CARDE T.M. 695/63

PROJECT No.
D46-02-10-01

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AERODYNAMIC CHARACTERISTICS, PREFLIGHT CALCULATIONS AND FLIGHT TEST RESULTS OF CARDE'S BLACK BRANT I - (01 TO 07) FIRINGS AT FORT CHURCHILL

by

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DEFENCE RESEARCH BOARD

CANADIAN ARMAMENT RESEARCH AND DEVELOPMENT ESTABLISHMENT

Valcartier, Quebec

UNCLASSIFIED

June, 1963

UNCLASSIFIED

REPORT NO: CARDE TECH. MEMO 695/63

PROJECT NO: D46-02-10-01

TITLE: Aerodynamic Characteristics, Preflight Calculations and Flight Test Results of CARDE'S Black Brant I - (01 to 07) Firings at Fort Churchill

AUTHORS: H. K. Clark and J. R. Delisle

DATED: June, 1963

SECURITY GRADING: UNCLASSIFIED

INITIAL DISTRIBUTION: OCTOBER, 1963

8 - DSIS Circ: UK Liaison Officer

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LIST OF SYMBOLS

A_B - Body cross-sectional area, ft^2.

A_e - Nozzle exhaust plane area, ft^2.

a - Acceleration, ft/sec^2.

C_D - Drag coefficient.

C_{D_f} - Skin friction drag coefficient.

C_{D_w} - Wave drag coefficient.

$C_{L\alpha o}$ - Combined zero lift curve slope per radian.

$C_{L\alpha B}$ - Body zero lift curve slope per radian.

$C_{L\alpha f}$ - Fin zero lift curve slope per radian.

c_s - Specific heat of skin material.

D - Drag, lb.

d - Body diameter, in.

G - Heat capacity of skin = $\rho_s \gamma_s c_s$.

g - Acceleration due to gravity = 32.2 ft/sec^2.

H - Altitude, ft.

h - Heat transfer factor, $\frac{slug}{ft^2\ sec.}$

I_{sp} - Specific impulse, lb-sec/lb.

I_p - Pitch inertia, slug ft^2.

i - Enthalpy of air at temperature chu/slug = $\int_0^t c_p\, dt$.

i_r - Recovery enthalpy.

i_w - Wall enthalpy.

M - Mach number.

M_i - Instantaneous mass of the rocket, during flight, slugs.

M_o - Initial mass of the rocket, slugs.

P_i - Instantaneous pressure during flight, lb/ft^2.

q	-	Dynamic pressure $= \frac{1}{2} \rho v^2$
R	-	Range, ft.
R_e	-	Reynolds number.
T	-	Thrust, lb.
T_{abs}	-	Temperature ^{o}K.
T_c	-	Temperature ^{o}C.
T_w	-	Wall temperature ^{o}K.
t	-	Time, sec.
V	-	Velocity, ft/sec.
W	-	Weight, lb.
X	-	Distance along the surface, ft.
$\ddot{X}$	-	Longitudinal acceleration, g's.
X_{cg}	-	Centre of gravity, in.
X_{cp}	-	Centre of pressure, in.
$\ddot{Y}$	-	Yaw acceleration, g's.
$\ddot{Z}$	-	Pitch acceleration, g's.
α	-	Angle of attack.
β	-	$(M^2 - 1)^{\frac{1}{2}}$
γ	-	Ratio of specific heat.
δ_{xoz}	-	Pitch angle of attack.
δ_{xoy}	-	Yaw angle of attack.
$\delta CN/\delta\alpha\ c$	-	Combined zero lift curve slope.
$\delta CM/\delta\alpha$	-	Combined lift moment.
θ	-	Launch or position angle, degrees.
$\dot{\theta}$	-	Pitch rate, rad/sec.
$\dot{\phi}$	-	Roll rate, rad/sec.
$\ddot{\psi}$	-	Yaw acceleration, rad/sec^2.

$\ddot{\theta}$ - Pitch acceleration, rad/sec^2.

μ - Viscosity of air, slug/ft. sec.

ρ - Density of air, slug/ft^3.

ρ_s - Density of skin material, lb/ft^3.

t_s - Wall material thickness, ft.

SUBSCRIPTS

i - Instantaneous conditions.

0 - Initial conditions.

S_L - Sea-level condition.

r - Recovery conditions, i.e., conditions at the wall for zero heat transfer.

s - Wall material.

V - Vacuum condition.

w - Conditions at the wall.

LIST OF FIGURES

INTRODUCTION

In 1956, a programme was initiated at the Canadian Armament Research and Development Establishment (CARDE) to carry out research and development on solid propellants. This programme anticipated the need for a rocket to dynamically test the propellant. The 17.2-inch-diameter, 16-foot-long Raven Engine from the U.K. Skylark Rocket was selected for the following reasons:-

a) It provided a useful size for testing propellant grains exposed to triaxial strains.

b) It had performance capabilities to meet high-altitude research requirements, that is, to lift a 140-pound payload to an altitude of 100 miles.

The Bristol Aeroplane Company, U.K., modified the Raven engine's forward and rear-end attachments to suit CARDE's special requirements. They also manufactured the engine casing and the fin assembly, whereas the nose cone was made by Bristol Aero-Industries Limited, Winnipeg. CARDE retained the design, development and manufacture of the nozzle and propellant for the rocket engine. In the initial phase of the propellant development programme, the engines were statically tested to obtain internal ballistics and propellant data. This initial work (1, 2, 3) was completed prior to the dynamic testing of the vehicles. In September 1959 four vehicles, BB I - (01 to 04), were flight-tested at the Fort Churchill U.S. Rocket Range Facilities (USRRF) with the engines conditioned at 65°F and 95°F. Following these tests, further development testing was carried out at CARDE at the lower temperature range (minimum -20°F). In May 1960 three vehicles, BB I - (05 to 07), were flight-tested at temperatures ranging from -13°F to +14°F.

This report describes the flight test objectives, the instrumentation, the characteristics of the Black Brant rocket vehicle and the range facilities. The flight test results are presented and compared with the predicted data where possible.

FLIGHT TEST OBJECTIVES

General

The object of this test series was to obtain experimental data of vehicle dynamics, aerodynamic heating and engine performance with the propellant initially conditioned at a certain temperature. Trajectory information was also required for correlation with the predicted performance.

The body dynamics (which are a result of the interactions of the wind dynamic pressure profile, the engine thrust, the structural misalignments, the stability margin and the inertia) are complex and beyond the scope of this report. This subject is, however, under continual study and flight information is gathered for later analysis. The most immediate use

for the test results is to derive representative figures for transient and cyclic accelerations along with the experimental results of aerodynamic heating. The flight measurements were biased towards these objectives. The range and type of instruments used in this test series for each vehicle are given in Appendix "B".

The engine performance objectives were to determine the propellant operation over a temperature range of -13°F to +100°F and to compare the performance results with previous static firings.

ROCKET VEHICLE

General

The Black Brant I rocket vehicle uses the CARDE 15KS25000 solid propellant engine for its propulsion unit. It is aerodynamically stabilized by three large, fixed fins and is uncontrolled in flight. The basic vehicle is 17.2 inches in diameter, approximately 25 feet long and has a fin semi-span of 39 inches. The launch weight of the vehicles fired in this test series varies from 2670 to 2820 pounds; the complete launch details are given in Appendix "A". Figures 1 and 2 are, respectively, a photograph of the vehicle and an outline of the configuration.

The Black Brant I rocket vehicle is designed to carry 125 to 250 pounds of instrumentation for engine and vehicle testing. It is estimated that with a 140-pound payload the vehicle can attain close to 100 miles in altitude in a nearly vertical firing. Alternatively, the vehicle will lift a 230-pound payload to an altitude of 60 miles.

The check-out data for each vehicle in terms of the measurement of the aerodynamic surfaces, the weights and the moments of inertia in both the empty and loaded conditions are given in Appendices "A" and "C".

Nose Cone

The nose section, which provides space for the instrumentation, is made up of two major parts: a 60-inch long cone (8° semi-angle) and a 20-inch long cylindrical bay. The total internal volume available for payload is 5 cubic feet, of which 2.4 cubic feet is in the conical section and 2.6 cubic feet in the cylindrical bay. The main instrumentation package is cantilevered at Station 73.0. A secondary mount is provided in the cone at Station 31.0. Mounting surfaces for the telemetry and radar beacon antennas are catered for on the cylindrical section. To provide easy access to the whole of the instrument package, the entire nose cone ahead of the joint can be removed by disconnecting the clamping ring (Station 66). The assembled nose section is shown in Figures 3A and 3B.

Rocket Engine

The solid propellant rocket engine, identified as the 15KS25000 propulsion unit, is the main CARDE-developed item in the vehicle. Figure 4A is a photograph of the engine casing and Figure 4B, an engine layout.

The complete reporting on this propulsion unit is covered by References 1, 2 and 3 and general engine data are given in Table II of Appendix "A". The complete rocket engine, which consists of a filled engine, an igniter and a nozzle, weighs approximately 2250 pounds. The engine is 17.2 inches in diameter and the overall length, including the nozzle, is approximately 17.0 feet. The engine casing is manufactured by the inert arc welding of #12 (.104-inch) type 4130 steel sheets to the forged end enclosures.

Igniter Assembly

The igniter assembly consists of the main igniter charge, a flame train and an electrically initiated McCormick Selph M-45 squib. The electrical initiator has a resistance of 1 ohm and requires a minimum firing current of 1.5 amps for satisfactory operation. Figure 5A is a photograph of the igniter assembly.

Nozzle

The nozzle was manufactured from 4340 steel and AGX graphite. The graphite is used for the upstream portion of the throat to withstand the high heat flux. The complete inner surface exposed to the gas stream is coated with aluminum oxide (Rokide) to resist gas erosion. Figure 5B is a photograph of the nozzle and Figure 5C is a cross-sectional outline.

Fin Assembly

The fin assembly (Figures 6A and 6B) is fastened to the engine casing by means of longitudinal bolts. The three fins are bolted in slots onto the fin support structure which is a magnesium casting (DTD 683) stiffened to cater for the local loading of the fin root. The basic fin consists of steel skins, wooden spars and ribs, and an aluminum root attachment. The skins are overcoated with an asbestos phenolic plastic (durestos) and the leading edge is covered with a stainless steel cuff to protect it against aerodynamic heating. The planform area of each fin is 5.40 square feet; the root and the tip chords are 46.2 and 4.70 inches long respectively.

AIRBORNE INSTRUMENTATION

The airborne instrumentation for the first four Black Brant I firings (4) was selected on the basis that a simple system was required which would be consistent with acceptable response. This subsequently required that potentiometer-type transducers be used and that temperature be measured by means of thermistors to avoid the need of amplifiers associated with thermocouples. The allocation of telemetry channels, and the range, type and function of the instruments for each round are given in Appendix "B".

The basic telemetry is a 30-by-30 PDM-FM system consisting of an Ascop DC-M4 commutator and a TK-M4 transmitter operating at a frequency of 226.5 megacycles with a radiative power output of 3 to 4 watts. With a total sampling rate of 900 per second from a 30 rps commutator, the

outputs were transmitted through the antennas (Figures 3A and 3B) located on the cylindrical section just ahead of the motor. A photograph (Figure 7) illustrates the two different types of telemetry antennas used in this test series. Figure 8 is a photograph of an instrumented package.

RANGE

General

The overall range is under the control of the U.S. Rocket Range Facility at Fort Churchill which provides space, power and support to the CARDE firings. In this series of firings, CARDE supplied its own launcher, telemetry ground station, launch crew and firing officer and used the range facilities for safety control.

Ground Equipment

The range instrumentation used in this test series consisted of a) a CARDE telemetry ground station which gave "quick-look" data and recorded the complete flight test results on a magnetic tape; b) an MPQ 12 radar for tracking the beacon signal; c) an MPQ 18 radar unit for skin-tracking; and d) theodolite-tracked pibals for recording lower wind measurements (upper air and wind data were recorded by rawinsonde and supplied by the DOT at Fort Churchill). The meteorological data for the seven test firings are tabulated in Appendix "D".

Launcher

The CARDE Black Brant launcher is an underslung, zero-tip-off type which was erected at the Fort Churchill Rocket Range Facilities near the IGY Aerobee launcher. It is fixed in azimuth at 093° and its elevation angle may be adjusted from 70° to 85°. The boom carries one forward and two rear guide rails, 15 feet in length. The launcher in the horizontal and the elevated positions is shown in Figures 9 to 11. An end view of the launcher rail arrangement is shown in Figure 12.

PREFLIGHT CALCULATIONS AND DATA

General

The predicted performances for the Black Brant I vehicles were calculated using a thrust-time curve derived from sea-level static test at the appropriate temperature of the engine. The thrust-augmentation, caused by the reduction in the ambient pressure during the rocket flight, was added to the thrust to correct for the pressure flight history of the rocket. Pressure-time and thrust-time curves measured from the static testing of the Black Brant I engines are presented in Figures 13A and 14A.

The drag coefficient values used in the preflight performance calculations of these vehicles are shown in Figures 15A to 15D. The loss in energy due to drag was estimated to be 16 to 18 per cent of the engine's total energy.

The vehicles were fired for three different conditions of static stability at burnout; namely, maximum telemetry condition (1.1 calibres (body diameter)), minimum telemetry condition (.75 calibre), and maximum telemetry condition plus a 10-inch forward shift of the centre of gravity at burnout (1.6 calibres).

The calculated performance data were used to determine the aerodynamic heating of the skin temperature. The theoretical analysis was based upon the "intermediate enthalpy" method derived in References 5 and 6. The flat-plate, turbulent-boundary-layer theory, corrected for conical bodies, was used in the aerodynamic heating calculations of the cone's skin temperatures.

The complete analysis of the vehicle dynamics is a complex problem and is beyond the scope of this Technical Memorandum. Nevertheless, the basic equations which are necessary for interpretation of the trial results are presented. The problem is further complicated during the engine's burning phase by the lack of knowledge of the mass, the inertia and the alignment of the centres of mass and thrust.

Drag

The calculated drag coefficients for the Black Brant I configurations are presented in Figures 15A to 15D. The total values of the zero lift-drag coefficient versus Mach number (thrusting and coasting) (5, 10) are shown in Figures 15A and 15B. Figure 15C presents a breakdown of drag coefficients used in the performance calculations. The effect of the flight environment on the drag coefficient of the skin friction is shown in Figure 15D. Calculated drag values versus time for the planned flights are given in Figures 16A to 16E and the effects of the launch, weight and angle on drag are shown in Figure 16F.

Performance

The estimated flight performance of the vehicles was calculated by solving the equation of motion of a rocket including air resistance during the powered flight. A sea-level, altitude-corrected, thrust-time curve was used with the appropriate engine temperature condition in conjunction with the following equations.

The basic equation is:-

$$a = \frac{T_{SL} + (2116.8 - P_i)\, A_e - D}{M_i} - g \sin \Theta, \text{ g's} \qquad (1)$$

where a = acceleration, g's

T_{SL} = sea level thrust, lb.

A_e = nozzle exit area, ft^2.

P_i = instantaneous ambient pressure during flight, lb/ft^2.

D = drag, lb.

M_i = instantaneous mass of rocket during flight, slug.

θ = position angle.

The $(2116.8 - P_i)\ A_e$ term in equation (1) is called the "thrust-augmentation" and is used to correct for the decrease in ambient pressure during the powered flight of the rocket.

The drag D which is a function of flight speed V, the air density, the cross-sectional area A_B and the drag coefficient C_D is given by the following equation:-

$$D = \tfrac{1}{2} \rho V^2 \ C_D \ A_B, \text{ lb.} \qquad (2)$$

The instantaneous mass M_i of the rocket during flight at any time is given by:-

$$M_i = M_o - \frac{1}{I_{sp}} \int_0^t T_{SL}\, dt, \text{ lb.} \qquad (3)$$

where M_o = initial mass of the rocket, slugs.

I_{sp} = specific impulse, lb-sec/lb.

T_{SL} = sea-level thrust, lb.

t = time, sec.

(Further analysis has indicated that equation (3) gives optimistic results and that more accurate estimates can be obtained by using the vacuum, thrust and specific impulse.)

Using the above equations, the effects of launch, weight and angle on the peak altitude and the burnout velocity for the Black Brant I vehicles are shown in Figures 17 and 18. The calculated performance data of velocity and Mach number are presented in Figures 26A to 34E.

Stability

The stability calculations for the vehicles were derived using from References 7 and 8 the values of the zero lift-curve slope and the centre of pressure for the nose cone and the afterbody. Figure 19A presents the calculated variation of the centre of pressure and the product of the zero lift-curve slope and area versus Mach number for the nose cone and the afterbody combination. The values of the zero lift-curve slope for the fins were computed by using 4/B above Mach No. 2, along with the appropriate interference factors given in Reference 5. Figure 19B presents the variation of the centre of pressure and the zero lift-curve

slope with Mach number for the fins. The values of the zero lift-curve slope for the antennas used on BB I - (01 to 04) were taken from Reference 5 and the centre of pressure was assumed constant at the centre of area (Figure 19C). In the stability calculation of BB I - (05 to 07) the lift force from the telemetry antennas was assumed to be negligible. The variation of the centre of gravity and the combined centre of pressure versus Mach number for the vehicles are given in Figure 20. Calculated variations of the centre of gravity with time for BB I - (01 to 07) are presented in Figures 21A to 21E and the variations of the centre of gravity and the combined centre of pressure with Mach number are shown in Figures 22A and 22B. The values of the static stability margin versus Mach number for these test vehicles are given in Figures 23A to 23E.

Aerodynamic Heating

The Black Brant I performance capabilities, approximately M equal to 6.5, subjects it to severe aerodynamic heating conditions. This prompted an aerodynamic heating analysis of the vehicle. The calculated skin temperatures were based upon the method given in References 5 and 6, which features the "intermediate enthalpy".

The temperatures were calculated under two main assumptions: namely,

a) The flat-plate, turbulent-boundary-layer theory, for the cylindrical section. This theory was corrected for the conical body when applied to the cone.

b) Thin-skin, heat-transfer conditions, that is, no thermal gradient across the skin.

The heat-transfer coefficients, calculated from a Reynolds number evaluated at the intermediate enthalpy condition, were used in conjunction with the flight history of the rocket (Figure 31E) to compute the skin temperatures. For a skin thin enough for the thermal gradient to be zero, neglecting the internal cooling and the radiation, the basic equation is given by:-

$$G \frac{dTw}{dt} = h (i_r - i_w) \qquad (4)$$

where Tw = wall temperature ^{o}K.

t = time, sec.

G = the heat capacity of the skin ($\rho_s \tau_s c_s$)

ρ_s = the skin density

c_s = the skin specific heat

τ_s = the skin thickness

i_r = recovery enthalpy

i_w = wall enthalpy

h = heat transfer

Vehicle Dynamics

Assuming linear aerodynamics and a non-rotating rocket, the accelerations acting on the centre of gravity because of the instantaneous angle of attack on the vehicle can be written in the pitch coordinates as follows:-

$$\ddot{Z}_{cg} = \frac{\delta C_N/d\alpha \; q \; A_B}{M_i}, \; g's \qquad (5)$$

$$\ddot{\theta} = \frac{\delta C_M/\delta\alpha \; q \; A_B \alpha}{I_p}, \; rads/sec^2. \qquad (6)$$

From equations (5) and (6), the undamped pitching frequency can be expressed as:-

$$w = \frac{1}{2\pi} \left(\frac{\ddot{\theta}}{\alpha}\right)^{\frac{1}{2}} cps \qquad (7)$$

Using equations (5) and (6), the instantaneous lateral acceleration along the rocket can be expressed as:-

$$\ddot{Z}x = \ddot{Z}_{cg} + \ddot{\theta}x, \; ft/sec^2. \qquad (8)$$

where x = the distance from the centre of gravity to any station along the vehicle, ft.

Equation (8) can be rewritten in terms of the instrument station as follows:-

$$Z_{x1} = \ddot{Z} \; ins + \ddot{\theta} \; (x_1), \; ft/sec^2. \qquad (9)$$

where x_1 = the distance from the instrument station to any station along the vehicle, ft.

Plots of the pitch inertia versus time and the weathercocking frequency versus Mach number for BB I - (01 to 07) are given in Figures 24A to 24E and 25A to 25E respectively. The distribution of the lateral accelerations for various time intervals (5, 10, 15 seconds and burnout) and a unit g lateral acceleration at the centre of gravity are given in Figure 25F.

