDE FEET
3
6
9
12
15
2nd STAGE IGNITION DELAY - SECS.

Figure 5-3

Section 6

BLACK BRANT V

6 BLACK BRANT V

6.1 REQUIREMENT

To meet the requirement for carrying heavier payloads to increased altitudes, Black Brant V is being developed. It will be capable of carrying a payload of 150 pounds to an altitude of 240 miles.

6.2 CONFIGURATION

The basic configuration as detailed in Figure 6-1 will consist of:

6.2.1 NOSE

This is a tangent ogive followed by a cylindrical section for single stage role providing approximately 8 cubic feet of payload volume. The nose will be lighter than on Black Brant II to improve performance. Various cylindrical lengths will be available. The nose is replaced by Black Brant III for the two stage vehicle.

6.2.2 MOTOR

The motor, including the nozzle, will be identical for both roles. The use of higher strength steels will result in a lighter motor than used in Black Brant II.

6.2.3 STABILIZERS

Three fins. These will be smaller and lighter than the Black Brant II.

6.3 WEIGHTS

Weight of loaded Rocket Motor (Inc. nozzle), pounds 2,459

. kilograms... . . 1.115

Total Rocket Weight (minus payload), pounds..... . 2,639

, kilograms 1.190

6.4 PERFORMANCE DATA (85° LAUNCH)

Payload, pounds	75	150	300
Payload, kilograms	34	68	136
Maximum acceleration "G"	—	18	—
Launch velocity with 15 foot launcher. ft./sec.	—	82	—
Maximum velocity, ft./sec.	9,130	8,530	7.580
. meters/sec.	2,780	2,600	2.320
Altitude at burnout, feet	120,000	112,000	98,000

6.4 PERFORMANCE DATA (85° LAUNCH) Cont'd.

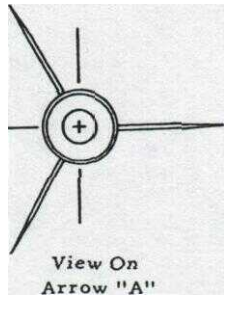
Peak Altitude, feet	1.430,000	1,267.000	1,000.000
. miles	270	240	190
. kilometers	435	386	305
Time to Peak Altitude, seconds	—	308	—
Range, feet	—	—	—
Propellant Temp. Range. °F		—20 to 120	(Objective)
. °C		—29 to 49	(Objective)

6.5 BALLISTIC DATA (70° F)

Square Wave Burning Time. seconds	23.5
Actual Burning Time (to zero thrust), seconds	28.5
Nominal Thrust (sea level), pounds	19.200
. kilograms	8.709
Total Impulse (sea level), pounds-seconds	452.000