Constant aerodynamic or thrust misalignment errors will be shown on the records by means of a lateral acceleration displaced from the zero.

Transient thrust misalignments and wind shears will be shown by

the deviation of the pitch rate from a damped or zero oscillation. The maximum slope of the pitch rate can be related to either thrust misalignment or wind shear.

FLIGHT TESTS

General

Black Brant I - (01 to 07) rocket vehicles were flight-tested at the Fort Churchill Rocket Range Facilities from September 1959 to May 1960.

The detailed firing data, the flight objectives and the test results of each rocket vehicle are described in the following sections. A summary of the Black Brant I rocket firings is presented in Table I.

TABLE I

CARDE BLACK BRANT I FIRINGS

Code	Launch Date	Launch Angle Degrees	Engine Temp. °F	@Payload lb	Altitude miles
BB I - 01	5/9/59	70	69	222	62
BB I - 02	5/9/59	70	65	230	57
BB I - 03	8/9/59	70	95	112	82
BB I - 04	10/9/59	70	95	107	80
BB I - 05	18/5/60	80	5	106	60
BB I - 06	24/5/60	81	14	140	100
BB I - 07	28/5/60	80	-13	130	103

@ Payload values were based upon a BB I nominal launch weight (less payload) of 2577 pounds.

BLACK BRANT I - (01 and 02)

General

BB I - (01 and 02) were the first two of a series of Black Brant I vehicles to be tested. These vehicles were launched at an elevation angle of 70° at 09.27 and 16.24 cst on 5 September 1959. The engines were conditioned to a temperature of 73°F before launch and the vehicles were ballasted for a 1.6-calibre static stability margin at burnout.

Flight Objectives

The flight objectives for BB I - (01 and 02) were as follows:-

a) To obtain propellant ballistic data by means of telemetered information when the engine was dynamically fired at temperatures between 60°F and 70°F.

b) To obtain trajectory and dispersion data.

c) To measure the temperatures of the nose cone and the engine head end during the flight.

d) To measure the longitudinal and the lateral accelerations.

Flight Results

Radar skin-tracked BB I - 01 for the first 53 seconds of flight time. A peak altitude of 324,000 feet at X+153 seconds and an impact range of 715,500 feet at X+283 seconds were extrapolated from the radar data. A plot of this trajectory (11) is shown in Figure 32A. No velocity was recorded for the BB I - 01 flight.

Radar skin-tracked BB I - 02 during its entire flight. A peak altitude of 297,000 feet at X+162 seconds was recorded with an impact range of 726,000 feet at X+295 seconds. A plot of the trajectory (11) is shown in Figure 33B. The comparison of calculated and reduced trajectory data for BB I - (01 and 02) is shown in Figure 34A.

Telemetry data were received throughout the entire BB I - 01 flight but were lost 52 seconds after launch for the BB I - 02 flight. The measured temperatures of the skin and engine head end versus time (11) are shown in Figures 35A and 35B. Figures 36A and 36B present the telemetry records of the engine pressure, the X, Y and Z accelerations, the skin temperatures on both the cone (Station 40) and the cylindrical section (Station 68). Tabulated, reduced data on the accelerations and the skin temperatures for both firings (11) are presented in Appendix "B". The maximum longitudinal accelerations were recorded as 13.5 g's at X+13.0 seconds and 15 g's at X+14.5 seconds for BB I - (01 and 02) respectively. The maximum lateral accelerations recorded in BB I - (01 and 02) were .68 g and .48 g respectively.

BLACK BRANT I - (03 and 04)

General

BB I - (03 and 04) were launched at an angle of 70 quadrant elevation on 8 September 1959 at 09.14 cst and 10 September at 15.45 cst respectively. The engines for these rounds were conditioned to a temperature of 95°F before launch and the vehicles were ballasted for the minimum telemetry condition (.75-calibre static stability margin at burnout).

Flight Objectives

The flight objectives for BB I - (03 and 04) were as follows:-

a) To obtain propellant ballistic data when the engine was dynamically fired at a temperature range of 90°F to 100°F.

b) To obtain trajectory and dispersion data.

c) To measure the temperatures of the skin and the engine head end.

d) To measure the longitudinal and lateral accelerations.

Flight Results

Radar tracking on BB I - (03 and 04) was lost a few seconds after launch; consequently, no trajectory plot or velocity record was obtained for either flight.

The telemetry signal on BB I - 03 flight failed at X+15 seconds. Telemetry data were obtained for the entire flight of BB I - 04. Figures 36C and 36D present the telemetry recordings of the engine pressure, the $\ddot{X}$, $\ddot{Y}$ and $\ddot{Z}$ accelerations, and the skin temperatures on both the cone (Station 40) and the rokide patch on the cylindrical section (Station 66). Tabulated, reduced data on the accelerations and the skin temperatures for these vehicles (11) are presented in Appendix "B". The maximum longitudinal accelerations were recorded as 16.7 g's at X+13 seconds and 16.6 g's at X+12.5 seconds respectively. The maximum lateral accelerations recorded in BB I - (03 and 04) were 1.20 g's and .88 g respectively. Plots of the measured temperatures of the skin and engine head end versus time (11) are shown in Figures 35C and 35D.

BLACK BRANT I - (05 and 06)

General

BB I - 05 was launched at an elevation angle of 80° on 18 May 1960 at 15.40 cst. The vehicle was ballasted for minimum telemetry condition (.75 calibre at burnout) and the engine was conditioned to a temperature of +5°F.

BB I - 06 was launched at an elevation angle of 81° on 24 May 1960 at 11.44 cst. The vehicle was ballasted for the maximum telemetry condition (1.1 calibre at burnout) and the engine was conditioned to a temperature of +14°F.

Flight Objectives

The flight objectives for these two vehicles were as follows:-

a) To obtain propellant ballistic data when the engine was dynamically fired at the lower temperature range.

b) To obtain trajectory and dispersion data.

c) To determine the temperature of the engine's inner surface.

d) To determine the value of thrust misalignment of the rocket engine and its variation in direction.

e) To determine the launcher effect on the initial vehicle motion and the interaction of the thrust misalignment with the aerodynamics for the first 5 seconds of flight.

f) To measure the temperatures of the nose cone and the engine head end.

g) To measure the longitudinal and the lateral accelerations.

Flight Results - BB I - 05

No trajectory data were recorded for BB I - 05 flight because the radar beacon failed prior to its installation and the radar was ineffective in skin-tracking the vehicle. A peak altitude of 320,000 feet at X+150 seconds and an impact range of 290,000 feet at an impact time of X+290 seconds were calculated from the integration of the telemetered acceleration-time curve. A burnout velocity of 4,600 feet per second at X+15.7 seconds at an altitude of 32,700 feet was estimated. The trajectory plot for this vehicle (12) is given in Figure 33C. The calculated and the reduced trajectory data are compared in Figure 34C. The reduced trajectory data derived from an integrated, telemetered acceleration-time curve may not be relevant to the actual rocket trajectory.

Figure 36E presents telemetry records of the engine pressure, the $\ddot{X}$, $\ddot{Y}$ and $\ddot{Z}$ accelerations, the skin temperatures at Station 40, and the vehicle pitch, yaw and roll rates for the first 25 seconds of flight. At X+16 seconds a sharp drop-off in BB I - 05 engine pressure was recorded which coincided with the initiation of high dynamic acceleration on the vehicle. These results were attributed to either a nozzle, engine casing, or vehicle tail-end failure. A maximum longitudinal acceleration of 15.7 g's was recorded at X+15 seconds and the lateral accelerations reached an off-scale value of 5 g's at the time of failure (Figure 36E). Plots of the reduced skin and motor temperatures (12) are shown in Figure 35E.

Flight Results - BB I - 06

No radar data were recorded on the BB I - 06 flight because the radar beacon failed and the radar was ineffective in skin-tracking the vehicle. A peak altitude of 560,000 feet at X+190 seconds and an impact range of 260,000 feet at an impact time of X+374 seconds were calculated from the integration of the telemetered acceleration-time curve. A burnout velocity of 5,770 feet per second at X+20 seconds at an altitude of 63,400 feet was estimated from this data. The trajectory plot for BB I - 06 (12) is shown in Figure 33D. The calculated and the reduced trajectory data for BB I - 06 are compared in Figure 34D.

Good telemetry data were received for the first 20 seconds (Figures 36F and 36G). Figure 36F presents the telemetry records of the engine pressure, the $\ddot{X}$, $\ddot{Y}$ and $\ddot{Z}$ accelerations, the skin temperature at Station 40, and the vehicle pitch, yaw and roll rates for the first 25 seconds of flight time. Figure 36G presents the $\ddot{Z}$ acceleration, the roll, pitch and yaw rates, the ogive pitch and yaw for the entire flight, and the ogive pitch and yaw for the first 25 seconds of flight. A maximum longitudinal acceleration of 15.2 g's was recorded at X+14.5 seconds. Plots of the measured and the calculated accelerations versus time are presented in Figure 27D. Plots of the skin and the engine temperatures (12) are shown in Figure 35F. From Reference 12, a maximum lateral acceleration of 2.29 g's was recorded at X+20 seconds. A maximum nose skin temperature of 258°C was recorded at X+22.5 seconds.

BLACK BRANT I - 07

General

Black Brant I - 07 was fired at an 80° angle of elevation on 28 May 1960 at 12.27 cst at -13°F. The vehicle was ballasted for the maximum telemetry condition (1.1 calibre at burnout) and the engine was conditioned to a temperature of -13°F.

Flight Objectives

The flight objectives were as follows:-

a) To determine the propellant ballistic data when the engine was dynamically fired at a low temperature (-13°F).

b) To obtain trajectory and dispersion data.

c) To measure the temperature of the engine's inner surface.

d) To measure the skin and engine temperatures.

e) To measure the static pressure.

f) To determine the longitudinal acceleration.

Flight Results

No trajectory data were recorded for BB I - 07 because the radar beacon radiated a weak signal and the radar failed to skin-track the vehicle. A peak altitude of 580,000 feet at X+200 seconds of flight and an impact range of 330,000 feet at an impact time of X+395 seconds were calculated from the integration of the telemetered acceleration-time curve. A maximum burnout velocity of 5,986 feet per second at X+20 seconds at a burnout altitude of 64,200 feet was estimated. A trajectory plot for BB I - 07 (12) is shown in Figure 33E. The calculated and reduced trajectory data are compared in Figure 34E.

Telemetry data were received for the entire flight of BB I - 07. Figure 36H presents the telemetry recordings of the static and engine pressures, the $\ddot{X}$ - acceleration, the skin temperatures on the cone (Stations 40 and 58) and on the cylindrical section (Station 66). Tabulated, reduced data on the accelerations, the skin and engine-head temperatures, the static and engine pressures (12) are presented in Appendix "B". A maximum longitudinal acceleration of 17 g's was recorded at X+13.7 seconds. Plots of the measured and the calculated accelerations versus time are presented in Figure 27G. Plots of the measured skin and engine temperatures versus time (12) are shown in Figure 35G.

CONCLUSIONS AND DISCUSSIONS

The flight test results indicated that six of the seven BB Is were considered successful. One vehicle, BB I - 05, was a failure, probably because of the engine. The theoretical and experimental performance analyses for Black Brant I rockets were found to agree. The vehicles proved to be aerodynamically stable for all three conditions. The engine pressure-time curves drawn from the dynamic firings were essentially the same as the sea-level pressure-time curves determined from static firings. An engine with a shorter burning time was obtained in the BB I - 07 test which resulted in a higher longitudinal acceleration than predicted. Radar data were recorded for one flight only; the radar beacon units had failed and the existing radar equipment at the range proved to be unsatisfactory. No radar skin-tracking was carried out for any of the flights although it would have been possible to about 50,000 feet. The development of an improved beacon unit and an improvement in the existing radar equipment are warranted. The predicted performance data are biased optimistically, but our present studies indicate that a better correlation can be obtained between theoretical and experimental data by modifying the expression for the assumed mass variation during the burning phase. Reduced trajectory data computed from the integrated, telemetered acceleration-time curve are not considered accurate because of the effect of changes in the angle to the rocket axis.

The telemetry records were generally satisfactory when considered in relation to the peak design altitude of 60,000 feet. More than 50 per cent of the telemetry records were received throughout the complete flight and the remaining records were lost before peak altitude. However, the BB I - 03 telemetry was completely lost 15 seconds after launch (Figure 36C). Telemetry recordings of the engine pressure, and the $\ddot{X}$, $\ddot{Y}$ and $\ddot{Z}$ accelerations during the burning phase were exceptionally good for all rounds. The skin temperature measurements on BB I - (01 to 04) flights were rather dubious and erroneous in comparison to the measured temperatures at the same station along the nose cone of BB I - 07. The erratic temperature measurements on BB I - (01 to 04) could probably be attributed to the type of thermistors used on these rounds. The measured temperatures on BB I - 07 were found to be approximately 70 per cent of the predicted temperature.

The measured value of maximum thrust misalignment was found to

be less than 1 milliradian, of which part can be attributed to wind shears. The measured vehicle roll rate was found to be less than 1 rps. However, since only two vehicles were instrumented for dynamic measurements of vehicle motions - of which one failed at X+16 seconds and the other encountered a telemetry failure at X+10 seconds -, more flight test data would be required in order to substantiate the rocket's dynamic characteristics.

The test series showed that the Black Brant I performed satisfactorily and demonstrated its ability to lift a 140-pound payload to an altitude of 100 miles. A reduction in structure weight, a slight modification of the vehicle configuration and an increase in engine performance would make the Black Brant vehicle a valuable, solid-propellant, high-altitude-sounding rocket.

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APPENDIX "A"

VEHICLE & PERFORMANCE DATA FOR

BLACK BRANT I - (01 to 07)

Vehicle Data

The nominal figures used for the basic Black Brant I rocket vehicle are given in the following tables.

Table I

Vehicle Nominal Weights

Nose cone empty wt., lb.	127
Motor empty wt., lb.	367
Propellant wt., lb.	1,750
Nozzle wt., lb.	45
Inert wt., lb.	83
Fin assembly wt., lb.	193
All up wt., lb.	2,565
Discharge wt., lb.	1,766
Burnt wt., lb.	799
Payload, lb.	100 - 250

Table II

Black Brant I Engine Data

Case O.D., in.	17.20
Parallel length, in.	184.
Nozzle throat dia., in.	5.30
Nozzle exit dia., in.	11.50
Expansion ratio, sec.	4.70
Burning time, sec.	13.5
Action time, sec.	17.5
Propellant specific impulse, (S.L.), lb-sec/lb.	217.
Total impulse (sea level), lb-sec.	385,000.
Case thickness, in.	.104

Table III

Vehicle Nominal Dimensions

Length overall, in.	292.00
Body Dia., in.	17.2
Cone semi-apex angle, degrees	8°
Length of conical section, in.	60
Length of cylindrical section, in.	20
Gross volume (Payload compartment), ft^3.	5.0
Fin semi-span, in.	39
Fin root chord, in.	46.20
Fin tip chord, in.	4.70
Fin area, ft^2.	5.40
Fin sweep back angle L.E., degrees	55°

Launch & Performance Data for Black Brant I - (01 to 07)

Black Brant I - (01 - 02)

Launch Data

Rocket:	CARDE Black Brant I - 01	CARDE Black Brant I - 02
Date:	Sept. 5th 1959	Sept. 5th 1959
Time of firing:	0927 est.	1624 est.
Engine temperature:	69°F	65°F
Launch angle:	70° 26'	70° 28'
Azimuth:	093°	093°
Launch wt., lb:	2,799	2,807
Est. burnt wt., lb:	1,019	1,027
Payload, lb:	222	230

Calculated and Reduced Performance Data for BB I - (01 - 02)

Performance Data	Calculated BB I (01 - 02)	Data Reduction BB I - 01	Data Reduction BB I - 02
Burnout altitude, ft:	51,950	-	25,000
Burnout velocity, ft/sec:	5,300	-	5,160
Max. acceleration, gs:	13.6	14.2	15.8
Burnout time, sec:	19.00	17.11	16.66
Peak altitude, ft:	356,750	324,000	297,000
Time to peak altitude, sec:	158	153	162
Impact range, ft:	680,000	715,000	726,000
Impact time, sec:	310	283	295

Black Brant I - (03 - 04)

Launch Data

Rocket:	CARDE Black Brant I - 03	CARDE Black Brant I - 04
Date:	Sept. 8th 1959	Sept. 10th 1959
Time of firing:	0914 est.	1548 est.
Engine temperature:	95°F	95°F
Launch angle:	70° 29'	70° 27'
Azimuth:	093°	093°
Launch wt., lb.:	2,689	2,684
Est. burnt wt., lb.:	909	904
Payload, lb.:	112	107

Calculated and Reduced Performance Data for BB I - (03 - 04)

Performance Data	Calculated BB I (03 - 04)	Data Reduction BB I - 03	Data Reduction BB I - 04
Burnout altitude, ft:	56,500	No radar	No radar
Burnout velocity, ft/sec:	5,730	Data available	Data available
Max. acceleration, gs:	15.3	16.7	16.6
Burnout time, secs	19.0	16.6	16.3
Peak altitude, ft:	434,000		
Time to peak altitude, secs	122		
Impact range, ft:	790,000		
Impact time, secs	336		

Black Brant I - (05 - 06)

Launch Data

Rocket:	CARDE Black Brant I - 05	CARDE Black Brant I - 06
Date:	May 18th, 1960	May 24th, 1960
Time of firing:	1540 cst	1144 cst
Engine temperature:	+5°F	+14°F
Launch angle:	80°	81°
Azimuth:	093°	093°
Launch wt., lb.:	2,683	2,717
Est. burnt wt., lb:	903	937
Payload, lbs	106	140

Calculated and Reduced Performance Data for BB I - (05 - 06)

Performance Data	Calculated BB I - 05	Data Reduction BB I - 05	Calculated BB I - 06	Data Reduction BB I - 06
Burnout altitude, ft:	64,000	32,700	63,450	63,400
Burnout velocity, ft/sec:	5,960	4,600	5,812	5,770
Max. acceleration, gs:	15.2	15.7	14.0	15.2
Burnout time, secs:	21.0	16.0	20.0	20.0
Peak altitude, ft:	546,000	320,000	535,000	530,000
Time to peak altitude, secs	194	150	192	195
Impact range, ft:	647,000	162,000	531,000	260,000
Impact time, secs:	378	290	374	374

Black Brant I - 07

Launch Data

Rocket:	CARDE Black Brant I - 07
Date:	May 28th, 1960
Time of firing:	1227 cst
Engine temperature:	-13°F
Launch angle:	80°
Azimuth:	093
Launch wt., lb:	2,707
Est. burnt wt., lb:	927
Payload, lb:	130

Calculated and Reduced Performance Data for BB I - 07

Performance Data	Calculated BB I - 07	Data Reduction BB I - 07
Burnout altitude, ft:	60,500	64,236
Burnout velocity, ft/sec:	5,830	5,986
Max. acceleration, gs:	14.0	17.0
Burnout time, sec:	21.0	20.0
Peak altitude, ft:	528,000	580,000
Time to peak altitude, sec:	191	200
Impact range, ft:	641,000	330,000
Impact time, sec:	373	395

Weights and Centres of Gravity Check-Out Data for Black Brant I - (01 to 07).

Black Brant I - 01

Items	Without Propellant Weight lb	Without Propellant C. of G. Sta.	With Propellant Weight lb	With Propellant C. of G. Sta.
Complete vehicle with instrumentation and ballast.	893.5	160.08		
After reballasting.	967.5	149.96	2799	165.31
Engine casing, nozzle and igniter.	416	184.05	2249	176.18
Nose cone assembly with instrumentation and ballast.	356.5	41.32	356.5	41.32
Fin assembly.	193.0	275.95	193	275.95

* Nozzle weight of 47 lb. (at Sta. 271.1) was not included in these figures.

Black Brant I - 02

Items	Without Propellant Weight lb	Without Propellant C. of G. Sta.	With Propellant Weight lb	With Propellant C. of G. Sta.
Complete vehicle with instrumentation and ballast.	969	150.39		
After reballasting.	969	150.39	*2760	163.72
Engine casing nozzle and igniter.	413	188.75	*2201.5	174.12
Nose cone assembly with instrumentation and ballast.	360.75	41.09	360.75	41.09
Fin assembly.	194	275.92	194	275.92

* Nozzle weight of 47 lb. (at Sta. 271.1) was not included in these figures.

Black Brant I - 03

Items	Without Propellant Weight lb	Without Propellant C. of G. Sta.	With Propellant Weight lb	With Propellant C. of G. Sta.
Complete vehicle with instrumentation and ballast.	949	149.99		
After reballasting.	*949	149.99	* **2753	163.94
Engine casing, nozzle and igniter.	400	186.04	* **2195	174.03
Nose cone assembly with instrumentation and ballast.	*355	41.54	* 355	41.54
Fin assembly.	192.75	276.00	192.75	276.00

* Ballast weight of 110 lb. (at Sta. 24.50) was removed prior to launch to obtain minimum telemetry condition.

** Nozzle weight of 46 lb. (at Sta. 271.1) was not included in these figures.

Black Brant I - 04

Items	Without Propellant Weight lb.	Without Propellant C. of G. Sta.	With Propellant Weight lb	With Propellant C. of G. Sta.
Complete vehicle with instrumentation and ballast.	*943.5	150.44		
After reballasting.	*943.5	150.49	* **2748	164.26
Engine casing, nozzle and igniter.	395	187.64	* **2198.5	174.65
Nose cone assembly with instrumentation and ballast.	*353.62	41.46	* 353.62	41.46
Fin assembly.	193.75	275.84	193.75	275.84

* Ballast weight of 110 lb. (at Sta. 24.50) was removed prior to firing to obtain minimum telemetry condition.

** Nozzle weight of 46 lb. (at Sta. 271.1) was not included in these figures.

Black Brant I - 05

Items	Without Propellant Weight lb	Without Propellant C. of G. Sta.	With Propellant Weight lb	With Propellant C. of G. Sta.
Complete vehicle with instrumentation and ballast.	849	166.94	2683	171.35
After reballasting	849	166.94	2683	171.35
Engine casing, nozzle and igniter.	409.25	186.89	2242.5	176.35
Nose cone assembly with instrumentation and ballast	244.25	47.74	244.25	47.74
Fin assembly.	193.0	275.65	193.0	275.65

Black Brant I - 06

Items	Without Propellant Weight lb	Without Propellant C. of G. Sta.	With Propellant Weight lb	With Propellant C, of G. Sta.
Complete vehicle with instrumentation and ballast.	*855.25	168.29	*2687.75	171.70
After reballasting.	855.25	168.29	2687.75	171.70
Engine casing, nozzle and igniter.	415	188.43	2248.37	176.83
Nose cone assembly with instrumentation and ballast.	*242.75	47.67	242.75	47.67
Fin assembly.	193.5	275.71	193.5	275.7

* Ballast weight of 29 lb. (at Sta. 22) was added prior to firing to obtain maximum telemetry condition.

Black Brant I - 07

Items	Without Propellant Weight lb	Without Propellant C. of G. Sta.	With Propellant Weight lb	With Propellant C. of G. Sta.
Complete vehicle with instrumentation and ballast.	*837.5	168.05	*2670.5	171.74
After reballasting.	*837.5	168.05	2670.5	171.74
Engine casing, nozzle and igniter.	410	186.50	2242	175.95
Nose cone assembly with instrumentation and ballast.	*232.62	46.45	* 232.62	46.45
Fin assembly.	192.75	275.66	192.75	275.66

* Ballast weight of 37 lb. (at Sta. 22) was added prior to launch to obtain maximum telemetry condition.

Moments of Inertia Check-Out Data for Black Brant I - (01 to 07)

ROLL

Vehicles	Without Propellant Slugs, ft^2.	With Propellant Slugs, ft^2.
BB I - 01	19.06	34.28
BB I - 02	18.99	
BB I - 03	18.87	
BB I - 04	18.65	
BB I - 05	18.53	35.30
BB I - 06	18.47	35.03
BB I - 07	18.21	36.12

PITCH & YAW

Vehicles	Without Propellant Slugs, ft^2.	With Propellant Slugs, ft^2.
BB I - 01	2107.30	3327.61
BB I - 02	2146.3	*3235.33
BB I - 03	2090.85	*3236.27
BB I - 04	2083.19	*3247.66
BB I - 05	1668.87	2777.74
BB I - 06	1804.46	2890.61
BB I - 07	1764.30	2948.28

* These figures were obtained without nozzle.

APPENDIX "B"

TELEMETRY INSTRUMENTATION AND TABULATED FLIGHT DATA REDUCTION RESULTS FOR BLACK BRANT I - (01 to 07).

Allocation of Telemetry Channels - Range, Type and Location of Measuring Devices for BB I - (01 to 07).

Black Brant I - (01 to 04)

Channel No.	Type	Location	Range
1	Pressure #1	Engine	0-2000 psi
2	$\ddot{X}$ acceleration	-	-5g to +35g
3	Temperature #1	Nose cone (Sta. 40)	100°C to 300°C
4	Pressure #1	Engine	0-2000 psi
5	$\ddot{Y}$ acceleration	-	± 5g
6	Temperature #2	Nose cone (Sta. 40)	-50°C to 100°C
7	Pressure #1	Engine	0-2000 psi
8	$\ddot{Z}$ acceleration	-	± 5g
9	Temperature #3	Nose cone (Sta. 40)	100°C to 300°C
10	Pressure #1	Engine	0-2000 psi
11	Temperature #4	Cylinder (Sta. 68)	100°C to 300°C
12	Temperature #5	Cylinder (Sta. 68)	100°C to 300°C
13	Pressure #1	Engine	0-2000 psi
14	0 volt	Monitor	-
15	+ 10 volts	Monitor	-
16	Pressure #1	Engine	0-2000 psi
17	Temperature #6	Cylinder (Sta. 68)	100°C to 300°C
18	Temperature #7	Engine head end	-50°C to +50°C
19	Pressure #1	Engine	0-2000 psi
*20	Temperature #8	Engine head end	100°C to 250°C
21	Temperature #9	Engine head end	100°C to 250°C
22	Pressure #1	Engine	0-2000 psi

Black Brant I - (01 to 04) (Cont'd)

Channel No.	Type	Location	Range
*23	Temperature #10	Engine head end	100°C to 250°C
24	+ 5 volts	Monitor	-
25	Pressure #1	-	0-2000 psi
26	Pressure #2	-	0-2000 psi
27	+ 28 volts	Monitor	-
28	Pressure #1	-	0-2000 psi
29 & 30	Synchronize the decoding ground equipment		
*20	Temperature #8	Rokide patch BB I - (03 & 04) cylinder (Sta. 66)	100°C to 250°C
*23	Temperature #10	Rokide patch BB I - (03 & 04) cylinder (Sta. 66)	100°C to 250°C

Black Brant I - (05 & 06)

Channel No.	Type	Location	Range
1	Pressure #1	Engine	0-1000 psi
2	$\ddot{X}$ acceleration	-	-3g to 17g
3	Pressure #2	Engine	0-2000 psi
4	Temperature #1	Engine head end	-30°C to 100°C
5	$\ddot{Y}$ acceleration	-	$\pm$ 2.5g
6	Pressure #1	Engine	0-1000 psi
7	Temperature #2	Between casing and liner	-30°C to 300°C
8	Pressure #1	Engine	0-1000 psi

Black Brant I - (05 & 06) (Cont'd)

Channel No.	Type	Location	Range
9	Temperature #3	Between casing and liner	-30°C to 300°C
10	$\ddot{Z}$ acceleration	-	± 5g
11	Pressure #1	Engine	0-1000 psi
12	Temperature #4	Nose cone (Sta. 40)	100°C to 300°C
13	Pressure #2	Engine	0-2000 psi
14	0 volt	Monitor	-
15	10 volts	Monitor	-
16	Pressure #1	Engine	0-1000 psi
17	Temperature #5	Cylindrical section (Sta. 68)	+100°C to 300°C
18	Pressure #2	Engine	0-2000 psi
19	Roll rate	-	± 720°/sec.
20	Ogive yaw	-	± 5°
21	Pressure #1	Engine	0-1000 psi
22	Pitch rate	-	± 50°/sec.
23	Pressure #2	Engine	0-2000 psi
24	Ogive pitch	-	± 5°
25	Yaw rate	-	± 50°/sec.
26	Pressure #1	-	0-2000 psi
27	+ 28 volts	Monitor	-
28	Pressure #2	Engine	0-2000 psi
29 & 30	Synchronize the decoding ground equipment.		

Black Brant I - 07

Channel No.	Type	Location	Range
1	Pressure #1	Engine	0-1000 psi
2	$\ddot{X}$ acceleration	-	-3g to +17g
3	Pressure #2	Engine	0-2000 psi
4	Temperature #1	Motor head end	-30°C to 100°C
5	Pressure #3	Static Pressure	0-15 psia
6	Pressure #1	Engine	0-1000 psi
7	Temperature #2	Between casing and liner	-30°C to 300°C
8	Pressure #2	Engine	0-2000 psi
9	Temperature #3	Engine	+50°C to 300°C
10	± 5 volts	Monitor	-
11	Pressure #1	Engine	0-1000 psi
12	Temperature #4	Nose cone (Sta. 40)	+50°C to 250°C
13	Pressure #2	Engine	0-2000 psi
14	0 volt	Monitor	-
15	10 volts	Monitor	-
16	Pressure #1	Engine	0-1000 psi
17	Temperature #5	Nose cone (Sta. 58)	+50°C to 250°C
18	Pressure #2	Engine	0-2000 psi
19	Temperature #6	Nose cone (Sta. 40)	+50°C to 250°C
20	Temperature #7	Nose cone (Sta. 58)	+50°C to 250°C
21	Pressure #1	Engine	0-1000 psi
22	Temperature #8	Nose cone (Sta. 40)	+50°C to 250°C
23	Pressure #2	Engine	0-2000 psi

Black Brant I - 07 (Cont'd)

Channel No.	Type	Location	Range
24	Temperature #9	Nose cone (Sta. 58)	+50°C to 250°C
25	Temperature #10	Cylinder (Sta. 66)	+50°C to 250°C
26	Pressure #1	Engine	0-1000 psi
27	+ 28 volts	Monitor	-
28	Pressure #2	Engine	0-2000 psi
29 & 30	Synchronize the decoding ground equipment.		

Tabulated Data Reduction Flight Results for BB I - (01 - 07)

$\ddot{X}$ - Longitudinal Acceleration - g's

Time Sec.	BB I-01	BB I-02	BB I-03	BB I-04	BB I-05	BB I-06	BB I-07
0	0.5	0.4	0.3	0.3	1.5	1.3	1.3
0.2	8.8	-	-	10.4	9.5	9.2	10.0
0.3	-	-	10.2	-	-	9.4	10.0
0.5	-	0.4	-	-	-	9.2	9.9
1	8.8	0.4	10.2	10.4	9.1	9.2	10.0
2	9.4	9.2	10.3	10.7	9.2	9.3	10.2
3	10.0	9.2	11.0	10.9	9.7	9.7	10.7
4	10.2	9.7	11.0	11.0	9.9	10.0	10.7
5	10.4	10.0	11.1	11.5	10.0	9.9	11.0
6	10.6	10.0	11.4	11.8	10.2	10.3	11.4
7	10.8	10.3	11.8	12.3	10.5	10.5	11.6
8	11.0	10.5	12.0	12.5	10.7	10.7	11.9
9	11.2	10.7	12.6	12.7	11.0	11.0	12.4
10	11.4	10.9	13.4	13.6	11.2	11.5	13.1
11	11.9	11.5	14.3	14.5	11.5	12.0	13.9
12	12.8	12.3	15.7	15.6	12.3	12.7	15.0
12.5	-	-	-	16.6	-	-	-
13	13.5	12.7	16.7	15.9	13.2	13.6	16.5
14	13.1	14.2	12.4	10.5	14.5	14.9	16.9
14.5	-	15.0	-	-	-	-	-
15	8.3	13.7	5.7	5.5	15.7	14.3	13.5
15.6	-	-		-	15.7	-	-
16	3.4	7.5		1.1	-1.8	10.3	6.8
17	1.2	2.9		-0.9	-2.3	6.5	3.1
18	-1.2	0.0		-1.9	-1.8	3.0	0.8
19	-1.7	-1.7		-2.1	-1.2	1.2	-0.3
20	-2.2			-1.4	-0.8	-	-0.7
21	-1.9			-1.2	-0.4	-0.71	-0.3
22	-1.6			-0.8	-0.2	-0.44	-0.1
23	-1.4			-0.4	-0.2	-	0.0
24	-1.2			-0.3	-0.1	-	0.3
25	-1.1			-0.3	-0.1	-	0.3
26	-1.0			-0.1	-0.1	-	0.4
27	-1.1			0.1	-0.1	-	0.6
28	-1.0			0.3	-0.1	-	0.5
29	-0.9			0.4	-0.1	0.6	0.7
30	-0.9			0.5	0.1	0.7	0.7
31	-0.9			0.5	0.1	0.7	0.7
32	-0.9			0.5	0.3	0.8	0.7
33	-0.8			0.5	0.3	0.8	0.7
34	-0.5			0.6	0.3	0.8	0.7
35	-0.5			0.6	0.3	0.8	0.7
36	-0.4			0.6	0.3	0.8	0.8
37	-0.4			0.6	0.3	0.8	-
38	-0.4			0.6	0.3	0.8	-
39	-0.2			0.6	0.2	0.8	-
40	-0.2			0.6	0.2	0.8	0.8

$\ddot{Y}$ - Lateral Acceleration - g's

Time Sec.	BB I - 01	BB I - 02	BB I - 03	BB I - 04	BB I - 05	BB I - 06
0	-0.01	0.15	0.0	0.13	0.23	0.2
.2	-0.20	-	-	0.11	-	0.2
.3	-	-	0.0	-	-	0.02
.5	-	0.15	-	-	-	-
1	-0.14	0.15	0.0	0.11	-	-
2	-0.16	0.09	0.0	0.11	-	0.02
3	-0.16	0.09	0.0	0.11	-	-
4	-0.16	0.09	0.0	0.11	-	-
5	-0.16	0.09	0.0	0.11	0.01	0.02
6	-0.16	0.07	0.0	0.11	0.01	0.01
7	-0.16	0.07	-0.04	0.11	-0.01	-
8	-0.16	0.03	-0.06	0.11	-0.03	0.01
9	-0.10	-0.10	-0.10	0.13	-0.05	-
10	-0.04	-0.12	-0.16	0.13	-0.07	-
11	0.01	-0.16	-0.20	0.15	-	0.02
12	-0.01	-0.28	-0.30	0.17	-	-
12.5	-	-	-	-	-0.08	-
13	-0.10	-0.36	-0.70	0.31	-0.08	0.17
14	-0.01	-0.40	-1.20	0.51	-0.10	0.003
14.5	0.29	-0.44		-	-0.08	-
15	0.10	-0.48		0.51	-0.20	-
15.5	-	-		-	*	0.27
16	0.04	-0.24		0.31		0.20
17	-0.16	-0.32		1.31		-
18	0.41	-0.12		0.31		0.28
19	-0.43	-0.01		0.51		0.04
20	0.21			1.01		-2.27
21	0.00			0.81		-0.07
22	0.04			0.51		-
23	0.18			0.29		-
24	0.18			0.37		-
25	0.00			0.15		-
26	0.00			0.31		-
27	0.16			0.27		-
28	0.00			0.23		-
29	0.01			0.31		0.07
30	0.01			0.27		0.15

* record off scale

$\ddot{Z}$ - Lateral Acceleration - g's

Time Sec.	BB I - 01	BB I - 02	BB I - 03	BB I - 04	BB I - 05	BB I - 06
0	-0.42	-0.35	-0.34	-0.23	1.10	-0.08
.2	-0.04	-	-	-	-	-
.3	-	-	-0.10	-	-0.27	-
.5	-	-0.35	-	-	-0.17	-
1	-0.04	-0.35	-0.12	0.02	-	-
2	-0.06	-0.04	-0.14	-0.02	-	-
3	-0.10	-0.14	-0.14	-0.02	-	0.02
4	0.00	-0.04	-0.04	0.08	-0.12	-0.03
5	0.00	-0.04	0.0	0.08	-	0.00
6	0.00	0.00	0.04	0.19	0.04	0.12
7	0.00	0.00	0.06	0.19	-	-
8	0.02	0.00	0.06	0.06	-	0.12
9	0.10	0.00	0.06	0.00	-	-
10	0.10	0.00	0.06	-0.06	0.04	0.12
11	0.00	0.00	-0.04	-0.34	-	0.11
12	0.00	0.00	-0.14	-0.45	0.09	-0.08
12.5	-	-	-	-	0.12	-
13	-0.04	-0.10	-0.04	-0.83	0.22	-0.09
14	0.06	-0.27	0.16	-0.45	-	-0.28
14.5	-	-0.28		0.02	-	-0.25
15	-0.39	-0.29		0.19	0.22	-
15.5	0.06	-		-0.38		-0.47
16	-0.17	-0.41		-0.38	-	-0.64
17	0.19	-0.31		-0.23	-	-0.60
18	-0.17	-0.21		-0.13	-	0.14
19	0.28	-0.10		0.19	-	-
20	0.50			0.04	-	-2.29
21	-0.04			-0.13	-	0.03
22	-0.04			-0.13	-	-
23	-0.04			-0.13	-	
24	-0.04			0.19	-	
25	-0.04			-0.02	2.40	
26	-0.04			0.11	-	
27	-0.04			0.17	-	
28	-0.04			-0.02	-	
29	-0.04			0.02	-0.69	
30	-0.04			0.06	0.94	

Skin and Engine Head-End Temperatures °C - BB I - 01

Time Sec.	Temp. # 2 Nose cone (Sta. 40)	Time Sec.	Temp. # 5 Cylinder (Sta. 68)	Time Sec.	Temp. # 7 Engine head end
0	10.5	0	-	0	7.5
1	10.5	47	-	17	7.5
2	10.5	48	110.0	18	8.0
3	10.7	49	-	31	8.0
4	11.2	96	-	32	8.1
5	12.0	97	129.2	33	8.3
6	15.0	102	129.2	34	8.4
7	17.0	103	129.0	35	8.5
8	20.5	104	129.0	36	8.7
9	27.7	105	128.7	37	8.9
10	35.5	106	128.7	38	9.0
11	44.2	107	128.3	39	9.0
12	50.5	108	128.0	40	9.2
13	55.0	109	127.5	41	9.2
14	58.5	110	127.5	42	9.4
15	61.0	111	127.5	50	10.3
16	62.5	112	127.5	60	11.5
17	64.1	113	127.0	70	12.6
18	65.3	120	127.0	80	13.8
43	65.3			80	15.0
44	65.1			100	16.2
67	65.1			110	17.3
68	65.0			120	18.5
83	65.0				
84	64.7				
99	64.7				
100	64.1				
119	64.1				
120	63.0				

Skin and Engine Head End Temperatures °C - BB I - 02

Time Sec.	Temp. # 1 Nose cone (Sta. 40)	Time Sec.	Temp. # 3 Nose cone (Sta. 40)	Time Sec.	Temp. # 6 Cylinder (Sta. 68)	Time Sec.	Temp. # 7 Engine head end
0	-	0	-	0	-	0	4.0
45	-	16	-	91	-	1	3.8
46	127.0	17	105.0	92	117.5	4	3.8
51	127.0	18	124.5	93	120.5	5	3.5
52	125.0	19	135.5	94	122.0	19	3.5
53	133.5	20		95	125.0	20	
54	132.5			96	127.5	46	
55	132.0			97	130.0	47	10.8
56	131.5			98	131.0	50	11.0
57	131.0			99	132.0	57	11.5
58	131.0			100	134.0	64	12.0
59	130.5			101	136.0	72	12.6
60	130.5			102	138.5	73	11.3
61	129.5			103	137.0	83	12.0
62	129.0			104	137.0	91	12.5
63	128.0			105	137.0	92	13.5
64	127.5			106	133.5	120	13.8
65	127.0			107	133.5		
66	127.0			108	133.0		
67	127.5			109	131.5		
68	127.5			110	129.0		
69	127.0			111	126.0		
70	127.0			112	122.0		
80	127.0			113	120.0		
81				114	116.5		
				115	112.5		
				116	109.0		
				117	105.0		
				118	103.0		