BLACK BRANT V

17" ROCKET



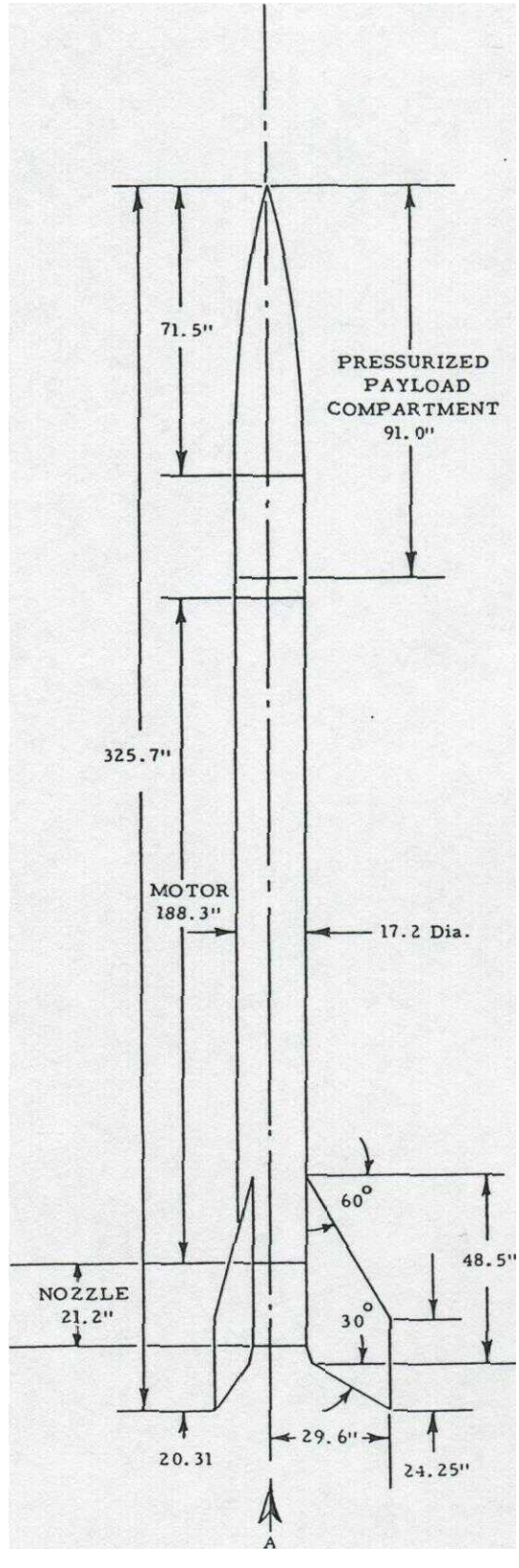


Figure 6-1

EFFECT OF PAYLOAD ON PEAK ALTITUDE

BLACK BRANT V

TOTAL VEHICLE WT. 2639 LBS
(Without Payload)
LAUNCH ANGLE 85°
NO DISPERSION

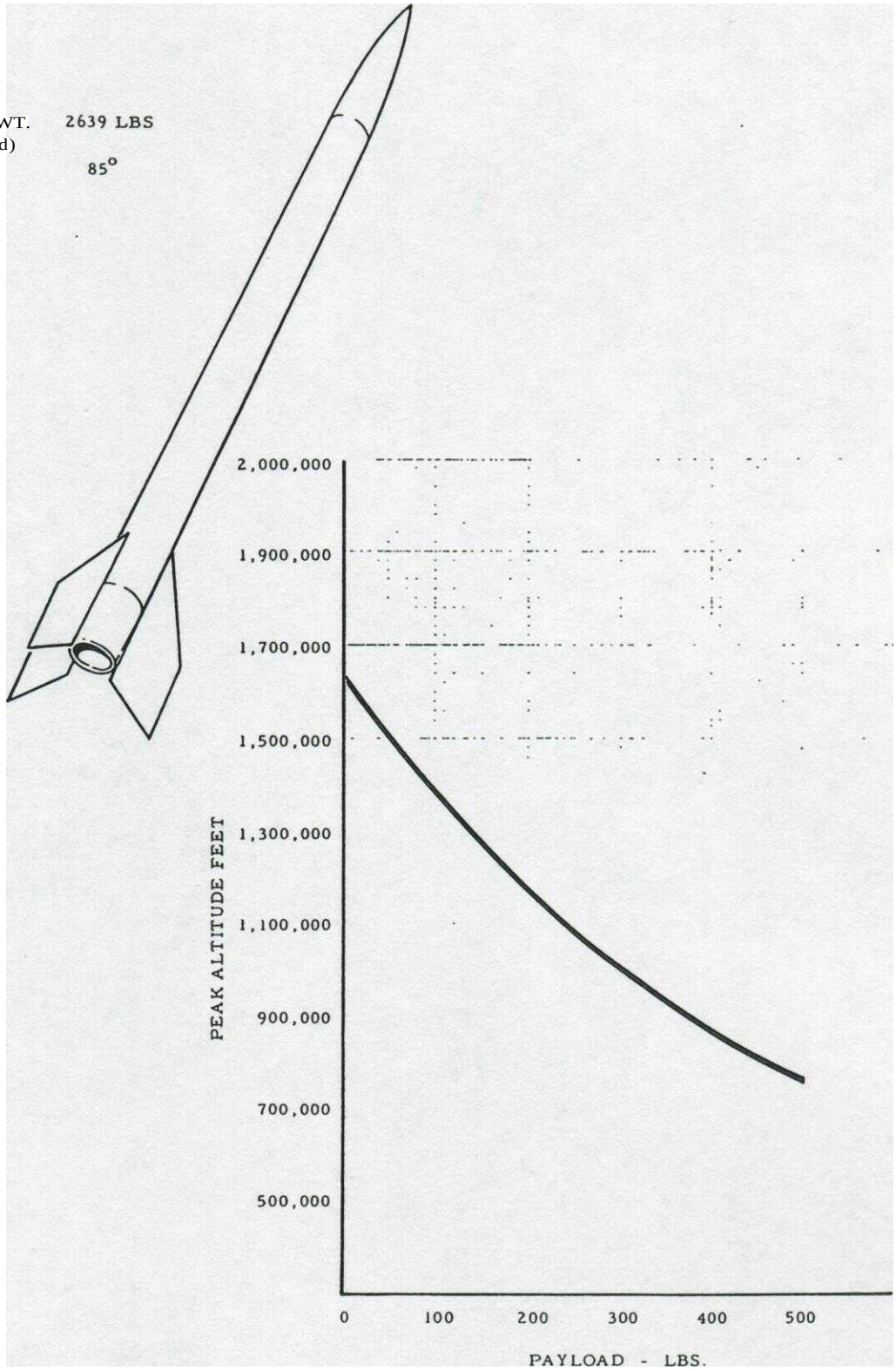


Figure 6-2

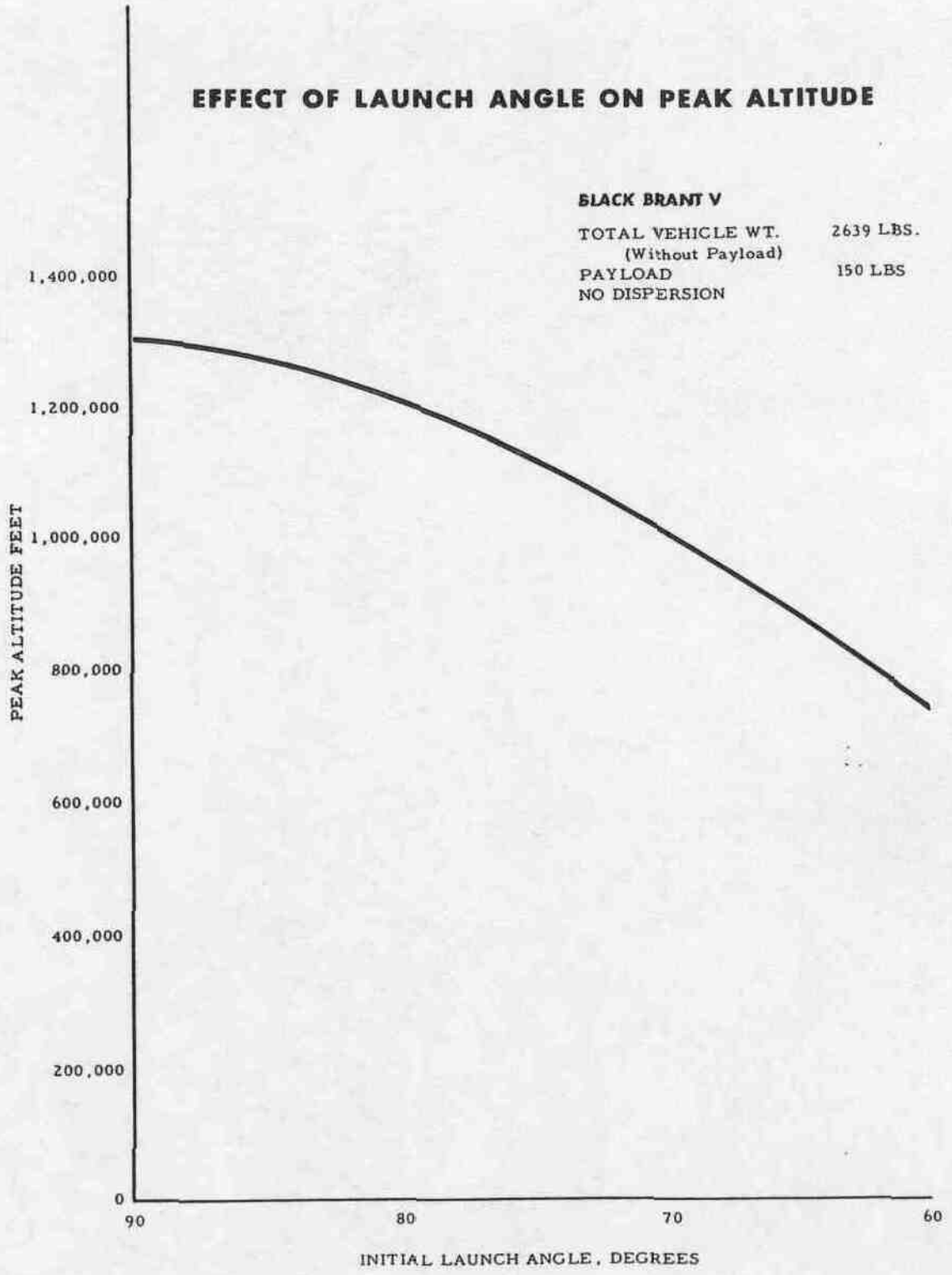

EFFECT OF LAUNCH ANGLE ON PEAK ALTITUDE
BLACK BRANT V
TOTAL VEHICLE WT. 2639 LBS.
(Without Payload)
PAYLOAD 150 LBS
NO DISPERSION
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
PEAK ALTITUDE FEET
90
80
70
60
INITIAL LAUNCH ANGLE, DEGREES

Figure 6-3

TYPICAL OGIVE NOSE CONE

BLACK BRANT V

(22" forward body shown)

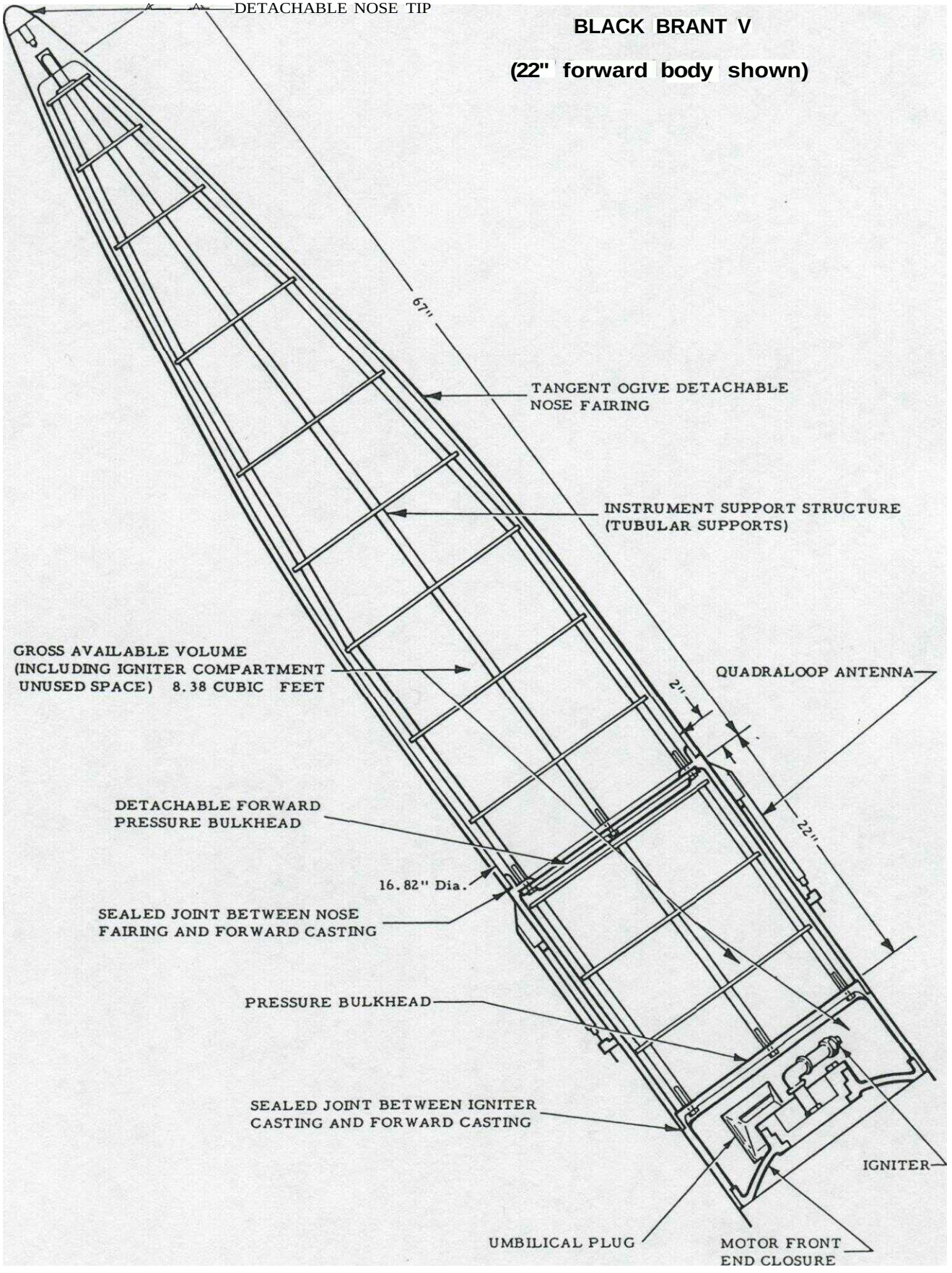


Figure 6-4

Section 7

INSTRUMENTATION

7 INTRODUCTION

Bristol has available standard telemetry packages for the Black Brant vehicles and is currently developing instruments for measuring rocket performance.

7.1 TELEMETRY PACKAGES

Two basic packages are presently available.

The package for the 17" vehicle provides 10 telemetry channels and that for the 10" vehicle has 5 channels. The basic 10" package which has been designed for the Black Brant III is completely transistorized, however, a version using vacuum tubes is also available. All of these packages have one of the channels, "time multiplexed". which is capable of handling up to 25 sources of commutated information.

Design environmental conditions for the basic 17" package include acceleration of 26 g. for one minute, shock loading of 25 g. for 10 milliseconds and a design temperature range of from minus 20° to plus 75° Centigrade.

Both versions of the 10" package have been designed for vibrational acceleration of 15 g. at 20 to 2,000 c.p.s. with a maximum acceleration of 60 g., and shock loading of 50 g. for 10 milliseconds. Design temperature range for these packages is also minus 20° to plus 75° Centigrade.