Skin and Engine Head End Temperatures °C - BB I - 04

Time Sec.	Temp. # 1 Nose cone (Sta. 40)	Time Sec.	Temp. # 2 Nose cone (Sta. 40)	Time Sec.	Temp. # 7 Engine head end
0	-	0	2.5	0	8.0
14	-	1	2.9	17	8.0
15	111.5	2	2.9	18	8.1
16	121.5	3	2.9	19	8.1
17	129.5	4	3.0	20	8.1
18	135.5	5	3.3	21	8.1
19	142.7	6	5.0	22	8.3
20	149.0	7	8.0	23	8.3
21	155.0	8	11.0	24	8.4
22	162.0	9	18.5	25	8.6
23	168.2	10	27.0	26	8.7
24	175.2	11	38.5	27	8.9
25	184.0	12	50.0	28	9.0
26	190.5	13	67.0	29	9.2
27	193.0	14	82.0	30	9.3
28	200.0	15	99.5	31	9.3
29	206.0	16		32	9.5
30	212.5			40	10.4
31	218.0			50	11.5
32	222.0			60	12.7
33	229.0			70	13.8
34	230.0			80	15.0
35	238.5			90	16.1
36	244.0			100	17.2
37	248.0			110	18.4
38	254.0			120	19.5
39					

Skin and Engine Head-End Temperatures °C - BB I - 04

Time Sec.	Temp. # 8 Rokide Cylinder (Sta. 68)	Time Sec.	Temp. # 5 Cylinder (Sta. 68)	Time Sec.	Temp. # 10 Rokide Cylinder (Sta. 68)
0		0	-	0	-
25	-	17	-	81	-
26	103.2	18	100.0	82	100.0
27	107	19	107.5	83	101.8
28	111	20	114.8	84	103.0
29	113	21	125.0	85	103.5
30	116.2	22	129.0	90	109.2
31	119	23	135.5	95	114.9
32	123.5	24	141.5	100	120.5
33	126	25	148.2	102	122.8
34	128	26	155.5	105	125.2
35	129	27	164.0	110	129.1
		28	168.0	115	133.1
		29	172.7	120	137.0
		30	178.0		
		31	184.0		
40	137				
		33	193.0		
		35	202.0		
		36	206.0		
45	144				
		38	213.0		
		40	219.5		
50	150				
		45	230.0		
		50	238.5		
60	159.2				
		52	242.0		
65	163	60	246.0		
		64	250.0		
70	167				
		69	253.0		
75	169.5				
		120	250.0		
80	171.8				
85	173.3				
90	175.2				
95	176.8				
100	177.7				
120	177.7				

Skin and Engine Temperatures °C - BB I - 05

Time Sec.	Temp. # 1 Engine Head End	Temp. # 2 Between casing & liner	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Cylinder (Sta. 66)
0.0	-4.5	13.4	-4.0		
0.1	-4.2				
0.25	-		"		
0.29	-3.4				
0.3		"			
0.31	- .3				
0.32			3.7		
0.35		18.8			
0.36	-3.8				
0.38			-5.5		
0.44	-1.5				
0.48	1.0				
0.5	-3.2		-4.0		
0.55	.1				
0.60	-3.6	-8.2	9.0		
0.7	-3.1				
0.75			1.0		
0.8	-3.6				
1.0	-3.8	-10.0	"		
1.5	"	-11.2			
2.0	-4.0	"			
2.5	"	-13.8	"		
3.0	-4.2	-10.0	2.5		
3.5	"	"	"		
4.0	"	"	"		
4.5	"	"	"		
5.0	-4.0	-10.0	1.0		
5.5	-4.4	-10.0	3.7		
6.0	-4.5	"	1.0		
6.5	"	"	5.0		
7.0	"	"	"		
7.5	-4.2	"	"		
8.0	-4.0	-6.0	6.6		
8.5	-3.6	-2.6	8.0		
9.0	-3.8	2.0	9.9		
9.5	-3.8	3.9	13.5		
10.0	-3.6	7.9	14.0		
10.5	-4.0	11.2	15.9		
11.0	-3.8	15.2	20.6		
11.5	-3.6	19.8	23.5		
12.0	-4.2	24.5	27.0	85	
12.5	-3.6	29.5	31.0	97	
13.0	"	33.4	35.5	107.6	
13.5	-3.4	38.5	40.0	120.5	
14.0	-3.6	44.5	44.4	130.4	

Skin and Engine Temperatures °C - BB I - 05 (Cont'd)

Time Sec.	Temp. # 1 Engine Head End	Temp. # 2 Between casing & liner	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Cylinder (Sta. 66)
14.5	-3.4	49.5	48.7	143.4	
14.6				147.3	
14.65				149.5	
14.7				151.4	
14.8				152.4	
14.9				154.0	
15.0	-3.2	55.3	53.0	156.7	86
15.2		57.1			
15.5			57.1	168.3	93
15.6					95
15.7	-3.2				107.8
15.75		69.0	58.0		
15.8	1.2	72.1	61.2		
15.9	"				
15.95	.3				
16.0		71.1	62.3		"
16.05			63.2		
16.08	1.4				
16.1		"			
16.15					101.6
16.2	.1	69.4	62.3		
16.4					106.0
16.5		69.9	63.2		
16.6	"		"		108.5
16.8	- .8	69.4	63.0		"
17.0	.3	70.9	65.8		113.2
17.3	.7				
17.35					116.0
17.4		71.8	66.2		
17.5		71.2	65.8		114.5
17.6	- .5				
17.7					118.8
17.8	.3	73.0	67.7		120.0
18.0		73.4	68.2		121.9
18.2	.2	74.0			123.0
18.4	- .5	73.6			"
18.45			69.0		
18.5		73.7	69.2		
18.6		74.7			124.5
18.8	.1				126.5
19.0		75.3	71.3		127.3
19.2	.4				
19.4					128.6
19.5		76.1	71.8		
19.6	- .5				
19.8	- .4				
20.0	- .7	76.8	72.8		131.4

Skin and Engine Temperatures °C - BB I - 05 (Cont'd)

Time Sec.	Temp. # 1 Engine Head End	Temp. # 2 Between casing & liner	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Cylinder (Sta. 66)
20.4	-1.0				
20.5		77.7	73.4		
21.0	-1.2	78.3	73.9		133.0
21.5	-1.5	78.8	74.2		
22.0	-1.8	"	74.9		134.2
22.5	-2.4	"	75.3		
23.0	-2.7	"	75.5		135.3
23.5	-2.9	79.1	"		
24.0	-3.1	79.4	"		136.1
24.5	-3.2	79.6	75.6		
25.0	"	79.9	"		136.7
25.5	-3.2	80.0	76.0		137.2
26.0	-3.4	"	76.2		137.5
26.5	-3.4	80.4	76.4		138.1
27.0	"	"	"		136.9
27.5	"	"	"		"
28.0	"	"	76.2		136.7
28.5	-3.8	"	"		137.5
29.0	-3.8	80.4	76.0		136.9
29.5	"	"	76.4		"
30.0	"	80.8	77.0		"
30.5	-3.4	81.2	77.4		137.5
31.0	-3.2	"	"		"
31.5	"	"	"		"
32.0	-3.4	"	77.5		"
32.5	-3.8	80.8	77.1		136.9
33.0	-4.2	"	76.4		"
33.5	-4.0	"	77.1		"
34.0	-3.6	"	77.4		137.5
34.5	"	81.2	"		"
35.0	"	"	"		137.2
35.5	-3.4	81.5	"		136.9
36.0	"	81.9	"		
36.5	-3.2	82.2	"		
37.0	"	"	77.7		
37.5	"	81.9	"		
38.0	-3.6	81.7	"		
38.5	-4.0	81.0	77.4		
39.0	"	80.8	"		
39.5	"	"	"		
40.0	"	"	"		136.9

Skin and Engine Temperatures °C - BB I - 06.

Time Sec.	Temp. # 1 Engine Head End	Temp. # 2 Between casing & liner	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Cylinder (Sta. 66)
0.0	4.2	16.0	16.9		
0.5	2.8	12.1	10.0		
1.0	3.0	13.6	11.4		
1.5	2.8	"	"		
2.0	"	"	"		
2.5	"	"	"		
3.0	"	12.7	"		
3.5	"	13.6	"		
4.0	"	"	12.1		
4.5	2.7	14.3	"		
5.0	"	"	"		
5.5	2.8	14.9	"		
6.0	"	"	"		
6.5	"	"	12.6		
7.0	"	15.2	13.3		
7.5	3.0	15.6	14.2		
8.0	"	18.7	15.0		
8.5	"	19.8	16.3		
9.0	2.8	20.2	17.3		
9.5	"	21.9	18.9		
10.0	3.0	24.3	19.9		
10.5	"	26.0	23.0		
11.0	"	29.2	24.7		
11.5	"	31.3	26.0		
12.0	"	35.0	29.0		
12.5	3.0	24.3	19.9		
12.8		40.4			
13.0	3.0	40.1	35.0	92.8	
13.4		43.2			
13.5	3.0		38.2	102.8	92.8
13.8		41.8			
14.0	3.0	40.9	42.1	114.8	104.7
14.5	3.0	36.8	46.5	129.1	110.0
14.9		31.2			
15.0	3.0		49.9	141.4	115.3
15.4		36.7			
15.5	3.2		54.2	155.0	121.8
15.9		67.6			
16.0	3.2		57.6	161.2	123.3
16.2		62.3			
16.5	3.0	54.0	61.7	170.3	134.3
16.7		56.7			
17.0	2.7	59.1	65.3	176.8	141.2
17.2		55.7			
17.5	2.7	591.	67.5	186.4	147.6

Skin and Engine Temperatures °C - BB I - 06.(Cont'd)

Time Sec.	Temp. # 1 Engine Head End	Temp. # 2 Between casing & liner	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Cylinder (Sta. 66)
17.7		55.1			
18.0	2.3	81.9	69.3	193.5	153.0
18.3		96.7			
18.5	2.0		72.4	204.3	158.2
18.6		89.9			
18.7		92.3			
19.0	1.8	84.0	74.3	212.3	164.0
19.1		79.2			
19.25		84.0			
19.5	1.8	84.7	77.9	223.6	170.0
19.8		81.8			
19.9		72.5			
20.0	2.0	77.2	80.3	231.2	176.0
20.3		79.7			
20.5	1.8		82.5	240.2	181.0
20.7		93.5			
20.8		88.6			
20.93		83.5			
21.0	2.0	87.2	84.2	245.8	184.1
21.2		88			
21.3		97.8			
21.5	2.2	98.2	83.7	252.5	189.1
22.0	"	96.8	84.1	255.3	192.0
22.5	"	97.7	84.8	258.3	194.8
23.0	1.9	96.8	85.6		197.0
23.5	1.9	96.0	86.0		199.1
24.0	"	95.3	87.2		200.6
24.5	"	92.7	88.2		203.7
25.0	"	93.2	88.9		204.8
25.5	"	91.8	89.8		206.7
26.0	"	91.7	80.4		207.3
26.5	1.9	93.2	90.9		208.0
27.0	"	93.6	91.8		209.0
27.5	"	93.3	92.5		210.9
28.0	"	94.1	"		211.3
28.5	"	94.4	93.6		211.9
29.0	"	94.9	93.8		212.9
29.5	"	95.3	94.0		213.9
30.0	"	95.4	"		214.3
30.5	"	96.8	"		"
31.0	"	"	"		214.7
31.5	"	96.4	"		"
32.0	"	"	"		214.9
32.5	2.2	"	"		"
33.0	2.3	97.3	"		215.8

Skin and Engine Temperatures °C - BB I - 06 (Cont'd)

Time Sec.	Temp. # 1 Engine Head End	Temp. # 2 Between casing & liner	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Cylinder (Sta. 66)
33.5	2.4	97.7	94.2		215.8
34.0	2.6	98.2	"		"
34.5	2.4	98.9	"		"
35.0	"	99.7	"		"
35.5	2.3	100.1	"		"
36.0	2.2	100.7	"		"
36.5	2.3	101.9	94.7		216.0
37.0	"	102.8	95.0		"
37.5	2.6	103.4	95.3		"
38.0	"	105.0	95.0		"
38.5	2.8	104.8	95.3		"
39.0	2.8	105.0	95.3		216.0
39.5	"	107.7	"		"
40.0	"	111.8	95.8		"

Skin and Engine Temperatures °C - BB I - 07.

Time Sec.	Temp. # 1 Engine Head End	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Nose cone (Sta. 58)	Temp. # 6 Nose cone (Sta. 40)
0	0	8.0			
.1	-1.0	-2.0			
.5	-0.7	8.0			
2.5	-0.7	"			
3	-1.0	"			
3.5	"	"			
4	- .7	"			
4.5	"	"			
5	-1.0	"			
5.5	"	"			
6	- .7	"			
6.5	"	10.0			
7	"	"			
7.5	"	"			
8	"	12.6			
8.5	"	"			
9	"	15.0			
9.5	"	16.2			
10	-1.5	"			
10.5	"	21.2	52.0		
11	"	23.0	60.0		55.8
11.5	- .7	26.0	70.5	58.0	63.4
12	- .3	28.2	79.5	65.0	70.7
12.5	- .7	32.0	91.5	77.5	78.0
13	- .3	34.5	98.8	84.7	88.0
13.5	.3	39.7	113.4	98.5	97.6
14	.4	43.2	123.5	106.5	106.0
14.2		45.8			
14.4	1.1	43.2	138.0	120.0	115.8
14.6	"	48.0			
15	"	51.3	148.0	133.5	126.4
15.5	1.5	56.5	165.5	150.2	137.9
16	1.9	60.0	182.2	165.0	150.2
16.5	2.3	69.0	198.0	183.9	162.0
17	2.6	77.5	213.0	209.0	175.0
17.5	"	86.7	225.0	227.0	190.8
18	"	125.5	236.0	239.5	199.5
18.3	"	88.3			
18.4	"	88.9	245.0	239.5	213.1
18.6		87.0			
19	3.0	89.3		249.0	220.1
19.2		91.6			
19.5	3.5	91.5			232.0
20	"	"			238.0
20.5	"	"			249.0

Skin and Engine Temperatures °C - BB I - 07. (Cont'd)

Time Sec.	Temp. # 1 Engine Head End	Temp. # 3 Between casing & liner	Temp. # 4 Nose cone (Sta. 40)	Temp. # 5 Nose cone (Sta. 58)	Temp. # 6 Nose cone (Sta. 40)
21	3.5	92.7			
21.5	"	"			
22	"	93.5			
22.5	"	94.0			
23	"	"			
23.5	"	94.5			
24	4.2	95.5			
24.5	"	96.2			
25	4.2	96.2			
25.5	"	96.8			
26	"	"			
26.5	"	97.1			
27	"	98.2			
27.5	"	99.7			
28	"	99.0			
28.5	"	99.7			
29	"	100.0			
29.5	"	"			
30	4.6	99.7			
30.5	"	100.0			
31	"	101.0			
31.5	"	"			
32	"	"			
32.5	"	102.0			
33	"	102.5			
33.5	"	"			
34	5.0	"			
34.5	"	"			
35	5.5	"			
35.5	"	"			
36	"	"			
36.5	"	"			
37	5.8	"			
40	5.8	"			

Skin and Engine Temperatures °C - BB I - 07 (Cont'd)

Time Sec.	Temp. # 7 Nose cone (Sta. 58)	Temp. # 8 Nose cone (Sta. 40)	Temp. # 9 Nose cone (Sta. 58)	Temp. # 10 Cylinder (Sta. 66)
9.5	59.0		54.7	53.0
10	65.0	50.0	61.0	57.7
10.5	73.5	55.0	69.0	64.2
11	84.4	61.0	76.7	72.0
11.5	97.0	69.0	88.0	80.5
12	106.5	76.5	99.0	86.4
12.5	121.2	88.0	110.8	93.7
13	133.7	97.5	123.8	102.2
13.5	149.0	109.3	135.9	111.5
14	169.4	116.5	118.0	118.8
14.4	193.5	129.3	163.3	128.5
15	213.5	136.9	179.3	138.0
15.5	235.7	144.8	198.0	148.8
16	251.5	155.4	217.0	160.7
16.5		166.0	239.0	175.8
17		174.0		183.4
17.5		182.0		189.9
18		188.8		195.0
18.4		196.7		202.5
19		202.2		204.5
19.5		211.2		215.2
20		215.6		"
20.5		221.5		221.5
21		225.4		"
21.5		230.0		228.2
22		235.0		"
22.5		240.0		235.0
23		243.5		
23.5		245.0		235.0
24		"		"
24.5		"		"
25		245.0		235.0
25.5		"		"
26		"		"
26.5		"		"
27		"		"
27.5		"		"
28		"		"
28.5		"		"
29		"		"
29.5		"		"
30		"		"
30.5		"		"
31		"		"
31.5		"		"
32		"		"

Skin and Engine Temperatures °C - BB I - 07 (Cont'd)

Time Sec.	Temp. # 7 Nose cone (Sta. 58)	Temp. # 8 Nose cone (Sta. 40)	Temp. # 9 Nose cone (Sta. 58)	Temp. # 10 Cylinder (Sta. 66)
32.5		245.0		235.0
33		"		"
33.5		"		"
34		"		"
34.5		"		"
35		"		"
35.5		"		"
36		"		"
36.5		"		"
37		"		"
40		"		"

Engine Pressure - p.s.i.g. - BB I - 05

Time Sec.	Pressure # 1 (p.s.i.g.)	Time Sec.	Pressure # 2 (p.s.i.g.)
0.0	13	0.0	168
0.1	25	0.2	176
0.4	790	0.4	764
1.0	763	1.0	751
2.0	731	1.5	743
3.0	738	2.0	739
4.0	748	2.5	735
5.0	"	3.0	743
6.0	738	4.0	735
7.0	733	5.0	735
8.0	"	6.0	"
9.0	"	7.0	731
10.0	723	8.0	722
11.0	710	9.0	"
12.0	706	10.0	710
13.0	"	11.0	702
14.0	708	12.0	689
14.8	"	13.0	"
15.0	700	14.0	"
15.7	643	15.0	"
15.75	27	15.1	"
15.9	10	15.7	635
16.05	21	15.75	105
16.2		15.8	114
16.55	0	16.0	"
16.8		16.1	68
17.2		16.3	81
17.3	4	16.9	27
17.5		17.0	68
19.0		17.45	0
20.0	0	17.75	68
		18.0	60
		18.3	14
		18.7	39
		20.0	35

Engine Pressure - p.s.i.g. - BB I - 06

Time Sec.	Pressure # 1 (p.s.i.g.)	Pressure # 2 (p.s.i.g.)
0	19	229
0.15	19	229
0.25	844	837
0.5	814	
1	789	804
2	752	779
3	"	762
4	"	762
5	"	762
6	752	754
7	748	754
8	748	746
9	740	742
10	738	738
11	727	729
12	723	725
13	723	721
14	725	721
14.3	727	721
14.5	712	716
15	659	654
15.75	540	557
15.82	498	495
16	467	477
17	298	288
18	176	188
19	95.7	101
19.91	48.4	81

Engine Pressure - p.s.i.g. - BB I - 07

Time Sec.	Pressure # 1 (p.s.i.g.)	Pressure # 2 (p.s.i.g.)	Pressure # 3 (p.s.i.g.)
0.0	18	23	14
.05			14.6
.15	893	873	
.2			"
.23			14.5
.4	882	"	
.53	863	844	
.6		860	
1.0	823	840	14.3
2.0	823	823	"
3	"	819	"
3.6			"
4	813	811	14.8
5	"	819	14.2
6	"	"	13.9
7	"	811	13.6
8	802	802	13.1
9	796	"	12.3
10	792	793	11.5
11	790	794	10.7
12	788	784	9.8
13	792	"	8.9
13.6	788	"	
14	748	748	7.7
15	572	556	6.3
16	329	327	5.1
17	205	201	3.4
18	93	114	2.6
19	43	64	1.7
19.1	41		
19.3	18		
19.5	20		
20	18	43	1.0

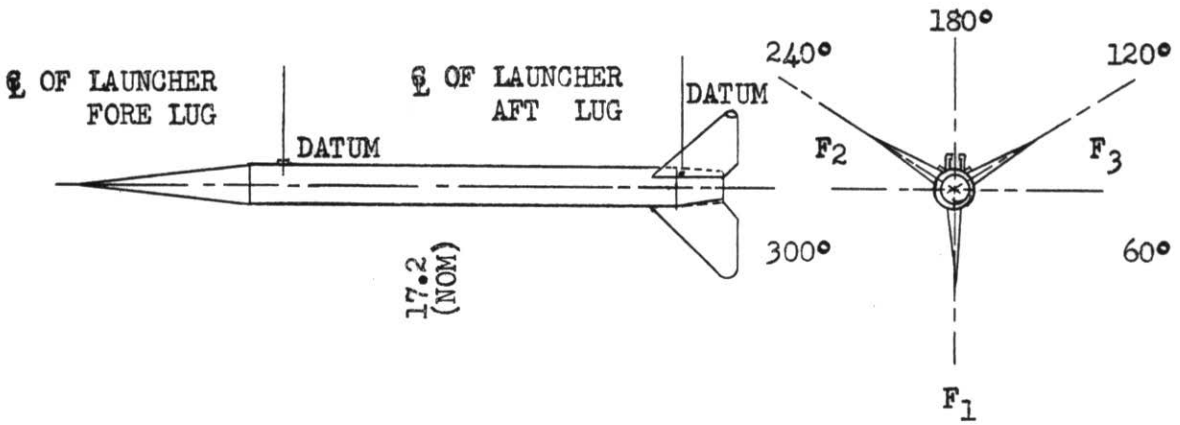
APPENDIX "C"

TABULATED CHECK-OUT AND ALIGNMENT DATA

FOR BLACK BRANT I - (01 to 07).

Tabulated Check-Out Data on Body, Fins, Telemetry Antennae, Nozzle Alignments and Variation of Forward and Rear Lugs from Nominal Dimensions For BB I - (01 - 07) Vehicles.

Body Alignment Data for BB I - (01 to 07)



Using the body at the fore and aft lugs to define the body datum axis and the root of Fin No. 1 as a vertical datum, deviation from the nominal radius at the following stations were measured and recorded. The permissible circumferential deviation was 0.06"/60° of circumference with a maximum of 0.180°.

Black Brant I - 01

	ANGULAR POSITION					
Station	0°	60°	120°	180°	240°	300°
31.92	+.005	+.040	+.005	0	+.065	+.050
62.17	-.040	-.034	-.041	-.040	-.008	-.028
81.83	-.025	+.015	-.018	-.015	+.002	+.021
100.00	-.035	+.022	-.028	-.013	+.027	+.025
120.00	-0.40	+.050	-.032	-.013	+.044	-.009
140.00	-.038	+.063	-.026	-.019	+.046	-.012
160.00	-.034	+.065	-.019	-.034	+.051	-.009
180.00	-.009	+.046	-.027	-.042	+.053	+.013
200.00	-.006	+.016	-.038	-.015	+.048	+.032
220.00	-.008	+.004	-.028	-.018	+.037	+.035
240.00	-.016	-.009	+.004	-.016	+.031	+.025
265.00	+.005	-.003	+.002	+.002	+.004	+.007
287.00	-	-	-	-	-	-

Black Brant I - 02

	ANGULAR POSITION					
Station	0°	60°	120°	180°	240°	300°
31.92	+.059	+.046	+.004	-.010	+.012	+.012
62.17	+.056	+.052	+.008	-.008	+.059	+.009
81.83	+.011	-.012	+.004	+.005	-.014	+.002
100.00	+.041	-.075	+.055	+.045	-.082	+.022
120.00	+.035	-.074	+.068	+.041	-.058	-.002
140.00	+.020	-.063	+.072	+.043	-.050	-.017
160.00	-.007	-.013	+.065	+.059	-.043	-.018
180.00	-.038	-.010	+.054	+.074	-.026	-.036
200.00	-.027	+.009	+.049	+.045	-.031	-.035
220.00	-.006	+.032	+.043	+.027	-.036	-.038
240.00	+.008	+.040	+.040	+.002	-.035	-.042
265.00	+.004	+.008	+.010	-.005	-.002	+.003
287.00	-	-	-	-	-	-

Black Brant I - 03

	ANGULAR POSITION					
Station	0°	60°	120°	180°	240°	300°
31.92	-.075	-.040	-.048	-.036	-.070	-.043
62.17	-.070	-.036	-.034	-.024	-.054	-.027
81.83	-.003	+.004	-.020	+.010	+.012	-.011
100.00	+.038	+.035	-.066	+.054	+.005	-.031
120.00	+.062	+.031	-.056	+.064	-.008	-.055
140.00	+.082	+.035	-.036	+.059	-.021	-.065
160.00	+.076	+.047	-.010	+.055	-.045	-.052
180.00	+.066	+.043	+.020	+.050	-.065	-.040
200.00	+.049	+.017	+.056	+.038	-.054	-.042
220.00	+.030	+.005	+.069	+.021	-.027	-.030
240.00	+.005	-.001	+.059	+.009	-.009	-.010
265.80	+.002	+.004	+.014	+.006	0	-.006
287.00	-	-	-	-	-	-

Black Brant I - 04

	ANGULAR POSITION					
Station	0°	60°	120°	180°	240°	300°
31.92	+.026	-.035	+.028	-.039	-.040	-.021
62.17	+.018	-.025	+.014	-.025	-.030	-.009
81.83	+.010	-.015	+.009	+.010	-.016	+.002
100.00	+.035	-.065	+.065	+.024	-.075	+.027
120.00	+.026	-.088	+.095	+.013	-.072	+.037
140.00	+.019	-.089	+.094	+.009	-.064	+.046
160.00	+.028	-.060	+.055	+.020	-.062	+.048
180.00	+.033	-.020	+.004	+.025	-.042	+.050
200.00	+.032	+.005	+.001	+.002	-.012	+.020
220.00	+.041	+.020	+.010	-.031	+.014	-.013
240.00	+.034	+.036	+.018	-.035	+.014	-.021
265.80	+.012	+.003	+.004	+.001	+.008	+.004
287.00	-	-	-	-	-	-

Black Brant I - 05

	ANGULAR POSITION					
Station	0°	60°	120°	180°	240°	300°
31.92						
62.17						
81.13	+.027	+.022	+.033	+.026	+.024	+.025
100.00	-.028	-.075	+.024	-.025	-.010	+.018
120.00	-.040	-.097	+.046	-.019	-.014	+.042
140.00	-.047	-.058	+.037	-.018	-.008	+.039
160.00	-.047	-.044	+.006	-.013	+.015	+.018
180.00	-.043	-.017	-.004	+.004	+.025	-.034
200.00	-.035	-.010	-.029	+.005	+.063	-.064
220.00	-.035	-.012	-.062	-.012	+.082	-.065
240.00	-.038	-.027	-.056	-.006	+.063	-.040
265.80	-.004	.000	-.003	-.002	-.001	-.003
287.00	-	-	-	-	-	-

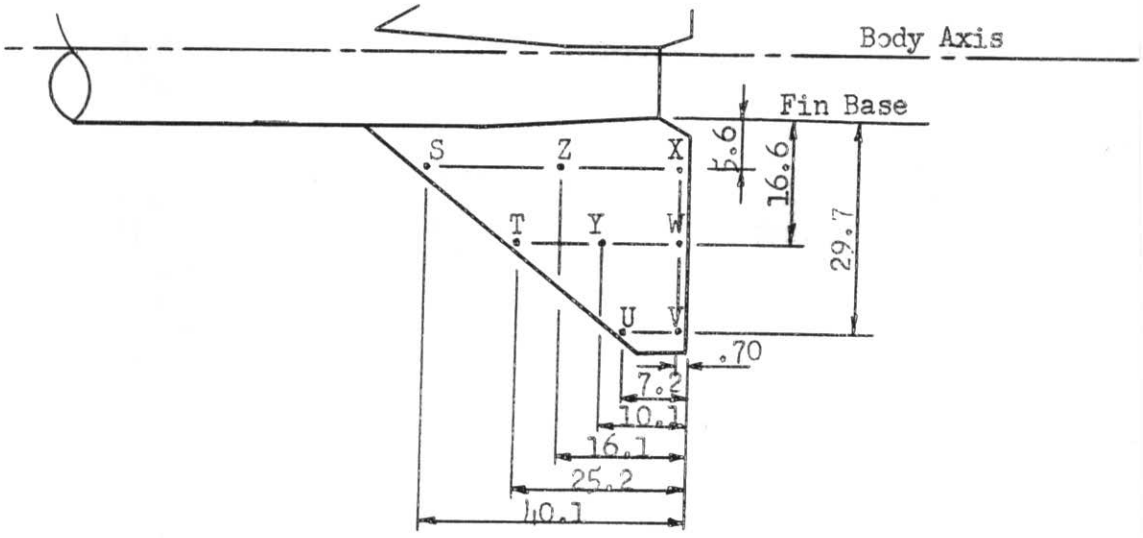
Black Brant I - 06

	ANGULAR POSITION					
Station	0°	60°	120°	180°	240°	300°
31.92						
62.17						
81.83	+.053	+.032	+.042	+.039	+.018	+.033
100.00	+.032	-.050	+.053	+.018	-.123	-.001
120.00	+.029	-.037	+.067	+.023	-.141	-.014
140.00	+.023	-.034	+.060	+.015	-.125	-.015
160.00	+.029	-.033	+.040	+.001	-.089	+.020
180.00	+.012	-.026	+.016	-.004	-.062	+.003
200.00	+.005	-.008	+.006	-.028	-.029	-.004
220.00	-.004	.000	-.020	-.046	+.010	+.017
240.00	.000	-.010	-.018	-.042	+.014	-.011
265.80	-.006	-.012	-.017	-.013	-.006	-.003
287.00	-	-	-	-	-	-

Black Brant I - 07

	ANGULAR POSITION					
Station	0°	60°	120°	180°	240°	300°
31.92						
62.17						
81.83	+.034	+.031	+.032	+.023	+.028	+.038
100.00	-.019	-.061	+.013	-.028	-.049	+.058
120.00	-.046	-.065	+.068	-.060	-.060	+.095
140.00	-.040	-.065	+.046	-.056	-.050	+.093
160.00	-.045	-.073	+.030	-.043	-.042	+.085
180.00	-.022	-.079	-.003	-.017	-.017	+.064
220.00	-.004	-.101	-.025	-.008	+.021	+.033
240.00	-.008	-.086	-.033	-.016	+.021	+.015
265.80	-.003	+.001	-.003	-.001	-.005	-.006
287.00	-	-	-	-	-	-

Fin Alignment Data for BB I - (01 to 07)



With a datum plane produced by the body axis and the mid-point of the root of Fin No. 1, the deviation from the datum plane at the following mid-points for Fins No. 1, 2 and 3 after rotating were recorded.

The permissible chordwise incidence error of the points S to X, T to W and U to V was 0.1"/ft. length of chord. The permissible variation of mid-point Z from the line joining S and X was 0.040+. Similarly, mid-point Y permissible variation from the line joining T and W was 0.030 in. The permissible dihedral error between points S and U and between points X and V was 0.501 in. The points T and W could vary from lines joining S and U, and X and V respectively by 0.050 in.

The first measurement is port and the second is starboard looking from the rear.

Black Brant I - 01

Fin No. 1	Port	Starboard	Port	Starboard	Port	Starboard
Root	S. +.032	-.032	Z. +.035	-.035	X. +.001	-.001
Mid Span	T. +.025	-.025	Y. +.039	-.039	W. +.004	-.004
Tip			U. +.019	-.019	V. +.026	-.026
Fin No. 2						
Root	S. -.050	+.050	Z. +.010	-.010	X. +.075	-.075
Mid Span	T. -.018	+.018	Y. -.020	+.020	W. +.012	-.012
Tip			U. -.011	+.011	V. +.022	-.022
Fin No. 3						
Root	X. -.071	+.071	Z. +.029	-.029	X. -.026	+.026
Mid Span	T. -.085	+.085	Y. -.040	+.040	W. -.016	+.016
Tip			U. -.077	+.077	V. +.015	-.015

Black Brant I - 02

Fin No.1	Port	Starboard	Port	Starboard	Port	Starboard
Root	X. +.021	-.021	Z. +.021	-.021	X. +.000	-.000
Mid Span	T. +.019	-.019	Y. +.004	-.004	W. +.007	-.007
Tip			U. +.005	-.005	V. +.008	-.008
Fin No.2						
Root	S. +.079	-.079	Z. +.041	-.041	X. -.017	+.017
Mid Span	T. +.083	-.083	Y. +.022	-.022	W. -.047	+.047
Tip			U. +.013	-.013	V. -.006	+.006
Fin No.3						
Root	S. +.111	-.111	Z. +.061	-.061	X. -.035	+.035
Mid Span	T. +.079	-.079	Y. +.035	-.035	W. -.030	+.030
Tip			U. +.058	-.058	V. +.005	-.005

Black Brant I - 03

Fin No.1	Port	Starboard	Port	Starboard	Port	Starboard
Root	S. -.017	+.017	Z. -.011	+.011	X. -.017	+.017
Mid Span	T. +.030	-.030	Y. -.005	+.005	W. -.025	+.025
Tip			U. +.020	-.020	V. -.015	+.015
Fin No.2						
Root	S. +.015	-.015	Z. -.018	+.018	X. -.009	+.009
Mid Span	T. +.027	-.027	Y. +.100	-.100	W. +.027	-.027
Tip			U. +.023	-.023	V. +.0005	-.0005
Fin No.3						
Root	S. +.030	-.030	Z. +.011	-.011	X. +.008	-.008
Mid Span	T. -.013	+.013	Y. -.017	+.017	W. -.028	+.028
Tip			U. +.032	-.032	V. -.011	+.011

Black Brant I - 04

Fin No.1	Port	Starboard	Port	Starboard	Port	Starboard
Root	S. +.010	-.010	Z. +.002	-.002	X. -.024	+.024
Mid Span	T. +.050	-.050	Y. -.010	+.010	W. -.015	+.015
Tip			U. -.050	+.050	V. -.002	+.002
Fin No.2						
Root	S. +.048	-.048	Z. -.005	+.005	X. -.060	+.060
Mid Span	T. +.052	-.052	Y. -.010	+.010	W. -.035	+.035
Tip			U. -.003	+.003	V. -.017	+.017
Fin No.3						
Root	S. -.008	+.008	Z. +.019	-.019	X. -.029	+.029
Mid Span	T. -.001	+.001	Y. +.022	-.022	W. -.006	+.006
Tip			U. +.038	-.038	V. +.022	-.022

Black Brant I - 05

Fin No.1	Port	Starboard	Port	Starboard	Port	Starboard
Root	S. -.055	+.055	Z. -.020	+.020	X. +.007	-.007
Mid Span	T. -.049	+.049	Y. +.003	-.003	W. -.008	+.008
Tip			U. -.004	+.004	V. +.011	-.011
Fin No. 2						
Root	S. +.018	-.018	Z. +.014	-.014	X. +.021	-.021
Mid Span	T. +.055	-.055	Y. +.031	-.031	W. +.037	-.037
Tip			U. +.006	-.006	V. +.000	-.000
Fin No. 3						
Root	S. +.058	-.058	Z. +.012	-.012	X. -.021	+.021
Mid Span	T. +.033	-.033	Y. -.013	+.013	W. -.027	+.027
Tip			U. -.033	+.033	V. +.008	-.008

Black Brant I - 06

Fin No. 1	Port	Starboard	Port	Starboard	Port	Starboard
Root	S. +.035	-.035	Z. -.012	+.012	X. -.015	+.015
Mid Span	T. +.043	-.043	Y. +.001	-.001	W. +.012	-.012
Tip			U. -.004	+.004	V. +.011	-.011
Fin No. 2						
Root	S. +.045	-.045	Z. +.020	-.020	X. -.003	+.003
Mid Span	T. +.033	-.033	Y. +.037	-.037	W. +.010	-.010
Tip			U. +.028	-.028	V. +.007	-.007
Fin No. 3						
Root	S. +.001	-.001	Z. -.004	+.007	X. -.015	+.015
Mid Span	T. +.045	-.045	Y. +.027	-.027	W. +.009	-.009
Tip			U. +.035	-.035	V. +.033	-.033

Black Brant I - 07

Fin No. 1	Port	Starboard	Port	Starboard	Port	Starboard
Root	S. +.014	-.014	Z. +.009	-.009	X. +.002	-.002
Mid Span	T. +.047	-.047	Y. +.014	-.014	W. +.016	-.016
Tip			U. +.033	-.033	V. +.017	-.017
Fin No. 2						
Root	S. +.033	-.033	Z. -.011	+.011	X. -.025	+.025
Mid Span	T. +.092	-.092	Y. +.029	-.029	W. -.029	+.029
Tip			U. +.073	-.073	V. +.010	-.010
Fin No. 3						
Root	S. +.022	-.022	Z. +.015	-.015	X. -.005	+.005
Mid Span	T. +.019	-.019	Y. +.028	-.028	W. +.016	-.016
Tip			U. +.031	-.031	V. +.009	-.009

Telemetry Antenna Alignment Data for BB I - (01 to 07)

Using the datum plane produced as before with body axis and Fin No. 1, the deviation of the leading and the trailing edge of the telemetry antenna from the datum plane, at the root, at the centre span and at the tips was recorded. The permissible variation of the trailing edge point to a leading edge point at a particular chord line was .030 inch.

The allowable variation between the root and leading edge and the root and tip of trailing edge was .200 inch.

Black Brant I - 01

Antenna No. I	L.E.	T.E.
Root	.080	.098
Mid Span	.107	.094
Tip	.086	.088
Antenna No. 2		
Root	.174	.172
Mid Span	.155	.156
Tip	.142	.121
Antenna No. 3		
Root	.067	.109
Mid Span	.055	.078
Tip	.052	.045

Black Brant I - 02

Antenna No. 1	L.E.	T.E.
Root	.045	.038
Mid Span	.050	.028
Tip	.045	.038
Antenna No. 2		
Root	.283	.243
Mid Span	.264	.213
Tip	.237	.171
Antenna No. 3		
Root	.180	.140
Mid Span	.172	.135
Tip	.155	.155

Black Brant I - 03

Antenna No. 1	L.E.	T.E.
Root	.018	.027
Mid Span	.002	.004
Tip	.027	.026
Antenna No. 2		
Root	.058	.085
Mid Span	.058	.065
Tip	.039	.042
Antenna No. 3		
Root	.302	.289
Mid Span	.282	.294
Tip	.283	.292

Black Brant I - 04

Antenna No. 1	L.E.	T.E.
Root	.036	.061
Mid Span	.061	.066
Tip	.056	.066
Antenna No. 2		
Root	.189	.141
Mid Span	.188	.173
Tip	.188	.185
Antenna No. 3		
Root	.101	.069
Mid Span	.079	.067
Tip	.073	.067

Black Brant I - 05

Antenna No. 1	L.E.	T.E.
Root	.017	.012
Mid Span	.040	.040
Tip	.065	.067
Antenna No. 2		
Root	.043	.043
Mid Span	.022	.020
Tip	.000	.000
Antenna No. 3		
Root	.072	.072
Mid Span	.087	.090
Tip	.107	.107

Black Brant I - 06

Antenna No. 1	L.E.	T.E.
Root	.000	.005
Mid Span	.000	.005
Tip	.017	.019
Antenna No. 2		
Root	.037	.032
Mid Span	.037	.029
Tip	.023	.025
Antenna No. 3		
Root	.010	.010
Mid Span	.028	.028
Tip	.045	.037

Black Brant I - 07

Antenna No. 1	L.E.	T.E.
Root	.038	.041
Mid Span	.030	.035
Tip	.035	.037
Antenna No. 2		
Root	.021	.007
Mid Span	.013	.001
Tip	.008	.007
Antenna No. 3		
Root	.049	.044
Mid Span	.055	.051
Tip	.071	.073

Launcher Lugs Deviation Data for BB I - (01 to 07)

The height of the fore and aft lugs and alignment of the aft lugs were recorded using the line joining the middle of the fore lug to the body axis as vertical datum axis. The permissible variation from the nominal dimension in height was 0.03in. The permissible variation from the nominal dimension for the transverse distance from ℄ was 0.04in. Also the sum of the transverse distances was not to exceed the sum of nominal distances by more than 0.06 in.

		Black Brant I						
	Nominal	01	02	03	04	05	06	07
Fore Lug								
Height from ℄ to top riding surface.	9.78"	9.769	9.750	9.796	9.750	9.760	9.751	9.778
Port Aft Lug								
Height from ℄ to top riding surface.	7.41"	7.422	7.351	7.411	7.415	7.431	7.412	7.41
Transverse distance from ℄ to inner riding surface.	6.00"	6.005	5.996	6.010	6.005	5.993	6.008	5.980
Starboard								
From ℄ to inner riding surface.	7.41"	7.414	7.361	7.415	7.420	7.401	7.403	7.394
Transverse distance from ℄ to inner riding surface.	6.00"	5.987	6.006	5.996	6.002	6.016	6.000	6.021

Nozzle Alignment Data for BB I - (01 to 07)

The angular differences between the nozzle axis obtained by joining the centres of the nozzle exit and throat and the body datum axis were recorded. The permissible angular variation was 5 minutes.