Some additional details are as follows:

7.1.1 17" TELEMETRY PACKAGE

Weight	35 lbs.
Volume	Approximately 700 cu. in.
Transmitter Power Output	5 watts.
Operating Voltage	26.2 volts. D.C. (Silver-zinc batteries)
Effective Range	Approximately 300 miles
Frequency	216 to 230 mc.
Band Width	300 kc.

7.1.2 TRANSISTORIZED 10" PACKAGE

Weight	Approximately 17 lbs.
Volume	Approximately 500 cu. in.
Transmitter Power Output	1 watt.
Operating Voltage	33.4 volts D.C. (Silver-zinc battery)
Effective Range	140 miles

7.1.2 TRANSISTORIZED 10" PACKAGE (Cont'd.)

Frequency	Capable of 216 to 260 **me.**
Band Width	300 kc.

7.1.3 10" VACUUM TUBE TELEMETRY PACKAGE

Weight	30 lbs.
Transmitter Power Output	5 watts.
Operating Voltage	26.2 volts D.C. (Silver-zinc batteries)
Effective Range	Approximately 300 miles
Frequency	216 to 230 me.
Band Width	300 kc.

7.2 QUADRALOOP ANTENNA

A new quadraloop telemetry antenna was developed by the Radio and Electrical Engineering Division of the National Research Council primarily for use on the Black Brant III vehicle where the high temperatures and mechanical forces make the use of blade antennas impractical.

This quadraloop antenna which weighs less than two pounds has a frontal area of less than one square inch and is capable of handling a power of 5 watts.

Radiation patterns checked on a model rocket indicate uniform coverage ± *2* db, in 60° cones fore and aft with two narrow nulls in the radial direction.

7.3 ALTITUDE SENSING INSTRUMENT

This unit utilizes the Pfotzer cosmic ray maximum layer to provide an inexpensive and yet reasonably accurate indication of the altitude achieved by the vehicle. Accuracy of plus or minus 2 to 5 km. is expected.

7.4 ROLL-RATE MAGNETOMETER

To measure the spin-rate and assist in determining vehicle attitude, a roll-rate magnetometer is used. This instrument utilizes the earth's magnetic field and provides an inexpensive substitute for a roll-rate gyro system.

7.5 GROUND TEST EQUIPMENT

A preflight telemetry check-out console has been developed primarily for use with the Black Brant **III** vehicle. With the addition of antenna and recording equipment. this console can be used as a complete ground station. Similar equipment is being developed for subsequent Black Brant vehicles.

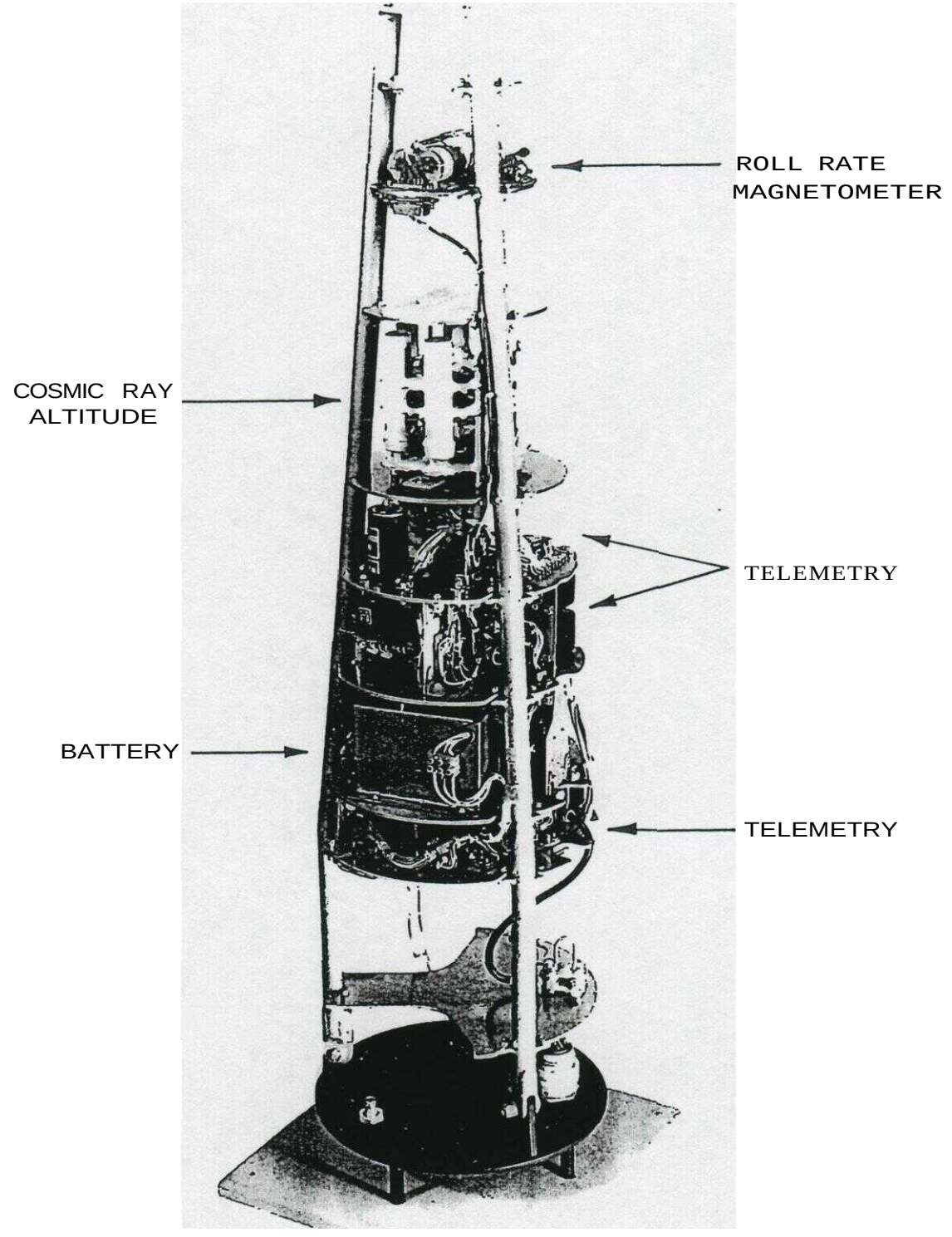


Figure 7-1 PROTOTYPE INSTRUMENTATION FOR BLACK BRANT III 10" ROCKET

Section 8

LAUNCHER EQUIPMENT

8 LAUNCHER EQUIPMENT

8.1 LAUNCHING EQUIPMENT GENERAL

8.1.1

Launching simplicity has been a major design criterion for the Black Brant rocket family. The vehicles are designed to enable launching from almost all boom or tower type launchers with only minor modification to the vehicles or launcher.

8.1.2

The standard vehicles are designed for use with an underslung three rail launcher, however, with minor modification the single rail system may also be employed. An optional four-fin kit is included in the design to provide further versatility.

8.2 LAUNCHER FOR BLACK BRANT III

8.2.1

A 10 foot effective length launcher for use in conjunction with Black Brant III will be available. The launcher is not a fixed installation, being capable of movement from site to site. It is stabilized by four out-riggers, which are bolted at their extremities to four small foundation points; these are permanently located at the firing site. The CBA launcher is an underslung type, the rocket carried on rails mounted on the underside of a large diameter tubular boom. This boom can be hydraulically elevated to a maximum of 90°. and the whole structure is capable of independent rotation through 360° in azimuth. A sketch showing general arrangement of the CBA launcher for Black Brant III is shown in figure 8.1.

8.2.2

Trajectory dispersion calculations for the Black Brant III are based on a launcher of 10 ft. 6 in. effective length, with "zero tip-off". Use of a longer launcher will reduce dispersion.