Vehicles	Angle of Nozzle to Datum Axis
BB I - 01	0° - 2' - 15" down towards Fin No. 1
BB I - 02	0° - 1' - 3" down towards Fin No. 1
BB I - 03	0° - 1' - 52" down towards Fin No. 1
BB I - 04	0° - 1' - 3" down towards Fin No. 1
BB I - 05	0° - 2' down towards Fin No. 1
BB I - 06	0° - 2' down towards Fin No. 1
BB I - 07	0° - 1' down towards Fin No. 1

APPENDIX "D"

METEOROLOGICAL DATA FOR

BLACK BRANT I - (01 to 07).

ANEMOMETER RECORDINGS OF WIND SPEED AND DIRECTION

ROCKET BB I - 01 DATE 5 Sept. 1959

TIME CST	WIND SPEED IN MPH	DIRECTION IN DEGREES
0630	13.0	147
0700	10.5	149
0730	13.0	151
0801	16.5	146
0858	12.0	160
X-60 SECONDS	12.5	153
X-45 SECONDS	10.5	145
X-30 SECONDS	10.0	156
X-15 SECONDS	11.0	160
X-TIME (0927 HRS 21.5 SECONDS)	9.5	149
X+15 SECONDS	10.0	154
0937	12.0	150

RADIOSONDE DATA FOR BB I - 01

RUN NO: 1 DATE: 5 Sept. 1959 RELEASE TIME: 0545 (C.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	999	+10.0	88	+ 8.1
60	197	990	+ 9.3	90	+ 7.7
420	1,378	950	+12.0	90	+10.4
760	2,493	912	+12.0	86	+ 9.8
1,640	5,381	818	+ 5.5	81	+ 2.5
2,420	7,940	744	+ 2.9	64	- 3.3
3,000	9,842	693	- 1.3	69	- 6.3
3,330	10,925	664	- 4.0	36	-16.9
4,030	13,222	607	- 9.0	48	-18.0
4,740	15,551	553	-13.6	75	-17.1
4,970	16,306	537	-13.5	74	-17.1
6,130	20,112	460	-20.9	68	-25.3
7,160	23,163	400	-28.8	67	-33.0
8,710	28,576	320	-40.0	58	-45.2
10,010	32,841	263	-51.1	MB	MB
11,180	36,680	220	-56.7		
11,740	38,517	202	-54.8		
13,200	43,307	160	-52.0		
13,810	45,308	146	-53.3		
14,520	47,638	131	-48.9		
15,370	50,426	115	-50.9		
17,350	56,922	85	-50.5		
18,880	61,942	67	-49.8		
19,190	62,959	64	- 47.6		

RADIOSONDE DATA FOR BB I - 01

RUN NO: 1 DATE: 5 Sept. 1959 RELEASE TIME: 0545 (G.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
22,306	73,183	40	-48.4		
28,000	91,864	17	-43.4		
31,548	103,504	10	37.5		

RAWIN DATA FOR BB I - 01

RUN NO: 2 DATE: 5 Sept. 1959 RELEASE TIME: 0545 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3		15.0	2.0	
3 - 4		25.0	1.0	
4 - 5		33.0		2.0
5 - 6		38.0		5.0
6 - 7		41.0		13.0
7 - 8		36.0		19.0
8 - 9		35.0		15.0
9 - 10		34.0		22.0
10 - 12		28.0		25.0
12 - 14		20.0		27.0
14 - 16		28.0		39.0
16 - 18		37.0		47.0
18 - 20		30.0		48.0
20 - 25		38.0		53.0
25 - 30		22.0		48.0
30 - 35		22.0		49.0
35 - 40		34.0		70.0
40 - 50		25.0		65.0
50 - 60		7.0		30.0
60 - 70	0	0		14.0
70 - 80		5.0		7.0
80 - 90	10.0		6.0	
90 - 100	6.0		0	0

PIBAL WIND DATA FOR BB I - 01

RUN NO. 1 DATE: 5 Sept. 1959 RELEASE TIME 0630 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		9.5	8.5	
120-240		16.0	12.0	
240-360		18.5	13.0	
360-480		18.5	10.5	
480-600		29.0	7.0	
600-720		33.0	6.0	
720-830		28.0	0	0
830-940		24.0		4.0
940-1050		19.0		5.0
1050-1160		17.0		5.0
1160-1270		12.0		1.0
1270-1380		10.0		1.0
1380-1490		8.0		2.0
1490-1600		4.0		1.0
1600-1710		3.0		2.0
1710-1820		7.0	8.0	
1820-1930		10.0	3.0	
1930-2040		9.0	7.0	

PIBAL WIND DATA FOR BB I - 01

RUN NO. 2 DATE: 5 Sept. 1959 RELEASE TIME 0700 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		10.0	8.0	
120-240		13.5	9.5	
240-360		16.5	10.0	
360-480		25.0	9.5	
480-600		29.0	5.0	
600-720		32.0	2.0	
720-830		28.0		5.0
830-940		23.0		4.0
940-1050		19.0		4.0
1050-1160		16.0		7.0
1160-1270		11.0	2.0	
1270-1380		15.0	0	0
1380-1490		12.0	2.0	
1490-1600		16.0	3.0	
1600-1710		15.0	3.0	
1710-1820		16.0	4.0	
1820-1930		20.0	4.0	
1930-2040		20.0	2.0	

PIBAL WIND DATA FOR BB I - 01

RUN NO. 3 DATE: 5 Sept. 1959 RELEASE TIME 0730 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		8.5	7.5	
120-240		10.5	6.0	
240-360		15.5	8.0	
360-480		25.5	7.0	
480-600		31.0	2.0	
600-720		32.0	0	0
720-830		30.0		8.0
830-940		26.0		3.0
940-1050		24.0	0	0
1050-1160		16.0	4.0	
1160-1270		17.0	4.0	
1270-1380		20.0	6.0	
1380-1490		19.0	6.0	
1490-1600		24.0	8.0	
1600-1710		20.0	10.0	
1710-1820		24.0	10.0	
1820-1930		22.0	10.0	
1930-2040		16.0	8.0	

PIBAL WIND DATA FOR BB I - 01

RUN NO. 6 DATE: 5 Sept. 1959 RELEASE TIME 0937 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		7.0	4.5	
120-240		9.0	7.0	
240-360		12.0	7.5	
360-480		16.5	8.0	
480-600		18.5	3.5	
600-720		20.0		1.0
720-830		19.0		1.0
830-940		20.0	.5	
940-1050		19.5	1.0	
1050-1160		21.0	2.0	
1160-1270		24.0	1.0	
1270-1380		22.0	4.0	
1380-1490		31.0	5.0	
1490-1600		28.0	6.0	
1600-1710		32.0	6.0	
1710-1820		28.0	4.0	
1820-1930		32.0	8.0	
1930-2040		30.0	16.0	

ANEMOMETER RECORDINGS OF WIND SPPED AND DIRECTION

ROCKET BB I - 02 DATE 5 Sept. 1959

TIME CST	WIND SPEED IN MPH	DIRECTION IN DEGREES
1324	6.0	135
1429	6.0	135
1526	6.5	120
X-60 SECONDS	4.5	105
X-45 SECONDS	0.5	105
X-30 SECONDS	0.5	105
X-15 SECONDS	8.5	120
X-TIME (1624 HPS 48 SECONDS)	3.0	120
X+15 SECONDS	8.0	115
1630	6.0	115

RADIOSONDE DATA FOR BB I - 02

RUN NO: 1 DATE: 5 Sept. 1959 RELEASE TIME: 1200 (C.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	994.2	+ 11.7	94%	+ 10.7
130	427	982	+ 11.2	90	+ 9.5
270	886	967	+ 14.6	89	+ 12.9
520	1706	935	+ 14.5	83	+ 11.5
1110	3642	870	+ 11.5	49	+ 1.4
1460	4790	835	+ 10.6	26	- 7.9
2140	6693	770	+ 5.4	69	+ 0.3
3200	10499	675	- 1.6	93	- 2.5
3850	12631	623	- 5.0	95	- 4.5
4500	14764	572	- 8.0	91	- 9.2
7201	23695	400	- 26.8	72	- 30.4
8890	29167	315	- 40.0	70	- 43.4
10510	34482	246	- 53.2	MB	MB
11150	36581	223	- 55.8		
12270	40256	188	- 51.6		
12900	42323	170	- 53.5		
14160	46457	140	- 53.5		
16341	53612	100	- 50.4		
18300	60039	74	- 51.3		
19210	63025	64	- 49.9		
20570	67487	52	- 52.4		
26875	88173	20	- 46.2		

RADIOSONDE DATA FOR BB I - 02

RUN NO: 2 DATE: 5 Sept. 1959 RELEASE TIME: 1626 (G.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	990	+ 10.0	98%	+ 9.7
630	2,067	915	+ 13.0	86	+ 10.7
1,120	3,675	865	+ 11.6	89	+ 9.9
2,480	8,136	733	+ 2.2	96	+ 1.6
3,290	10,974	664	- 1.0	94	- 1.8
5,000	16,404	535	- 10.0	64	- 15.5
6,490	21,293	437	- 20.8	51	- 28.2
7,161	23,494	400	- 27.8	47	- 35.7
10,250	33,629	254	- 51.0	MB	MB
10,970	35,991	228	- 49.3		
14,330	47,014	136	- 51.7		
16,356	53,661	100	- 50.0		
21,006	68,917	50	- 48.6		
23,349	76,605	35	- 49.1		

RAWIN DATA FOR BB I - 02

RUN NO: 3 DATE: 5 Sept. 1959 RELEASE TIME: 1200 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3		22.0	14.0	
3 - 4		26.0	15.0	
4 - 5		24.0	10.0	
5 - 6		25.0	5.0	
6 - 7		28.0		1.0
7 - 8		40.0		5.0
8 - 9		43.0		8.0
9 - 10		47.0		10.0
10 - 12		47.0		12.0
12 - 14		44.0		13.0
14 - 16		41.0		12.0
16 - 18		39.0		13.0
18 - 20		36.0		14.0
20 - 25		33.0		16.0
25 - 30		38.0		22.0
30 - 35		47.0		34.0
35 - 40		35.0		42.0
40 - 50		21.0		34.0
50 - 60		15.0		22.0
60 - 70		19.0		22.0
70 - 80		1.0		21.0
80 - 90		3.0		9.0
90 - 100				

RAWIN DATA FOR BB I - 02

RUN NO: 4 DATE: 5 Sept. 1956 RELEASE TIME: 1626 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3		23.0	3.0	
3 - 4		28.0		1.0
4 - 5		26.0	0	0
5 - 6		27.0	0	0
6 - 7		26.0		8.0
7 - 8		27.0		9.0
8 - 9		29.0		10.0
9 - 10		32.0		12.0
10 - 12		32.0		13.0
12 - 14		26.0		11.0
14 - 16		25.0		10.0
16 - 18		27.0		12.0
18 - 20		33.0		13.0
20 - 25		36.0		16.0
25 - 30		39.0		11.0
30 - 35		46.0		11.0
35 - 40		30.0		34.0
40 - 50		24.0		32.0
50 - 60		17.00		25.0
60 - 70		4.00		16.0
70 - 80		7.00		10.0
80 - 90				
90 - 100				

PIBAL WIND DATA FOR BB I - 02

RUN NO. 1 DATE: 5 Sept. 1959 RELEASE TIME 1324 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		6.0	7.5	
120-240		9.0	13.5	
240-360		10.0	14.0	
360-480		12.0	14.0	
480-600		18.5	18.5	
600-720		23.0	16.5	
720-830		30.0	22.0	
830-940		31.0	16.0	
940-1050		25.0	13.0	
1050-1160		28.0	12.0	
1160-1270		24.0	6.0	
1270-1380		31.0	12.0	
1380-1490		27.0	8.0	
1490-1600		26.0	6.0	
1600-1710		28.0	8.0	
1710-1820		20.0	0	0
1820-1930		20.0		2.0
1930-2040		20.0		4.0

PIBAL WIND DATA FOR BB I - 02

RUN NO. 2 DATE: 5 Sept. 1959 RELEASE TIME 1429 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		5.0	11.0	
120-240		10.5	19.5	
240-360		13.5	19.0	
360-480		18.0	17.0	
480-600		26.0	13.0	
600-720		24.5	11.5	
720-830		26.0	10.0	
830-940		26.0	6.0	
940-1050		23.0		5.0
1050-1160		22.0	0	0
1160-1270		28.0	0	0
1270-1380		28.0	1.0	
1380-1490		28.0	0	0
1490-1600		32.0	0	0
1600-1710		28.0	4.0	
1710-1820		28.0	4.0	
1820-1930		34.0	4.0	
1930-2040		38.0	2.0	

PIBAL WIND DATA FOR BB I - 02

RUN NO. 3 DATE: 5 Sept. 59 RELEASE TIME 1526 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		2.0		
120-240		11.5		
240-360		14.0		
360-480		17.0		
480-600		22.0		
600-720		18.0		
720-830		14.0		
830-940		10.0		
940-1050		12.0		
1050-1160		12.0		
1160-1270		12.0		
1270-1380		12.0		
1380-1490		12.0		
1490-1600		12.0		
1600-1710		16.0		
1710-1820		16.0		
1820-1930		20.0		
1930-2040	Balloon entered clouds			

PIBAL WIND DATA FOR BB I - 02

RUN NO. 4 DATE: 5 Sept. 1959 RELEASE TIME 1630 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		4.5	15.0	
120-240		7.5	19.0	
240-360		9.0	20.0	
360-480		14.0	14.5	
480-600		10.0	13.5	
600-720		10.0	15.5	
720-830		8.5	12.0	
830-940		9.0	12.0	
940-1050		17.5	12.0	
1050-1160		23.5	7.0	
1160-1270		20.0	5.0	
1270-1380		23.0	6.0	
1380-1490		29.0		1.0
1490-1600		28.0	0	0
1600-1710		24.0	5.0	
1710-1820		32.0	7.0	
1820-1930		36.0	3.0	
1930-2040		38.0	0	0

ANEMOMETER RECORDINGS OF WIND SPPED AND DIRECTION

ROCKET BB I - 03 DATE 8 Sept. 1959

TIME CST	WIND SPEED IN MPH	DIRECTION IN DEGREES
0542	13.0	282
0647	20.0	290
0730	26.0	303
0815	36.0	310
0823	25.0	312
X-60 SECONDS	25.0	300
X-45 SECONDS	25.0	291
X-30 SECONDS	23.0	313
X-15 SECONDS	29.0	306
X-TIME (0914 HRS 25.5 SECONDS)	28.0	306
X+15 SECONDS	26.0	291
0922	27.0	310

RADIOSONDE DATA FOR BB I - 03

RUN NO: 1 DATE: 8 Sept. 1959 RELEASE TIME: 0445 (C.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	997	+ 5.6	86	+ 3.5
220	722	970	+ 3.9	64	- 2.3
1,050	3,445	874	- 2.9	75	- 6.6
1,500	4,921	822	- 5.8	79	- 8.7
1,820	5,971	793	- 6.3	82	- 8.8
1,960	6,234	780	- 4.4	81	- 6.1
3,100	10,171	674	- 6.5	55	-14.0
3,650	11,975	630	- 9.7	56	-16.8
3,800	12,467	618	- 9.2	49	-17.8
4,100	13,451	594	-11.1	38	-22.6
4,800	15,748	540	-17.3	47	-25.8
5,680	18,635	480	-23.6	27	-37.4
7,005	22,982	400	-33.6	MB	MB
9,500	31,968	275	-53.6		
10,750	35,269	228	-45.0		
12,160	39,895	185	-44.5		
14,160	46,457	137	-45.8		
16,254	53,327	100	-47.0		
17,820	58,465	79	-45.4		
18,250	59,875	74	-48.5		
18,710	61,384	69	-46.9		
19,200	62,992	64	-47.2		
19,720	64,698	59	-42.2		
22,500	73,819	39	-48.8		
26,819	87,989	20	-47.4		

RADIOSONDE DATA FOR BB I - 03

RUN NO: 2 DATE: 8 Sept. 1959 RELEASE TIME: 0915 (G.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	1,002	+ 6.7	89%	+ 5.0
900	2,953	895	- 1.7	79	- 4.8
1,080	3,543	875	- 1.1	76	- 4.8
1,420	4,659	838	- 3.0	76	- 6.5
1,600	5,249	821	- 2.6	74	- 6.5
2,110	6,923	769	- 3.1	64	- 8.8
2,420	7,940	741	- 5.0	58	-11.8
3,450	11,319	649	- 6.4	38	-18.3
4,000	13,123	604	-10.0	24	-26.6
7,051	23,133	400	-32.7	MB	MB
7,650	25,098	366	-38.4		
9,700	31,824	270	-49.5		
10,360	33,989	245	-49.5		
10,900	35,761	225	-51.4		
11,700	38,386	199	-47.7		
12,480	40,945	177	-47.4		
13,190	43,274	159	-49.2		
16,246	53,300	100	-47.1		
18,200	59,711	74	-48.6		
21,520	70,604	44	-46.4		
23,150	75,952	35	-49.0		
30,281	99,147	12	-42.7		

RAWIN DATA FOR BB I - 03

RUN NO: 5 DATE: 8 Sept. 1959 RELEASE TIME: 0455 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3	15.0			43.0
3 - 4	20.0			44.0
4 - 5	20.0			41.0
5 - 6	14.0			42.0
6 - 7	13.0			44.0
7 - 8	12.0			43.0
8 - 9	13.0			46.0
9 - 10	15.0			55.0
10 - 12	19.0			60.0
12 - 14	15.0			54.0
14 - 16	18.0			56.0
16 - 18	21.0			58.0
18 - 20	25.0			59.0
20 - 25	21.0			59.0
25 - 30	18.0			59.0
30 - 35	15.0			63.0
35 - 40	8.0			62.0
40 - 50		1.0		50.0
50 - 60		6.0		34.0
60 - 70		7.0		21.0
70 - 80		5.0		18.0
80 - 90	3.0			21.0
90 - 100				

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RAWIN DATA FOR BB I - 03

RUN NO: 6 DATE: 8 Sept. 1959 RELEASE TIME: 0915 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3	22.0			27.0
3 - 4	26.0			27.0
4 - 5	26.0			27.5
5 - 6	23.5			30.0
6 - 7	21.0			34.0
7 - 8	21.0			37.0
8 - 9	26.0			38.0
9 - 10	24.0			37.5
10 - 12	14.0			37.5
12 - 14	12.0			42.0
14 - 16	10.0			42.5
16 - 18	8.5			50.0
18 - 20	5.0			47.0
20 - 25	2.0			50.0
25 - 30	2.5			70.0
30 - 35	7.0			94.0
35 - 40	4.0			80.0
40 - 50		2.0		57.0
50 - 60		9.0		32.0
60 - 70		11.0		20.0
70 - 80		10.0		8.0
80 - 90	0	0	4.0	
90 - 100		4.0	4.0	

PIBAL WIND DATA FOR BB I - 03

RUN NO. 1 DATE: 8 Sept. 1959 RELEASE TIME 0542 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	1.0			12.0
120-240	1.5			17.5
240-360	2.5			20.5
360-480	1.5			26.0
480-600	1.0			35.0
600-720	1.0			35.0
720-830	4.0			28.0
830-940	2.0			26.0
940-1050	8.0			31.0
1050-1160	5.0			32.0
1160-1270	6.0			32.0
1270-1380	4.0			32.0
1380-1490	4.0			32.0
1490-1600	12.0			32.0
1600-1710	8.0			36.0
1710-1820	10.0			38.0
1820-1930	10.0			36.0
1930-2040	6.0			32.0

PIBAL WIND DATA FOR BB I -03

RUN NO. 2 DATE: 8 Sept. 1959 RELEASE TIME 0647 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	0.5			19.5
120-240	4.5			26.0
240-360	6.0			19.0
360-480	7.0			31.0
480-600	12.0			33.0
600-720	13.5			33.5
720-830	15.5			38.0
830-940	13.0			34.0
940-1050	18.0			41.0
1050-1160	17.5			44.5
1160-1270	17.0			40.5
1270-1380	18.0			44.0
1380-1490	16.0			44.0
1490-1600	12.0			36.0
1600-1710		Clouds		
1710-1820				
1820-1930				
1930-2040				