BLACK BRANT III LAUNCHER

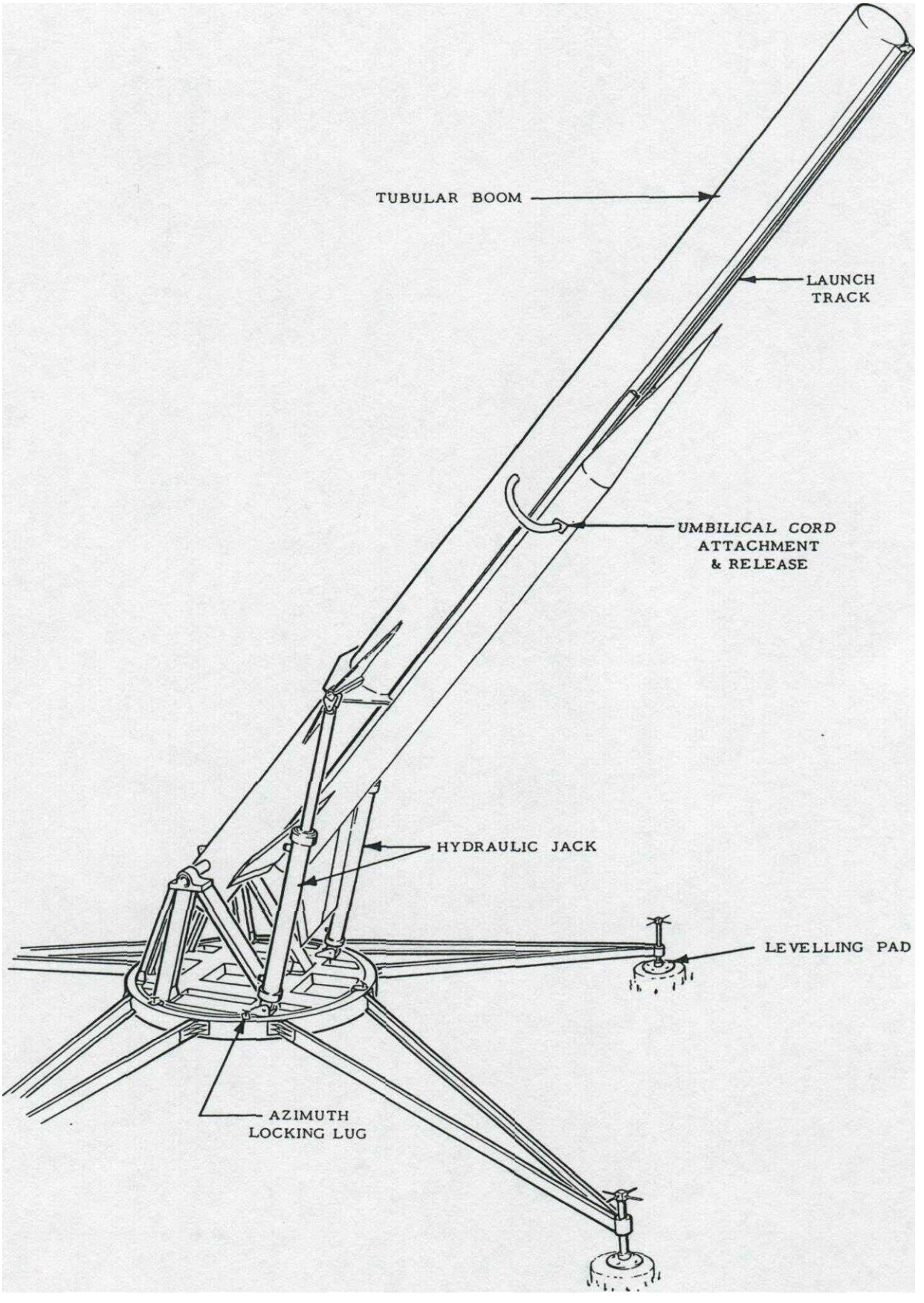


Figure 8-1

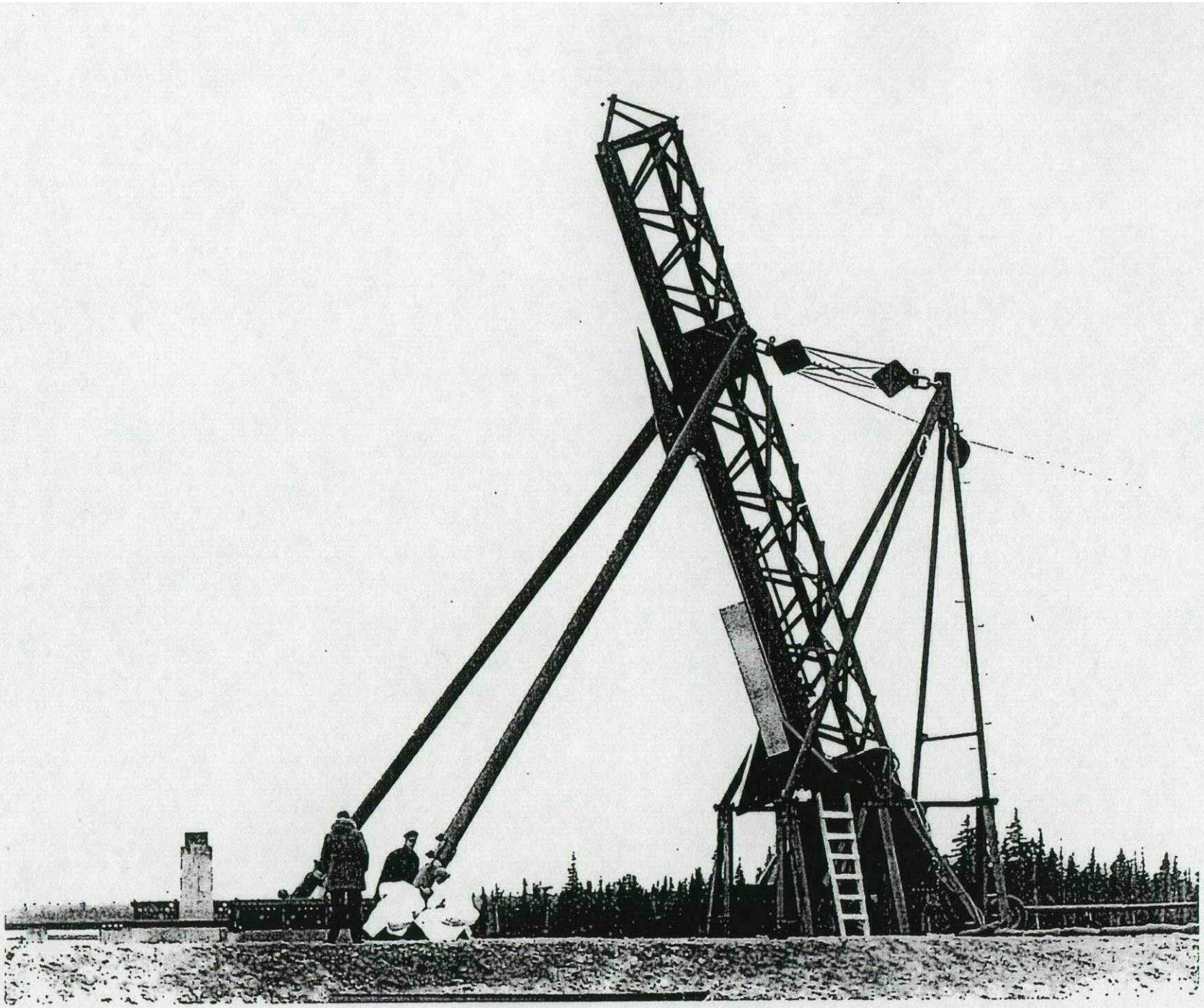


Figure 8-2 PREPARING TO LAUNCH A BLACK BRANT I ROCKET

Section 9

REVIEW OF THE CAPABILITIES OF BLACK BRANT FAMILY

9 REVIEW OF CAPABILITIES OF BLACK BRANT ROCKETS

BLACK BRANT	II-A	II-B	III	IV-A	V
Performance (Launch angle 85°)	150 pounds to 125 miles (660,000 ft.) (201 km.)	150 pounds to 180 miles (950,400 ft.) (290 km)	40 pounds to 120 miles (633,000 ft.) (193 km.)	40 pounds to 604 miles (3,190,000 ft.) (972 km.)	150 pounds to 240 miles (1,267,000 ft.) (386 km.)
Propellant	solid	solid	solid	solid	solid
Stages	single	single	single	two stage	single
Diameter (nominal)	17 inch	17 inch	10 inch	17 inch 1st stage 10 inch 2nd stage	17 inch
Length overall (approximate)	27.6 feet	27.6 feet	18.7 feet	37.6 feet	24 feet
Total weight at launch (approx. less payload)	2537 pounds	2817 pounds	621 pounds	3104 pounds	2639 pounds
Nose Cone: Nominal Payload	150 pounds	150 pounds	40 pounds	40 pounds	150 pounds
Payload Range	50 to 300 pounds	50 to 300 pounds	25 to 75 pounds	25 to 75 pounds	75 to 200 pounds
Volume available for payload	6.0 cubic feet (10400 cu. in.)	6.0 cubic feet (10400 cu. in.)	1.4 cubic feet (2400 cu. in.)	1.4 cubic feet (2400 cu. in.)	8 cubic feet (13800 cu. in.)
Longitudinal Acceleration (approximate maximum)	18 g.	18 g.	31 g. (estimate)	38 g. (estimate)	25 g. (estimate)

Section 10

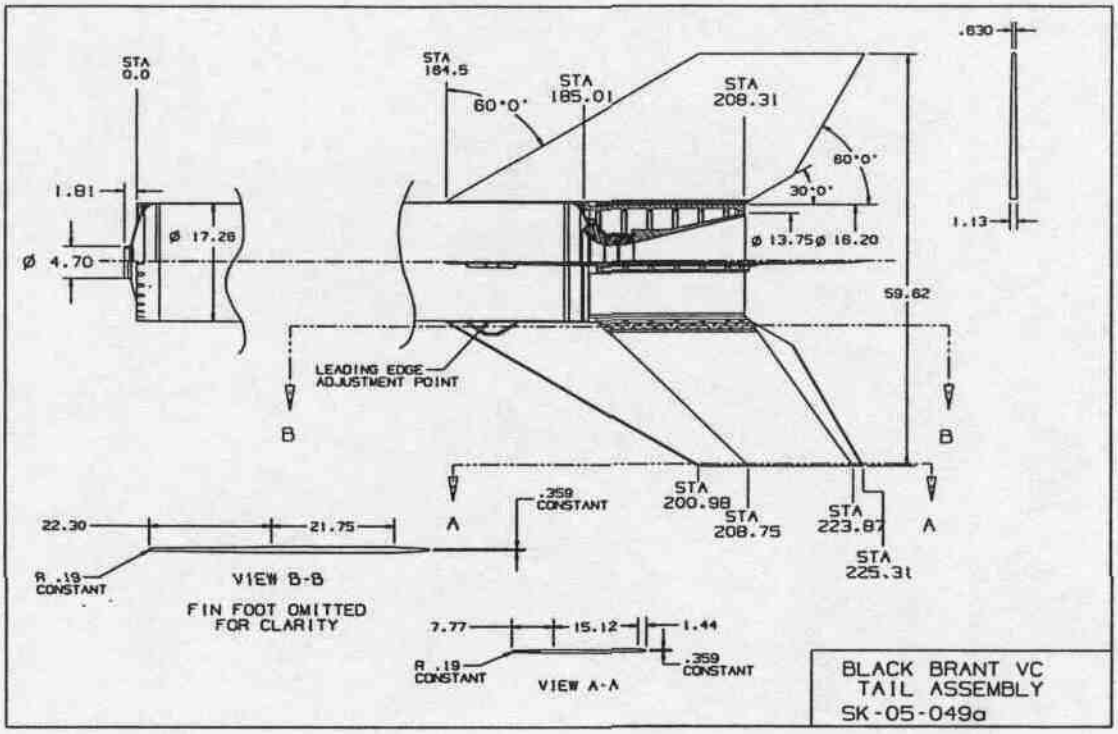
CONVERSION FACTORS

10 CONVERSION FACTORS — WEIGHTS AND MEASURES

10.1

The following conversion factors will serve as a handy reference to those factors that may be useful for the interpretation of information contained in the brochure:

Inches	x	.0835	=	feet (ft.)
Inches	x	2.54	==	centimeters (cm,
Centimeters	x	0.3937	=	inches (in.)
Feet	x	0.3048	=	meters
Meters	x	3.2808	=	feet (ft.)
Miles	x	1.6093	=	kilometers (km.)
Kilometers	x	0.62137	=	miles
Pounds	x	0.45359	=	kilograms
Kilograms	x	2.2046	=	pounds


STA 0.0
STA 184.5
60°0'
STA 185.01
STA 208.31
80°0'
30°0'
.830
1.13
1.81
Ø 17.28
Ø 4.70
Ø 13.75 Ø 18.20
59.62
LEADING EDGE ADJUSTMENT POINT
B
B
STA 200.98
STA 208.75
STA 223.87
STA 225.31
.359 CONSTANT
A
A
22.30
21.75
R .19 CONSTANT
VIEW B-B
FIN FOOT OMITTED FOR CLARITY
7.77
15.12
1.44
R .19 CONSTANT
.359 CONSTANT
VIEW A-A
BLACK BRANT VC
TAIL ASSEMBLY
SK-05-049a

NEWSLETTER

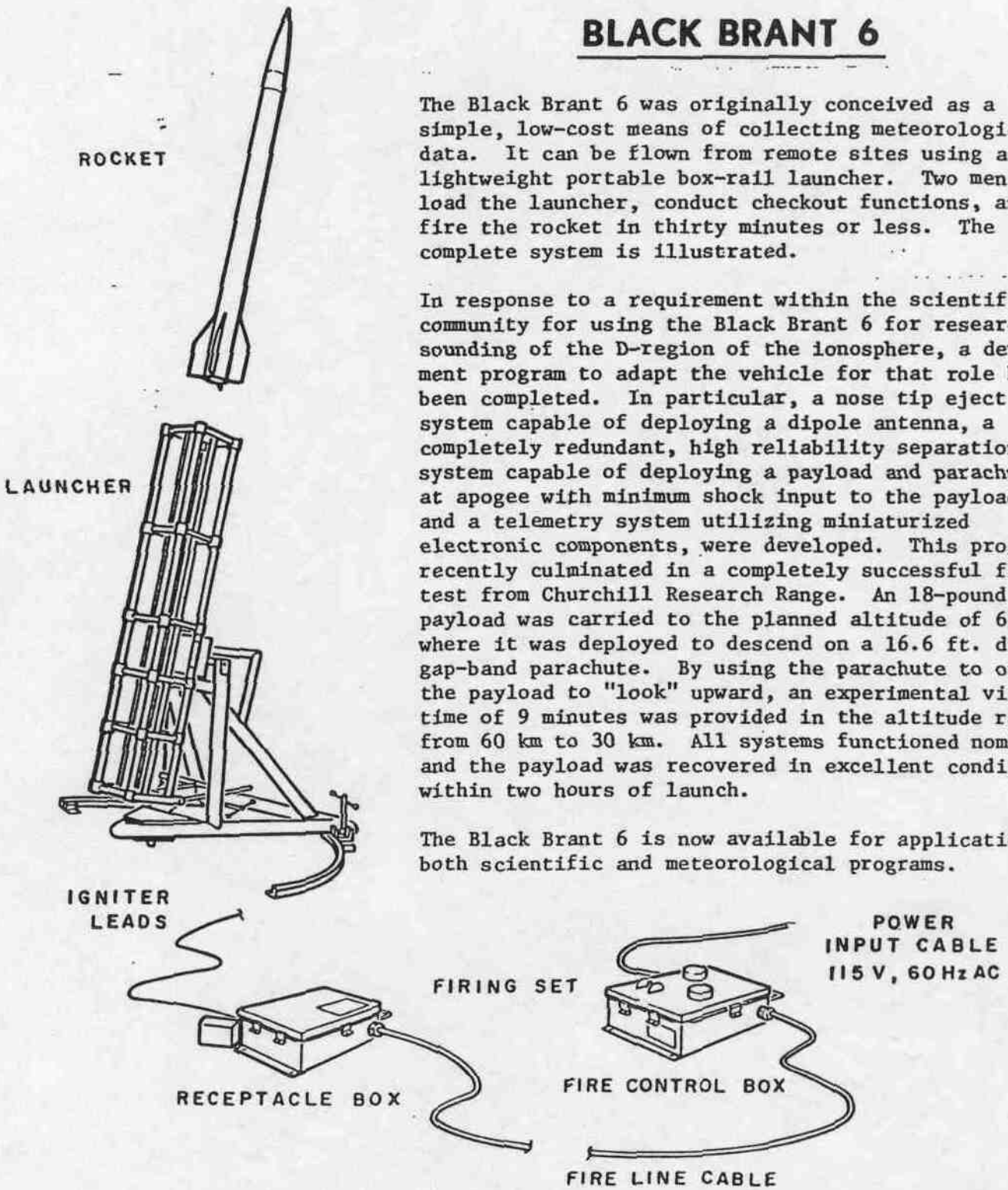
76-2 MAY 1976

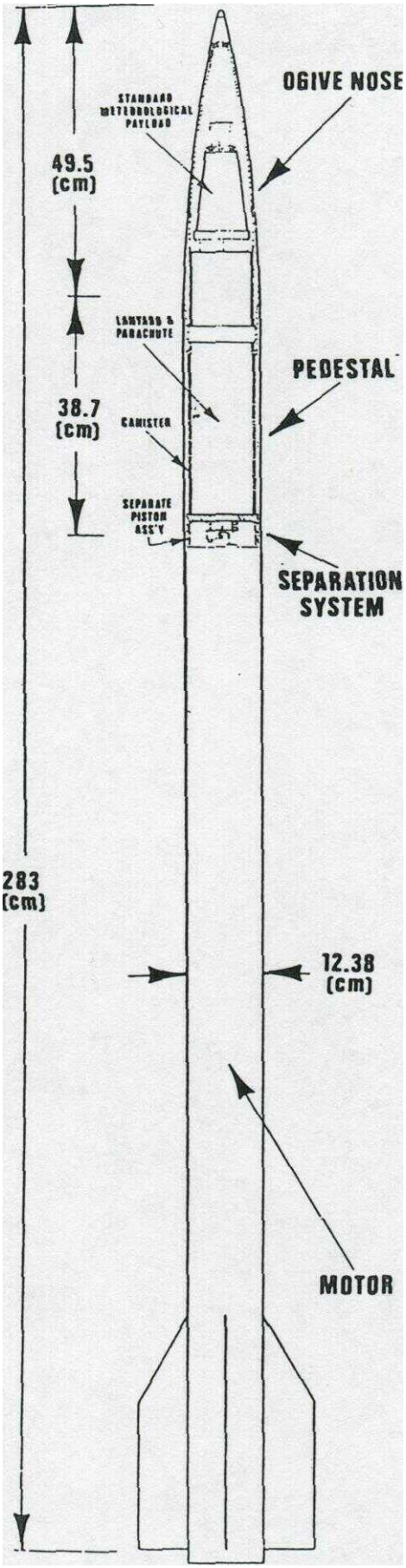
BLACK BRANT 6

The Black Brant 6 was originally conceived as a simple, low-cost means of collecting meteorological data. It can be flown from remote sites using a lightweight portable box-rail launcher. Two men can load the launcher, conduct checkout functions, and fire the rocket in thirty minutes or less. The complete system is illustrated.

In response to a requirement within the scientific community for using the Black Brant 6 for research sounding of the D-region of the ionosphere, a development program to adapt the vehicle for that role has been completed. In particular, a nose tip eject system capable of deploying a dipole antenna, a completely redundant, high reliability separation system capable of deploying a payload and parachute at apogee with minimum shock input to the payload, and a telemetry system utilizing miniaturized electronic components, were developed. This program recently culminated in a completely successful flight test from Churchill Research Range. An 18-pound payload was carried to the planned altitude of 60 km where it was deployed to descend on a 16.6 ft. disc-gap-band parachute. By using the parachute to orient the payload to "look" upward, an experimental viewing time of 9 minutes was provided in the altitude range from 60 km to 30 km. All systems functioned nominally and the payload was recovered in excellent condition within two hours of launch.