PIBAL WIND DATA FOR BB I - 03

RUN NO. 3 DATE: 8 Sept. 1959 RELEASE TIME 0730 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	11.5			20.5
120-240	11.5			20.0
240-360	8.0			22.5
360-480	10.0			22.5
480-600	12.5			19.5
600-720	13.0			23.0
720-830	11.0			27.0
830-940	15.0			24.0
940-1050	17.0			26.0
1050-1160	14.0			32.0
1160-1270	24.0			32.0
1270-1380	20.0			26.0
1380-1490	20.0			32.0
1490-1600	17.0			32.0
1600-1710	16.0			30.0
1710-1820	20.0			34.0
1820-1930	22.0			32.0
1930-2040	16.0			28.0

PIBAL WIND DATA FOR BB I -03

RUN NO. 4 DATE: 8 Sept. 1959 RELEASE TIME 0815 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	30.0			42.0
120-240	25.0			44.0
240-360	20.0			31.5
360-480	16.0			24.5
480-600	24.5			38.5
600-720	22.5			33.0
720-830	25.0			40.0
830-940	21.5			34.0
940-1050	26.0			40.0
1050-1160	24.5			42.5
1160-1270	28.0			44.0
1270-1380	24.0			42.0
1380-1490	36.0			44.0
1490-1600	28.0			44.0
1600-1710	20.0			40.0
1710-1820	20.0			40.0
1820-1930	20.0			48.0
1930-2040	20.0			40.0

PIBAL WIND DATA FOR BB I - 03

RUN NO. 5 DATE: 8 Sept. 1959 RELEASE TIME 0823 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	19.5			27.0
120-240	14.0			20.0
240-360	10.0			15.5
360-480	10.0			20.5
480-600	8.5			22.0
600-720	8.0			18.0
720-830	8.0			17.0
830-940	6.0			20.0
940-1050	11.0			25.0
1050-1160	11.0			29.0
1160-1270	10.0			24.0
1270-1380	9.5			24.0
1380-1490	9.0			27.0
1490-1600	16.0			34.0
1600-1710	12.0			32.0
1710-1820	16.0			35.0
1820-1930	12.0			28.0
1930-2040	12.0			30.0

PIBAL WIND DATA FOR BB I - 03

RUN NO. 6 DATE: 8 Sept. 1959 RELEASE TIME 0922 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	12.0			24.0
120-240	14.0			22.5
240-360	11.0			20.0
360-480	6.0			14.0
480-600	5.5			12.5
600-720	5.5			12.0
720-830	8.0			16.0
830-940	8.0			14.0
940-1050	12.0			17.0
1050-1160	15.0			22.0
1160-1270	16.0			20.0
1270-1380	12.0			20.0
1380-1490	11.0			18.0
1490-1600	14.0			17.0
1600-1710	14.0			20.0
1710-1820	14.0			22.0
1820-1930	11.0			20.0
1930-2040	5.0			20.0

ANEMOMETER RECORDINGS OF WIND SPPED AND DIRECTION

ROCKET BB I - 04 DATE 10 Sept. 59

TIME CST	WIND SPEED IN MPH	DIRECTION IN DEGREES
1300	20.0	190
1353	24.0	195
1435	17.0	192
1512	20.0	162
X-60 SECONDS	29.0	159
X-45 SECONDS	26.0	155
X-30 SECONDS	25.0	162
X-15 SECONDS	23.0	157
X-TIME (1548 HRS 35 SECONDS)	24.5	152
X+15 SECONDS	22.0	162
1555	23.0	168

RADIOSONDE DATA FOR BB I - 04

RUN NO: 1 DATE: 10 Sept. 1959 RELEASE TIME: 1205 (C.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	1,011	9.0	48%	- 1.4
980	3,215	897	- 0.9	64	- 6.7
1,120	3,675	880	- 1.0	69	- 5.9
1,250	4,101	868	+ 0.2	59	- 6.7
1,890	6,201	813	- 2.5	33	-16.4
2,560	8,399	735	- 5.9	60	-12.3
2,930	9,613	702	- 4.8	64	-10.5
4,000	13,123	610	-12.1	77	-15.4
5,430	17,815	503	-22.3	57	-28.5
5,810	19,062	477	-24.7	37	-35.3
7,095	23,278	400	-34.5	40	-43.6
8,020	26,312	305	-48.0		
10,300	33,793	247	-52.3		
11,200	36,745	216	-46.1		
12,480	40,945	178	-46.3		
12,900	42,323	167	-44.0		
14,610	49,933	129	-50.0		
15,300	50,197	118	-47.5		
16,292	53,451	100	-47.6		
20,200	66,273	55	-49.6		
21,700	71,194	44	-46.0		
24,680	80,971	28	-49.7		
29,290	96,096	14	-43.9		

RADIOSONDE DATA FOR BB I - 04

RUN NO: 2 DATE: 10 Sept. 1959 RELEASE TIME: 1811 (C.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	1,012	+ 4.4	74%	+ 0.1
540	1,772	945	+ 0.6	82	- 2.1
1,510	4,954	837	- 5.8	92	- 6.9
2,210	7,251	765	- 8.4	77	- 11.7
2,820	9,252	708	- 11.5	68	- 10.3
2,990	9,810	691	- 11.5	63	- 17.2
3,300	10,827	664	- 13.7	59	- 20.0
3,660	12,008	633	- 16.7	66	- 21.6
3,800	12,467	620	- 16.2	53	- 23.6
4,050	13,278	601	- 17.2	40	- 27.6
5,260	17,257	509	- 27.0	30	- 39.4
6,972	22,874	400	- 40.6	MB	MB
8,120	26,640	338	- 49.4		
8,740	28,674	307	- 49.3		
9,420	30,905	276	- 45.6		
10,040	32,940	256	- 46.2		
10,070	35,105	228	- 43.1		
11,800	38,714	194	- 43.2		
13,180	43,241	157	- 46.4		
14,300	46,916	133	- 45.3		
14,830	48,655	123	- 47.1		
15,380	50,459	113	- 46.0		
16,970	55,676	89	- 51.0		
17,570	57,644	81	- 47.0		
22,248	72,982	40	- 48.4		
25,348	83,163	24	- 47.4		

RAWIN DATA FOR BB I - 04

RUN NO: 1 DATE: 10 Sept. 1959 RELEASE TIME: 1205 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3		16.5		6.5
3 - 4		14.5		17.0
4 - 5		10.5		22.0
5 - 6		3.5		21.0
6 - 7	2.0			23.0
7 - 8	2.5			25.5
8 - 9	4.5			26.5
9 - 10	9.0			30.0
10 - 12	13.0			36.0
12 - 14	18.0			37.5
14 - 16	18.5			37.5
16 - 18	19.0			42.0
18 - 20	22.0			56.0
20 - 25	18.0			67.0
25 - 30	27.0			75.0
30 - 35	28.0			74.0
35 - 40	15.0			60.0
40 - 50		3.0		41.0
50 - 60		8.0		21.0
60 - 70		10.0		18.0
70 - 80		4.0		10.0
80 - 90		3.0		1.0
90 - 100				

UNCLASSIFIED
100

RAWIN DATA FOR BB I - 04

RUN NO: 2 DATE: 10 Sept. 1959 RELEASE TIME: 1811 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3	No winds because of low elevation angles -			
3 - 4	- 658 radiosonde equipment.			
4 - 5				
5 - 6				
6 - 7				
7 - 8				
8 - 9				
9 - 10				
10 - 12				
12 - 14				
14 - 16				
16 - 18				
18 - 20				
20 - 25				
25 - 30				
30 - 35				
35 - 40				
40 - 50				
50 - 60				
60 - 70				
70 - 80				
80 - 90				
90 - 100				

PIBAL WIND DATA FOR BB I - 04

RUN NO. 1 DATE: 10 Sept. 1959 RELEASE TIME 1300 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		16.0		3.0
120-240		18.0		5.0
240-360		16.0		5.5
360-480		16.0		4.0
480-600		15.0		5.0
600-720		17.0		6.0
720-830		16.5		6.5
830-940		14.5		7.0
940-1050		13.5		4.0
1050-1160		16.0		5.5
1160-1270		17.0		8.0
1270-1380		16.0		10.0
1380-1490		16.0		10.0
1490-1600		17.0		10.0
1600-1710		17.0		11.0
1710-1820		16.0		16.0
1820-1930		18.0		13.0
1930-2040		16.0		13.0

PIBAL WIND DATA FOR BB I - 04

RUN NO. 2 DATE: 10 Sept. 1959 RELEASE TIME 1353 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		21.0		3.0
120-240		31.0		7.0
240-360		31.0		7.0
360-480		28.0		8.0
480-600		30.0		6.0
600-720		32.0		8.0
720-830		28.0		7.0
830-940		28.0		7.0
940-1050		28.0		9.0
1050-1160		26.0		11.0
1160-1270		28.0		7.0
1270-1380		28.0		10.0
1380-1490		22.0		10.0
1490-1600		26.0		10.0
1600-1710		28.0		16.0
1710-1820		28.0		12.0
1820-1930		30.0		10.0
1930-2040		29.0		12.0

PIBAL WIND DATA FOR BB I - 04

RUN NO. 3 DATE: 10 Sept. 1959 RELEASE TIME 1435 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		22.0		4.0
120-240		28.0		7.0
240-360		34.0		9.0
360-480		29.0		8.0
480-600		28.0		6.0
600-720		25.0		4.0
720-830		22.0		5.0
830-940		23.0		4.0
940-1050		21.0		3.0
1050-1160		26.0		5.0
1160-1270		28.0		6.0
1270-1380		30.0		6.0
1380-1490		26.0		4.0
1490-1600		30.0		4.0
1600-1710		28.0		2.0
1710-1820		32.0		4.0
1820-1930		28.0		5.0
1930-2040		28.0		9.0

PIBAL WIND DATA FOR BB I - 04

RUN NO. 4 DATE: 10 Sept. 1959 RELEASE TIME 1512 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		15.0	10.0	
120-240		19.5	8.0	
240-360		27.0	13.0	
360-480		32.0	13.0	
480-600		37.0	13.0	
600-720		34.0	13.0	
720-830		34.0	14.0	
830-940		36.0	11.0	
940-1050		34.0	3.0	
1050-1160		26.0	2.0	
1160-1270		26.0	0.0	
1270-1380		20.0		2.0
1380-1490		25.0		4.0
1490-1600		28.0		5.0
1600-1710		32.0		4.0
1710-1820		33.0		6.0
1820-1930		36.0		4.0
1930-2040		38.0		8.0

PIBAL WIND DATA FOR BB I - 04

RUN NO. 5 DATE: 10 Sept. 1959 RELEASE TIME 1555 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		18.0	8.0	
120-240		25.0	8.0	
240-360		25.0	9.0	
360-480		27.0	10.0	
480-600		32.0	8.0	
600-720		37.0	7.0	
720-830		41.0	5.0	
830-940		44.0	5.0	
940-1050		48.0	5.0	
1050-1160		56.0	4.0	
1160-1270		48.0	2.0	
1270-1380		45.0		4.0
1380-1490		46.0		4.0
1490-1600		40.0		4.0
1600-1710		40.0		2.0
1710-1820		36.0		3.0
1820-1930		Clouds		
1930-2040				

ANEMOMETER RECORDINGS OF WIND SPPED AND DIRECTION

ROCKET BB I - 05 DATE 18 May 1960

TIME CST	WIND SPEED IN MPH	DIRECTION IN DEGREES
X-60 MIN.	3.5	095
X-45 MIN.	5.5	080
X-30 MIN.	2.0	087
X-15 MIN.	4.0	084
X-60 SECONDS	CALM	
X-45 SECONDS	5.0	085
X-30 SECONDS	4.5	090
X-15 SECONDS	2.0	045
X-TIME (1540 HRS 35 SECONDS)	2.0	012
X+15 SECONDS	CALM	
X+1 MINUTE	2.0	060
X+2 MIN.	1.0	100
X+3 MIN.	2.0	084
X+4 MIN.	2.5	098
X+5 MIN.	2.5	102
X+6 MIN.	1.5	100
X+7 MIN.	1.0	105
X+8 MIN.	1.5	105

RADIOSONDE DATA FOR BB-I-05

RUN NO: 1 DATE: 18 May, 1960 RELEASE TIME: 0845 (G.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	1017	+ 1.3	97%	+ 0.9
540	1772	949	0.0	63	- 6.2
1010	3314	895	- 2.9	69	- 7.7
1330	4364	860	- 1.5	46	-11.6
2070	6791	785	- 4.4	35	-17.5
2270	7447	764	- 3.9	28	-19.6
3230	10597	674	-11.5	51	-18.6
3590	11778	644	-12.0	62	-17.7
4060	13320	606	-15.6	68	-20.1
6070	19915	461	-30.1	34	-41.0
7075	23212	400	-38.0	51	-44.5
7940	26050	351	-46.0		
8980	29462	297	-51.1		
10080	33071	252	-53.4		
10520	34514	236	-49.1		
11500	37730	204	-49.7		
11780	38648	196	-45.8		
14830	48655	123	-50.3		
16178	53077	100	-49.1		
19880	65223	57	-49.4		
25480	83596	24	-50.6		
31294	102671	10	-41.3		
36185	118717	5	-27.5		

RADIOSONDE DATA FOR BB.I-05

RUN NO: 2 DATE: 18 May, 1960 RELEASE TIME: 1610 (C.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	1018	+ 1.7	92%	+ 0.5
440	1444	964	+ 1.6	64	- 4.4
880	2887	912	- 0.6	62	- 6.9
1200	3937	876	+ 1.2	58	- 6.1
1560	3118	837	- 0.6	35	-14.2
3040	9974	695	- 7.6	69	-12.2
4177	13704	600	-13.9	34	-26.3
4820	15814	550	-19.1	48	-27.3
5550	18209	499	-24.4	29	-37.4
7116	23346	400	-34.9		
9850	32316	264	-56.3		
10140	33268	251	-54.2		
10590	34744	235	-56.0		
11120	36483	216	-50.0		
13250	43471	155	-48.5		
16103	52831	100	-53.0		
19770	64862	57	-48.5		
24610	80742	27	-51.8		
31285	102641	10	-38.4		
36146	18589	5	-29.0		

RAWIN DATA FOR BB I - 05

RUN NO: 1 DATE: 18 May, 1960 RELEASE TIME: 0845 (G.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3	1.0			4.0
3 - 4	2.0			8.5
4 - 5	4.5			15.0
5 - 6	10.0			17.0
6 - 7	11.0			15.0
7 - 8	6.0			16.0
8 - 9	0.5			20.0
9 - 10		2.0		23.0
10 - 12		2.0		25.0
12 - 14		4.0		24.5
14 - 16		7.0		24.5
16 - 18		4.0		28.5
18 - 20		4.5		38.0
20 - 25		11.0		45.0
25 - 30		7.0		46.0
30 - 35		8.0		44.0
35 - 40		10.0		23.0
40 - 50		7.0		10.0
50 - 60	0.5			3.0
60 - 70	3.0		10.0	
70 - 80	0	0	17.5	
80 - 90	10.0		28.0	
90 - 100	0	0	34.5	

RAWIN DATA FOR BB I - 05

RUN NO: 2 DATE: 18 May, 1960 RELEASE TIME: 1610 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3	5.0		6.0	
3 - 4	9.0		1.0	
4 - 5	9.0			4.0
5 - 6	6.5			5.5
6 - 7	3.0			4.5
7 - 8	0	0		4.0
8 - 9		3.5		9.0
9 - 10		6.0		18.0
10 - 12		6.0		22.5
12 - 14		6.0		23.0
14 - 16		7.0		25.5
16 - 18		4.0		38.0
18 - 20		5.0		49.0
20 - 25		9.0		61.0
25 - 30		19.0		80.0
30 - 35		23.0		78.0
35 - 40		15.0		39.0
40 - 50		5.0		19.0
50 - 60	1.0			7.0
60 - 70		2.5	6.0	
70 - 80	2.0		12.5	
80 - 90	9.5		20.0	
90 - 100	10.0		30.0	
100 - 110	5.5		22.0	

PIBAL WIND DATA FOR BB I - 05

RUN NO. 1 DATE: 18 May, 1960 RELEASE TIME 0930 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	3.5		3.0	
120-240	5.5		4.0	
240-360	5.0		3.5	
360-480	3.5		2.0	
480-600	0			1.0
600-720		1.0		3.0
720-830	1.5			5.0
830-940	1.5			4.0
940-1050	1.0			5.5
1050-1160	0			5.5
1160-1270	1.5			5.5
1270-1380	1.5			5.5
1380-1490	3.0			5.0
1490-1600	0			5.0
1600-1710		0.5		6.0
1710-1820		1.0		5.5
1820-1930		1.0		6.0
1930-2040		0		6.0

PIBAL WIND DATA FOR BB I - 05

RUN NO. 1 DATE: 18 May, 1960 RELEASE TIME 1100 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-720	1.2		4.7	
720-1380	0.1			1.3
1380-2040		1.3		0.7
2040-2700		4.0		0
2700-3360		1.3		5.6
3360-4020		0		13.6
4020-4680	2.9			19.0
4680-5340	8.0			24.0
940-1050				
1050-1160				
1160-1270				
1270-1380				
1380-1490				
1490-1600				
1600-1710				
1710-1820				
1820-1930				
1930-2040				

PIBAL WIND DATA FOR BB I - 05

RUN NO. 2 DATE: 18 May, 1960 RELEASE TIME 1000 (GST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	7.0		8.0	
120-240	6.5		6.0	
240-360	2.0		2.5	
360-480	1.5		2.0	
480-600	2.5			0.5
600-720	5.0			0
720-830	3.5			2.0
830-940	3.0			2.0
940-1050	2.0			2.5
1050-1160	2.0			3.0
1160-1270	3.0			2.0
1270-1380	4.0			2.0
1380-1490	1.5			2.5
1490-1600	1.5			3.0
1600-1710		0.5		4.5
1710-1820		0		4.0
1820-1930		0		4.0
1930-2040	2.0			5.5

PIBAL WIND DATA FOR BB I - 05

RUN NO: 2 DATE: 18 May, 1960 RELEASE TIME: 1130 (C.S.T.)

MEAN WING COMPONENTS IN M.P.H.