The Black Brant 6 is now available for application to both scientific and meteorological programs.





PERFORMANCE DATA

PAYLOAD

Weight (Useful Payload) . . . . . 1.0 Co 6.8 Kgs.
Diameter (O.D.) . . . . . .12.38cm.
Length. . . . . .87.76cm.

LAUNCH DATA

Launcher. . . . . .Boxed Rail
Azimuth. . . . . .Variable 0 to 36C
Elevation. . . . . .Adjustable 60° to

TYPICAL VEHICLE FLIGHT DETAILS, 3.2 KGS. USEFUL PAYLOAD

Launch Angle, sea level. . . . . .80°
Apogee Altitude (nominal). . . . . .71Km.
Burnout Velocity (approx.) . . . . . 1450 m/s
Burnout Altitude (approx.). 9450m
Burning Time. . . . . .8.9 sees.
Time to Apogee. . . . . .120 sees.
Range at Apogee. . . . . .26Km.
Nominal Spin Rate at - • ' '
Separation/Apogee. . . . . .17 rps
Acceleration. . . . . .45g (max.)

WEIGHTS

Launch (3.2 Kgs. Payload with Parachute). . . . . .52.4Kg.
Nose Cone (phenolic) and Pedestal . . . . . 4.3 Kg.
Separation System & Cannister . . . . . 0.57 Kg.

ADDITIONAL DATA

Storage Life. . . . . .3 years

Temperature Limits (storage) . . . . . -53° C to 67° C
(operation) . . . . . -45° C to 61° C

Payload Separation

Initiation. . . . . .G-Switch
Delay. . . . . .Mechanical Timer
Method. . . . . .Gas Pressure

Parachute

Configuration. . . . . .Nylon Circular
Weight . . . . . .954 Kg.
Descent Rate (average) . . . . . 10 m/sec.

Payload Housing

Pedestal. . . . . .Integral with moto casing. Houses Separation System and Parachute.

Fire Control System Input . . . . . 115 Volts A.C.

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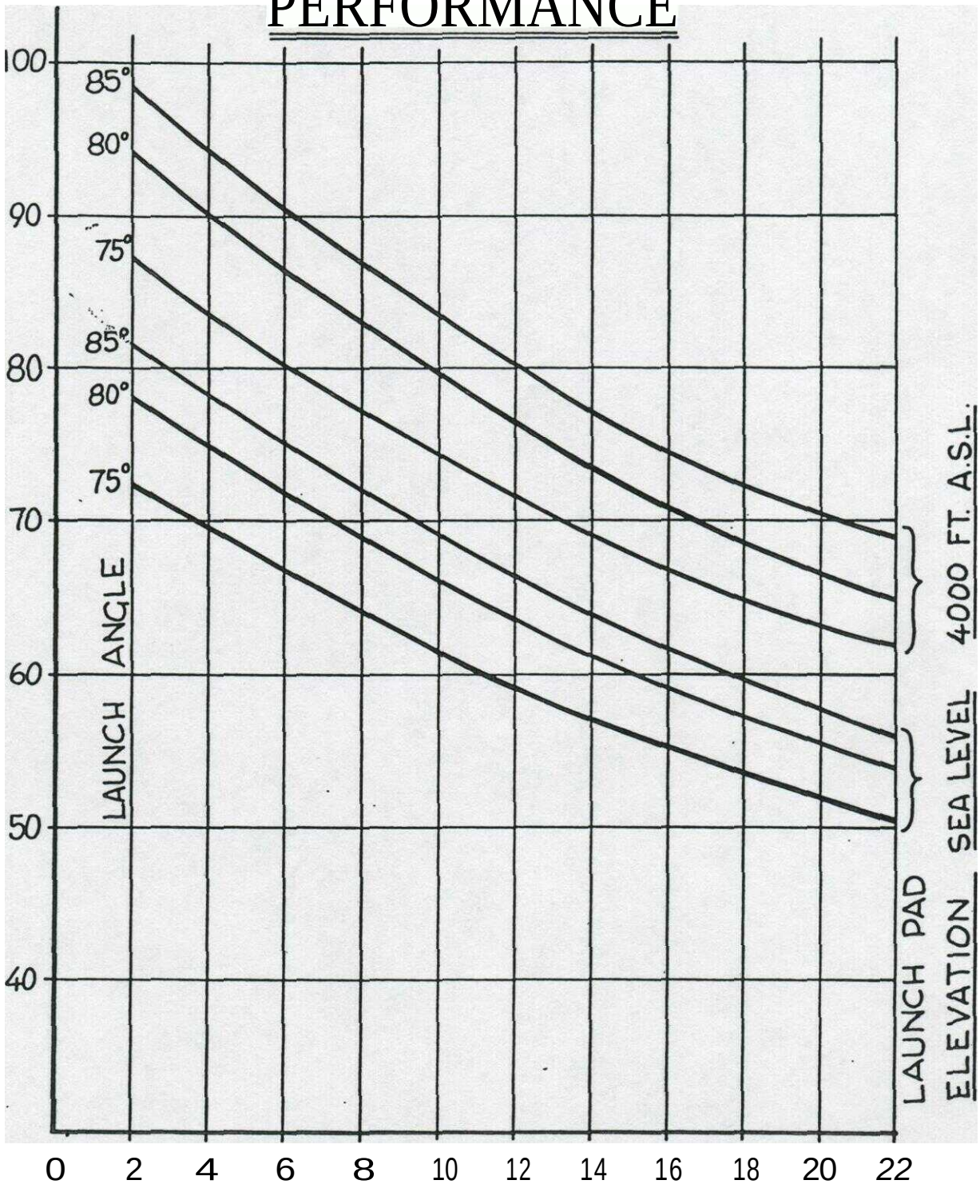
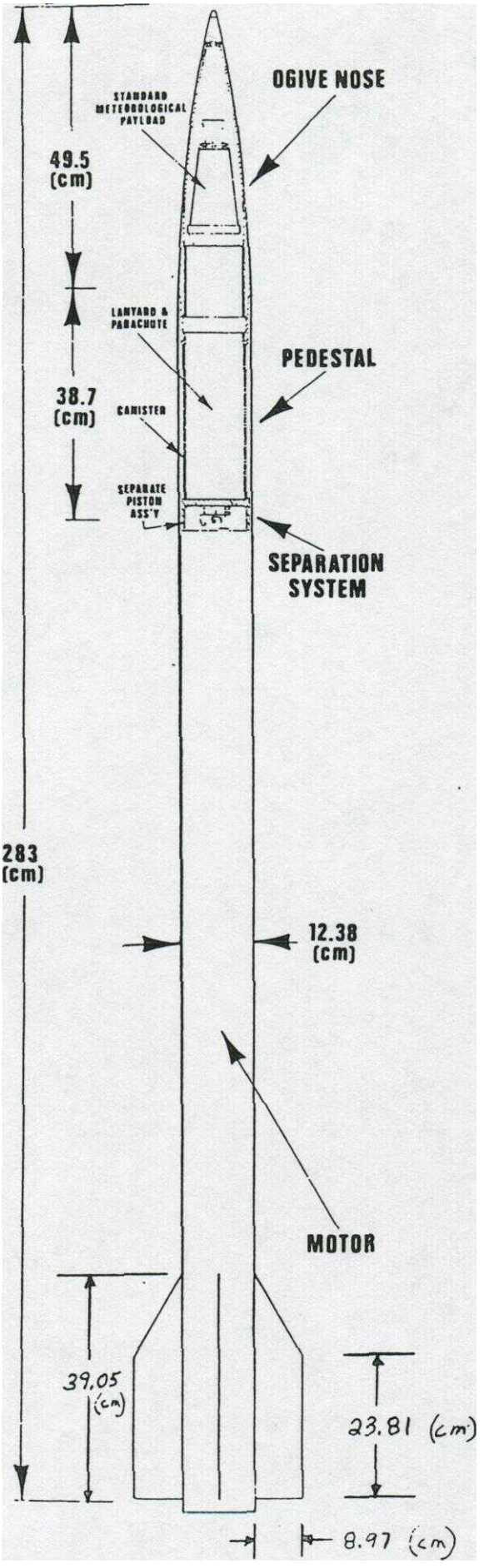
TWX 610-671-3598
TELEX 07-57774 - 07-S7804

BB 6 APOGEE PERFORMANCE





PERFORMANCE DATA

PAYLOAD

Weight: (Useful **Payload**) . . . . . **1.0 to 6.8 Kgs.**
Diameter (O.D.) . . . . . 12.38cm.
Length . . . . . 87.76 cm.

LAUNCH DATA

Launcher . . . . . Boxed Rail
Azimuth . . . . . Variable 0° to 36C
Elevation . . . . . Adjustable 60° to

TYPICAL VEHICLE FLIGHT DETAILS, 3.2 KGS. USEFUL PAYLOAD

Launch Angle, sea level . . . . . 80°
Apogee Altitude (nominal) . . . . . **71Km.**
Burnout Velocity (approx.) . . . . . 1450 m/s
Burnout Altitude (approx.) . . . . . 9450 m
Burning Time . . . . . 8.9 sees.
Time Co Apogee . . . . . 120 sees.
Range at Apogee . . . . . 26Km.
Nominal Spin Rate **at** Separation/Apogee **17rps**
Acceleration . . . . . 45g (max.)

WEIGHTS

Launch (3.2 Kgs. Payload with Parachute) . . . . . 52.4Kg.
Nose Cone (phenolic) and Pedestal . . . . . 4.3 Kg.
Separation System & Cannister . . . . . 0.57 Kg.

ADDITIONAL DATA

Storage Life . . . . . **3 years**

Temperature Limits (storage) . . . . . -53 C to 67 C
(operation) . . . . . -45° C to 61° C

Payload Separation

Initiation . . . . . G-Switch
Delay . . . . . Mechanical Timer
Method . . . . . **Gas Pressure**

Parachute

Configuration . . . . . Nylon Circular
Weight . . . . . 954Kg.
Descent Rate (average) . . . . . 10 m/sec.

Payload Housing

Pedestal . . . . . Integral with moto casing. Houses Separation System and Parachute.

Fire Control System Input . . . . . 115 Volts A.C.

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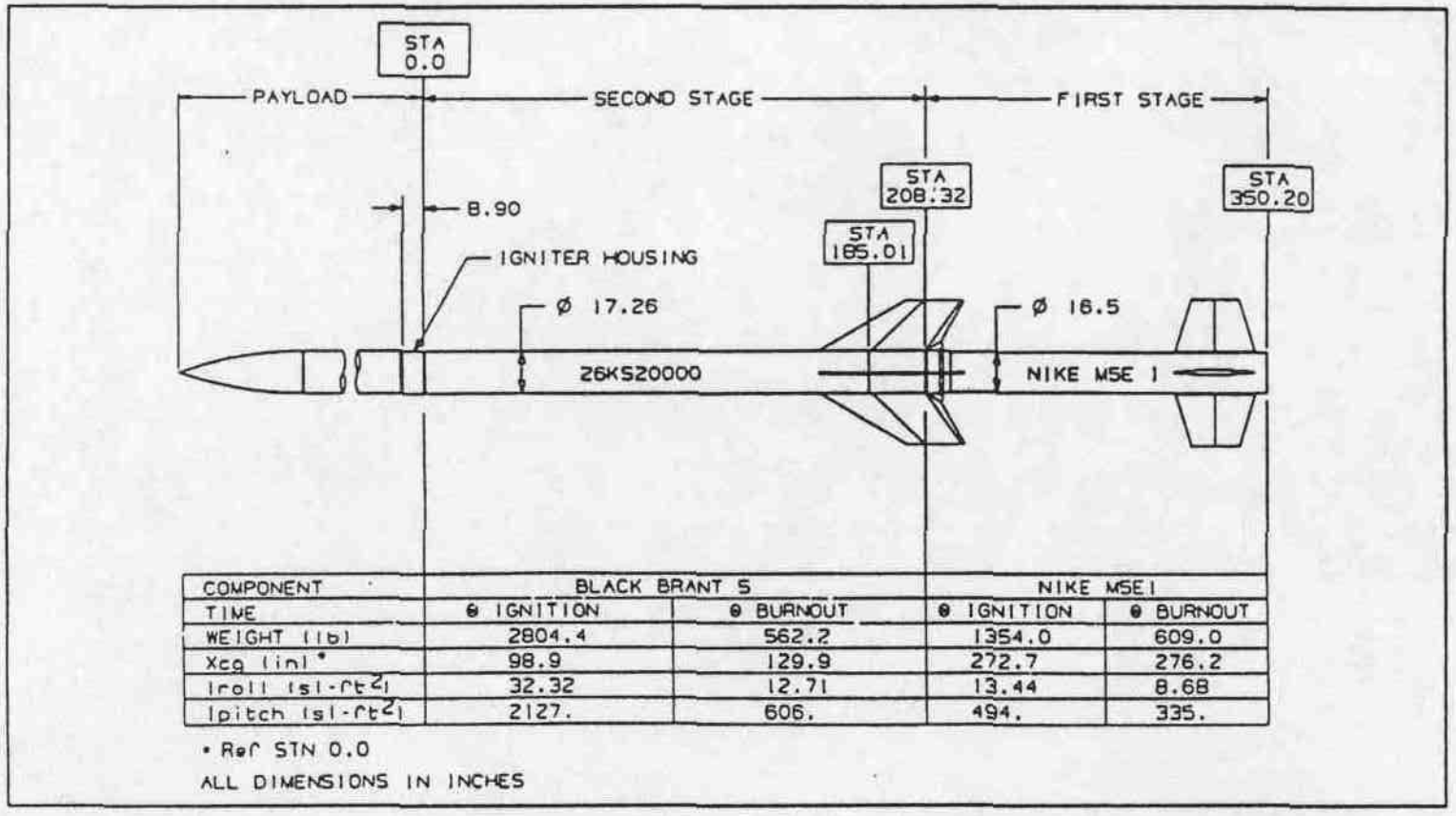


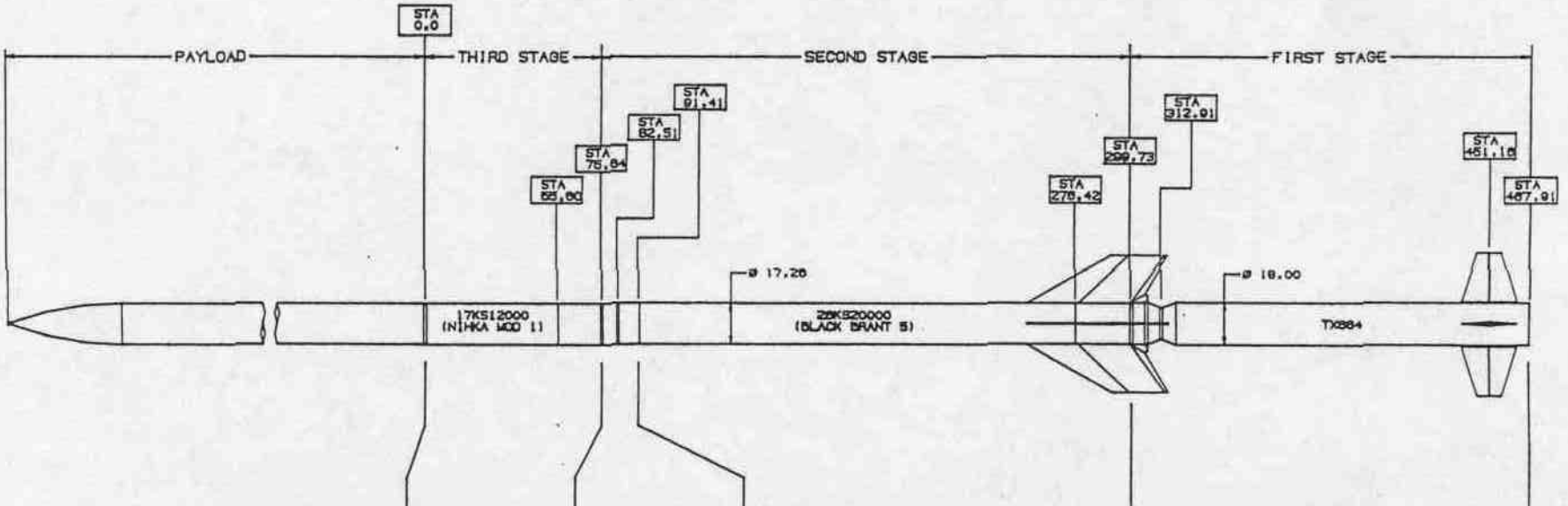
COMPONENT	BLACK BRANT 5		NIKE MSE1	
TIME	@ IGNITION	@ BURNOUT	@ IGNITION	@ BURNOUT
WEIGHT (lb)	2804.4	562.2	1354.0	609.0
Xcg (in)*	98.9	129.9	272.7	276.2
Iroll (sl-ft²)	32.32	12.71	13.44	8.68
Ipitch (sl-ft²)	2127.	606.	494.	335.

* Ref STN 0.0

ALL DIMENSIONS IN INCHES

BB8 VEHICLE

BB10B MOD1 VEHICLE PROPERTIES
RAIL LAUNCH CONFIGURATION

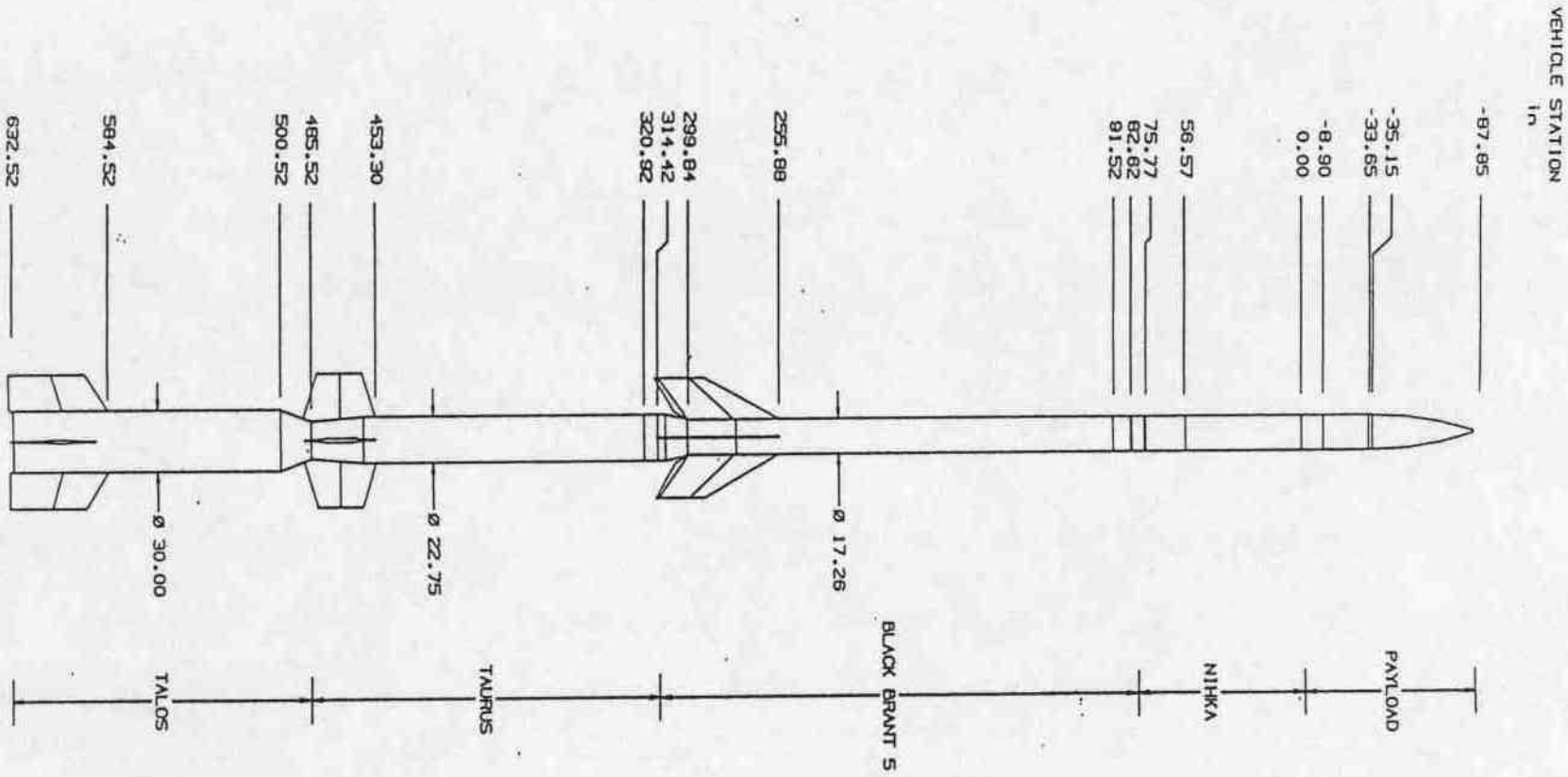


COMPONENT	NIHKA		INTERSTAGE **	BLACK BRANT 5		TX664	
TIME	IGN.	B.O.		IGN.	B.O.	IGN.	B.O.
WEIGHT (lb)	903.5	211.9	51.7	2776.5	525.0	2249.9	736.9
Xcg (in)*	29.7	38.7	83.6	188.0	220.0	388.0	378.9
Iroll (sl-ft²)	8.23	2.75	.72	31.31	11.90	24.7	17.0
Ipitch (sl-ft²)	71.2	28.2	.55	2060.0	574.0	1124.0	457.1

* Ref STN 0.0
**INCLUDES SEPARTION SYSTEM AND TTS IGNITER HOUSING

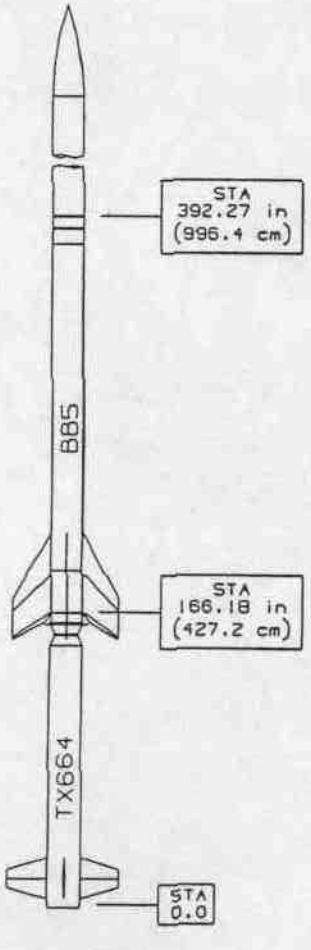
MAY 9, 1991

BB12 VEHICLE PROPERTIES



COMPONENT	TALOS		TAURUS		BLACK BRANT 5		NIHKA	
TIME	@ Ignition	@ Burnout	@ Ignition	@ Burnout	@ Ignition	@ Burnout	@ Ignition	@ Burnout
WEIGHT (lb)	4596	1763.0	3001.5	1336.5	2914.0	668.5	906.5	214.9
X cg (in) *	559.1	569.7	387.9	397.1	191.4	219.9	28.4	34.6
Iroll (sl-ft²)	155.92	89.4	54.07	32.28	33.93	14.31	8.36	2.31
Ipitch (sl-ft²)	1095	539	1507	1001	2170	650	76	32

* Ref Station 0.0



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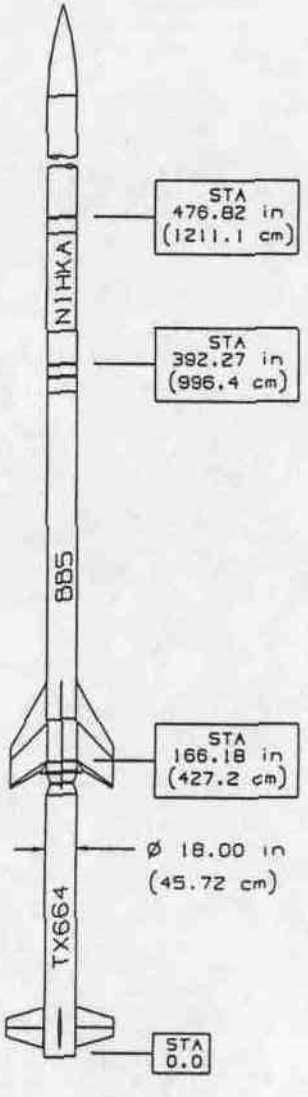
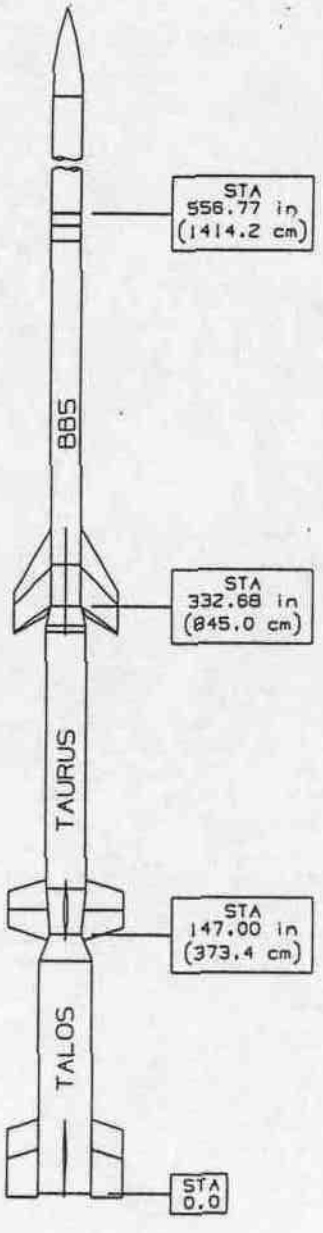
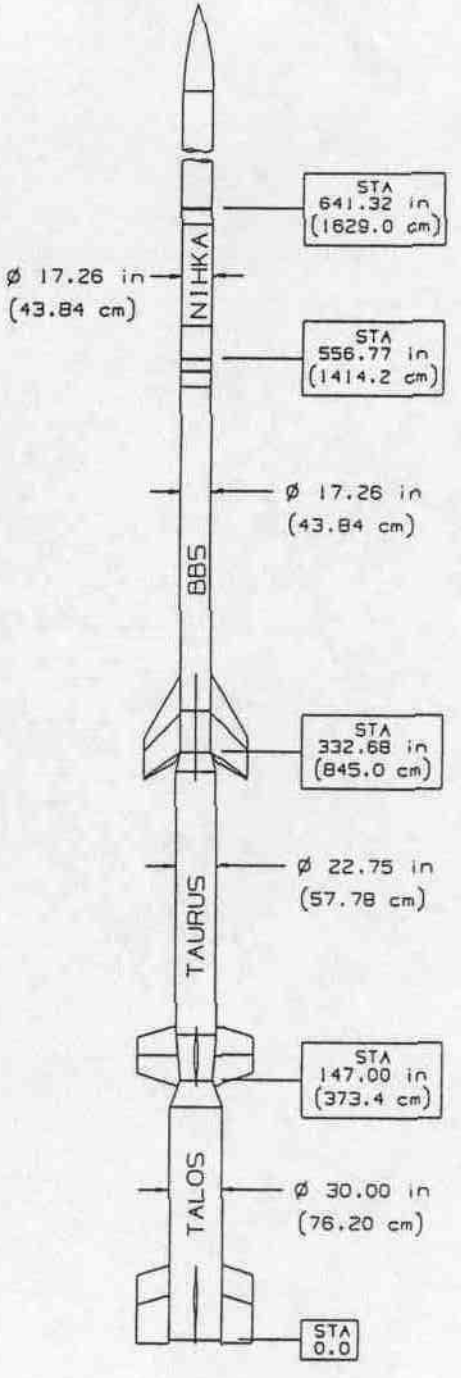


BB 10 MOD 1



BB 11



BB 12