LAYERS IN FEET	N	S	E	W
0-720	3.03		5.8	
720-1380	0.2		1.0	
1380-2040		3.0	0.2	
2040-2700		0.7		1.7
2700-3360	3.0			4.7
3360-4020	Obscured			
4020-4680				
4680-5340				

PIBAL WIND DATA FOR BB I - 05

RUN NO. 3 DATE: 18 May, 1960 RELEASE TIME 1015 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	7.5		7.0	
120-240	5.0		6.5	
240-360	4.0		7.0	
360-480	2.0		3.0	
480-600	3.0		1.0	
600-720	5.0			2.0
720-830	4.0			0.5
830-940	0			0
940-1050	2.5			0.5
1050-1160	3.5			6.0
1160-1270	1.5			2.0
1270-1380	0			2.5
1380-1490	0			2.5
1490-1600		1.5		1.5
1600-1710		2.0		1.5
1710-1820		0.5		1.0
1820-1930		2.5		1.0
1930-2040		2.5		1.0

PIBAL WIND DATE FOR BB I - 05

RUN NO: 3 DATE: 18 May, 1960 RELEASE TIME 1230 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-720	0.3		9.3	
720-1380	0.7		2.7	
1380-2040		3.5	0	
2040-2700		2.0	0	
2700-3360	4.6			6.9
3360-4020	5.0			16.0
4020-4680	12.0			14.3
4680-5340	11.0			16.7

PIBAL WIND DATA FOR BB I - 05

RUN NO. 4 DATE: 18 May, 1960 RELEASE TIME 1033 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	4.5		6.0	
120-240	6.0		7.0	
240-360	3.0		7.0	
360-480	3.0		5.0	
480-600	2.0		2.0	
600-720	3.0		1.0	
720-830	3.0			1.0
830-940	4.0		1.0	
940-1050	1.0		0	
1050-1160	3.0		0	
1160-1270	2.0			2.0
1270-1380	3.0			1.0
1380-1490	3.0			1.0
1490-1600	2.0			1.5
1600-1710	1.5			1.5
1710-1820		0.5		2.0
1820-1930		1.0		0.5
1930-2040		1.5		1.0

PIBAL WIND DATA FOR BB I - 05

RUN NO. 4 DATE: 18 May, 1960 RELEASE TIME 1330 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-720	1.7		10.7	
720-1380	0.3		5.0	
1380-2040		2.7	0	
2040-2700		1.7	0.8	
2700-3360	3.7			5.7
3360-4020	6.0			12.5
4020-4680	12.7			12.7
4680-5340	Obscured			

PIBAL WIND DATA FOR BB I - 05

RUN NO. 5 DATE: 18 May, 1960 RELEASE TIME 1130 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	5.5		5.0	
120-240	4.0		6.0	
240-360	3.5		8.0	
360-480	3.0		4.5	
480-600	2.5		5.0	
600-720	2.0		3.0	
720-830	1.0		1.0	
830-940	0		1.0	
940-1050		1.0	0	
1050-1160		1.0	0	
1160-1270		1.0	0.5	
1270-1380	1.0			1.0
1380-1490	2.0			1.0
1490-1600	5.0			0
1600-1710	4.0		1.0	
1710-1820	3.0		1.0	
1820-1930	1.5		0	
1930-2040	1.0			1.0

PIBAL WIND DATA FOR BB I - 05

RUN NO. 6 DATE: 18 May, 1960 RELEASE TIME 1230 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	2.5			
120-240	2.5			
240-360	0.5			
360-480		2.0		
480-600	1.0			
600-720	1.0			
720-830	2.0			
830-940	0.5			
940-1050	0.5			
1050-1160	1.0			
1160-1270		2.0		
1270-1380		3.0		
1380-1490		3.5		
1490-1600		3.5		
1600-1710		4.0		
1710-1820		3.5		
1820-1930		0		
1930-2040		4.0		

PIBAL WIND DATA FOR BB I - 05

RUN NO. 7 DATE: 18 May, 1960 RELEASE TIME 1300 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	6.0		9.0	
120-240		1.0	13.0	
240-360		0	10.0	
360-480	1.5		11.0	
480-600	1.5		9.0	
600-720	1.0		8.0	
720-830	0.5		5.0	
830-940	0		5.0	
940-1050		1.0	5.0	
1050-1160		1.0	4.0	
1160-1270		2.0	3.0	
1270-1380		1.5	3.0	
1380-1490		5.0	0.5	
1490-1600		3.5	3.0	
1600-1710		3.0		3.0
1710-1820		3.0		0.5
1820-1930		3.0		0.5
1930-2040		2.0		0.5

PIBAL WIND DATA FOR BB I - 05

RUN NO. 8 DATE: 18 May, 1960 RELEASE TIME 1330 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	3.5		10.0	
120-240	2.0		11.0	
240-360	1.0		10.0	
360-480	1.5		11.0	
480-600	3.0		10.0	
600-720	2.0		9.0	
720-830	2.0		9.0	
830-940	2.0		6.0	
940-1050	2.0		6.0	
1050-1160	0		5.0	
1160-1270		1.0	3.0	
1270-1380		2.0	3.0	
1380-1490		2.0	1.5	
1490-1600		5.0	2.0	
1600-1710		4.0		1.0
1710-1820		2.5		1.0
1820-1930		1.0		2.0
1930-2040		2.0		1.0

PIBAL WIND DATA FOR BB I - 05

RUN NO. 9 DATE: 18 May, 1960 RELEASE TIME 1400 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	2.0		11.0	
120-240	1.5		14.0	
240-360	0		14.0	
360-480	0.5		15.0	
480-600	2.0		11.0	
600-720	2.0		10.5	
720-830	1.0		10.0	
830-940	1.0		9.0	
940-1050	1.0		8.0	
1050-1160	1.0		6.5	
1160-1270		0.5	7.0	
1270-1380		2.0	5.0	
1380-1490		1.0	4.0	
1490-1600		2.5	2.0	
1600-1710		1.0	3.0	
1710-1820		1.0	0.5	
1820-1930		2.0	2.0	
1930-2040		2.0	0	

PIBAL WIND DATA FOR BB I - 05

RUN NO. 10 DATE: 18 May, 1960 RELEASE TIME 1415 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	2.5		7.5	
120-240	1.0		10.0	
240-360	1.0		12.0	
360-480	0		12.0	
480-600	1.0		11.0	
600-720	1.0		12.0	
720-830	0.5		10.0	
830-940	3.5		8.5	
940-1050		0.5	8.5	
1050-1160	1.0		9.5	
1160-1270		Obscured		
1270-1380				
1380-1490				
1490-1600				
1600-1710				
1710-1820				
1820-1930				
1930-2040				

PIBAL WIND DATA FOR BB I - 05

RUN NO. 11 DATE: 18 May, 1960 RELEASE TIME 1510 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		3.0	9.0	
120-240		0.5	8.5	
240-360		0	9.5	
360-480		2.0	7.5	
480-600		4.5	9.5	
600-720		Obscured		
720-830				
830-940				
940-1050				
1050-1160				
1160-1270				
1270-1380				
1380-1490				
1490-1600				
1600-1710				
1710-1820				
1820-1930				
1930-2040				

PIBAL WIND DATA FOR BB I - 05

RUN NO. 12 DATE: 18 May, 1960 RELEASE TIME 1520 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	3.0		6.5	
120-240		1.0	6.0	
240-360		2.5	13.0	
360-480		2.5	9.0	
480-600	Obscured			
600-720				
720-830				
830-940				
940-1050				
1050-1160				
1160-1270				
1270-1380				
1380-1490				
1490-1600				
1600-1710				
1710-1820				
1820-1930				
1930-2040				

PIBAL WIND DATA FOR BB I - 05

RUN NO. 13 DATE: 18 May, 1960 RELEASE TIME 1543 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	0.5		10.0	
120-240		0.5	11.5	
240-360		1.0	14.5	
360-480		2.0	16.0	
480-600		3.5	18.0	
600-720		4.5	10.5	
720-830		2.0	14.5	
830-940	1.0		13.5	
940-1050	1.0		14.0	
1050-1160	1.5		10.0	
1160-1270	0		8.0	
1270-1380	0		6.0	
1380-1490	0		4.0	
1490-1600		2.0	5.0	
1600-1710		1.0	5.0	
1710-1820	Obscured			
1820-1930				
1930-2040				

IMPACT PREDICTION

ROCKET BB I - 05

DATE: 18 May 1960

Release Time (CST)		Ballistic Wind Disp. of Impact CARDE K Factor			LAUNCHER SETTING			Theoretical Calculations		Predicted Impact	
Radio-sonde	Pibal	20 Ft. to 2040 Ft.	2040 Ft. to 100,000 Ft.	20 Ft. to 100,000 Ft.	Compo-nents in mils	TOTAL Degrees	TILT Azimuth in Degrees	Range in miles	Azimuth in Degrees	Range in miles	Azimuth in Degrees
0845	1035	N 0.8 E 1.4	S 2.67 W 3.053	S 1.87 W 1.65		80	093	71	093		
	1128	S 0.4 E 2.8	S 2.67 W 3.053	S 3.07 W 0.25				82	096		
	1230	S 0.1 E 3.4	S 2.60 W 3.05	S 2.61 E 0.35				86	095		
	1300	S 0.3 E 3.6	S 2.60 W 3.05	S 2.90 E 0.55				87	095		
	1330	S 0.3 E 3.9	S 2.60 W 3.0	S 2.90 E 0.9				90	095		
	1400	0.0 E 5.4	S 2.6 W 3.0	S 2.6 E 2.4				98	094		
	1415	0 E 4.4	S 2.6 W 3.0	S 2.6 E 1.4				93	095		
	1510	S 0.9 E 3.6	S 2.6 W 3.0	S 3.5 E 0.6				88	097		
	1520	Insufficient readings due to clouds								90	095
	*1543	0 E 5.7	S 2.6 W 3.0	S 2.6 E 2.7				100	094		

ANEMOMETER RECORDINGS OF WIND SPPED AND DIRECTION

ROCKET BB I - 06 DATE 24 May, 1960

TIME CST	WIND SPEED IN MPH	DIRECTION IN DEGREES
X-60 MIN	2.0	291
X-45 MIN	8.5	339
X-30 MIN	9.5	324
X-15 MIN	7.5	318
X-60 SECONDS	7.0	318
X-45 SECONDS	6.5	316
X-30 SECONDS	5.5	321
X-15 SECONDS	6.0	318
X-TIME (1144 HRS 46.5 SECONDS)	7.0	319
X+15 SECONDS	5.5	326
X+ 1 MIN	8.0	320
X+ 2 MIN	7.0	321
X+ 3 MIN	6.0	324
X+ 4 MIN	6.0	321
X+ 5 MIN	6.5	322
X+ 6 MIN	6.0	324
X+ 7 MIN	5.0	320
X+ 8 MIN	6.0	321

RADIOSONDE DATA FOR BB I - 06

RUN NO: 1 DATE: 24 May 60 RELEASE TIME: 0850 (C.S.T.)

HEIGHT METERS	HEIGHT FEET	PRESSURE MILLIBARS	TEMP C	REL. HUM. PERCENT	DEW POINT C
0	0	1009	+ 12.1	60	+ 4.6
590	1,936	940	+ 11.5	57	+ 3.4
1,750	5,741	818	+ 3.3	76	- 0.5
2,170	7,119	776	+ 3.1	47	- 7.1
2,970	9,744	702	- 0.7	79	- 3.9
3,200	10,499	682	- 0.1	75	- 4.0
4,180	13,714	603	- 6.9	39	- 18.4
4,670	15,321	566	- 8.9	28	- 24.0
5,260	17,257	524	- 14.3	47	- 23.1
6,290	20,636	456	- 20.4	33	- 32.5
7,261	23,822	400	- 27.5	43	- 36.3
8,790	28,839	321	- 39.1		
11,120	36,483	225	- 57.7		
12,900	42,323	170	- 65.7		
13,760	45,144	148	- 55.6		
16,241	53,284	100	- 55.4		
25,720	84,383	23	- 47.2		
30,719	100,784	11	- 36.4		

RAWIN DATA FOR BB I - 06

RUN NO: 1 DATE: 24 May, 1960 RELEASE TIME: 0850 (C.S.T.)

MEAN WIND COMPONENTS IN M.P.H.

LAYERS IN KILOFEET	N	S	E	W
2 - 3		2.0		11.0
3 - 4		3.0		11.5
4 - 5		3.0		14.0
5 - 6		1.5		17.5
6 - 7		0.5		20.0
7 - 8		4.0		27.0
8 - 9		6.0		32.5
9 - 10		6.0		40.5
10 - 12		10.5		48.0
12 - 14		14.0		48.0
14 - 16		14.0		44.5
16 - 18		16.0		45.0
18 - 20		17.5		45.0
20 - 25		14.5		44.0
25 - 30		14.0		54.5
30 - 35		11.5		49.5
35 - 40	13.0			61.5
40 - 50	0	0		32.5
50 - 60		0.5		10.0
60 - 70	4.0		2.0	
70 - 80	0.5		17.0	
80 - 90		5.0	34.0	
90 - 100		9.0	31.0	

PIBAL WIND DATA FOR BB I - 06

RUN NO. 1 DATE: 24 May, 1960 RELEASE TIME 0855 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		4.5		7.0
120-240		4.0		8.0
240-360		3.0		8.5
360-480		4.0		9.0
480-600		4.0		10.0
600-720		4.0		11.0
720-830		1.0		10.0
830-940	3.0			9.5
940-1050	2.0			10.0
1050-1160	1.0			10.0
1160-1270		1.0		10.0
1270-1380		3.0		9.0
1380-1490		1.0		14.0
1490-1600	1.0			10.0
1600-1710	1.0			6.0
1710-1820		1.0		11.0
1820-1930		1.0		10.0
1930-2040		1.0		10.0

PIBAL WIND DATA FOR BB I - 06

RUN NO. 1 DATE 24 May, 1960 RELEASE TIME 0855 (CST)

MEAN WIND COMPONENTS IN MPH

Layers in Feet	N	S	E	W
0-720		2.5		9.0
720-1380		0		10.0
1380-2040		1.0		10.0
2040-2700		2.0		10.0
2700-3360		2.0		14.0
3360-4020		3.0		15.0
4020-4680		1.0		16.0
4680-5340	1.0			15.0

PIBAL WIND DATA FOR BB I - 06

RUN NO. 2 DATE: 24 May, 1960 RELEASE TIME 0945 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		0.5		11.0
120-240		0.5		12.5
240-360		5.5		11.0
360-480		3.5		10.0
480-600		0.5		9.0
600-720		1.5		9.5
720-830		1.5		7.5
830-940		1.0		8.0
940-1050		1.0		6.5
1050-1160	2.5			9.5
1160-1270	0.5			6.5
1270-1380		3.0		6.0
1380-1490		0.5		5.0
1490-1600		4.0		7.0
1600-1710		7.0		8.5
1710-1820		5.0		9.5
1820-1930		4.0		9.0
1930-2040		3.5		10.5

PIBAL WIND DATA FOR BB I - 06

RUN NO. 2 DATE 24 May, 1960 RELEASE TIME 0945 (CST)

MEAN WIND COMPONENTS IN MPH

Layers in Feet	N	S	E	W
0-720		2.0		10.0
720-1380		0		7.0
1,380-2,040		4.0		8.5
2,040-2,700		2.5		11.5
2,700-3,360		4.0		13.0
3,360-4,020		5.0		15.0
4,020-4,680		4.5		19.0
4,680-5,340		3.0		16.5

PIBAL WIND DATA FOR BB I - 06

RUN NO. 3 DATE: 24 May, 1960 RELEASE TIME 1030 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	2.0			3.0
120-240	0			3.5
240-360		1.5		3.0
360-480		6.0		3.5
480-600		8.0		4.0
600-720		7.0		4.0
720-830		10.0		4.0
830-940		10.5		4.0
940-1050		11.0		4.0
1050-1160		11.0		3.0
1160-1270		11.0		4.0
1270-1380		7.0		7.0
1380-1490		4.0		9.0
1490-1600		5.0		9.0
1600-1710		4.0		9.0
1710-1820		4.0		9.0
1820-1930		4.0		9.0
1930-2040		4.0		10.0

PIBAL WIND DATA FOR BB I - 06

RUN NO. 4 DATE: 24 May, 1960 RELEASE TIME 1045 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	3.0			1.5
120-240	3.0			2.5
240-360	1.0			1.0
360-480		1.0		1.0
480-600		3.0		2.0
600-720		2.5		2.0
720-830		1.0		4.0
830-940		4.0		3.0
940-1050		5.0		5.0
1050-1160		5.5		5.0
1160-1270		6.0		8.0
1270-1380		2.5		5.0
1380-1490		3.0		7.0
1490-1600		3.0		7.0
1600-1710		3.0		8.0
1710-1820		2.5		8.0
1820-1930		3.0		8.5
1930-2040		5.0		7.0

PIBAL WIND DATA FOR BB I - 06

RUN NO. 5 DATE: 24 May, 1960 RELEASE TIME 1100 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	9.0			7.0
120-240	6.0			5.5
240-360	7.0			8.0
360-480	6.0			7.0
480-600	5.5			6.0
600-720	6.0			5.5
720-830	2.0			4.0
830-940		3.0		8.0
940-1050		1.0		3.0
1050-1160		2.0		3.0
1160-1270		1.0		2.5
1270-1380		3.0		4.0
1380-1490		5.0		4.0
1490-1600		5.0		6.0
1600-1710		9.0		5.0
1710-1820		6.0		5.0
1820-1930		6.0		8.0
1930-2040		8.0		9.0

PIBAL WIND DATA FOR BB I - 06

RUN NO. 6 DATE: 24 May, 1960 RELEASE TIME 1117 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	7.0			6.5
120-240	10.5			8.5
240-360	10.5			7.5
360-480	8.0			6.5
480-600	6.0			8.5
600-720	5.5			9.5
720-830	3.0			11.0
830-940		1.5		8.0
940-1050		2.0		6.0
1050-1160		2.0		7.0
1160-1270		5.0		7.5
1270-1380		5.0		6.5
1380-1490		4.5		7.0
1490-1600		4.5		7.5
1600-1710		3.5		8.5
1710-1820		5.5		8.0
1820-1930		obscured		
1930-2040				

PIBAL WIND DATA FOR BB I - 06

RUN NO. 7 DATE: 24 May, 1960 RELEASE TIME 1135 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	8.5			10.0
120-240	9.0			10.0
240-360	8.5			11.0
360-480	6.5			9.5
480-600	2.0			8.0
600-720		1.0		9.0
720-830		2.0		11.0
830-940		3.5		8.0
940-1050		4.0		7.0
1050-1160		4.0		7.0
1160-1270		7.0		7.0
1270-1380		7.0		8.0
1380-1490		7.0		5.0
1490-1600		6.0		7.5
1600-1710		6.0		9.0
1710-1820		7.0		10.0
1820-1930		5.0		9.0
1930-2040		6.0		10.0

PIBAL WIND DATA FOR BB I - 06

RUN NO. 8 DATE: 24 May, 1960 RELEASE TIME 1207 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	7.0			6.5
120-240	9.0			9.0
240-360	8.5			10.0
360-480	7.0			9.0
480-600	5.0			9.0
600-720	2.0			9.0
720-830		1.0		9.0
830-940		4.0		9.0
940-1050		4.0		9.0
1050-1160		7.0		8.0
1160-1270		8.0		7.5
1270-1380		8.5		8.5
1380-1490		8.0		8.5
1490-1600		10.0		11.0
1600-1710		7.0		10.0
1710-1820		5.5		12.0
1820-1930		5.0		7.0
1930-2040		9.0		8.0

IMPACT PREDICTION

ROCKET BB I - 06

DATE: 24 May, 1960

Release Time (CST)		Ballistic Wind Disp. of Impact CARDE K Factor			LAUNCHER SETTING			Theoretical Calculations		Predicted Impact	
Radio-sonde	Pibal	20 Ft. to 2040 Ft.	2040 Ft. to 100,000 Ft.	20 Ft. to 100,000 Ft.	Compo-nents in mils	TOTAL Degrees	TILT Azimuth in Degrees	Range in miles	Azimuth in Degrees	Range in miles	Azimuth in Degrees
0850	0855	S 1.0 W 4.0	S 1.05 W 5.02	S 2.05 W 9.02		82.5	093	6	220		
	0945	S 0.5 W 4.1	S 1.05 W 5.02	S 1.55 W 9.12				5	232		
	1030	S 1.3 W 1.6	S 1.16 W 4.87	S 2.46 W 6.47				17	110		
	1045	S 0.9 W 1.0	S 1.16 W 4.87	S 2.06 W 5.87				21	104		
	1100	N 0.8 W 2.1	S 1.16 W 4.87	S 0.36 W 0.97				11	96		
	1117	N 1.4 W 2.7	S 1.16 W 4.87	N 0.24 W 7.57				8	93		
						81	093	21	93		
	1135	N 0.9 W 3.9	S 1.16 W 4.87	S 0.26 W 8.77				13	93	Final	Prediction
	*1207	N 0.3 W 2.9	S 1.16 W 4.87	S 0.86 W 7.77				20	95		

* Post Shoot

ANEMOMETER RECORDINGS OF WIND SPPED AND DIRECTION

ROCKET BB I - 07

DATE 28 May, 1960.

TIME CST	WIND SPEED IN MPH	DIRECTION IN DEGREES
X-60 MIN	8	315
X-45 MIN	8	333
X-30 MIN	9	331
X-15 MIN	9	345
X-60 SECONDS	9	357
X-45 SECONDS	5	360
X-30 SECONDS	9	352
X-15 SECONDS	10	353
X-TIME (1227 HRS 0 SECONDS)	9	353
X+15 SECONDS	9	351
X+1 MIN	10	351
X+2 MIN	10	351
X+3 MIN	10	351
X+4 MIN	10	352
X+5 MIN	10	352
X+6 MIN	10	352
X+7 MIN	10	352
X+8 MIN	10	352

PIBAL WIND DATA FOR BB I - 07

RUN NO. 1 DATE: 28 May, 1960 RELEASE TIME 0850 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	5.0			10.5
120-240	6.0			10.0
240-360	6.0			13.5
360-480	7.0			16.5
480-600	11.5			16.0
600-720	13.0			14.0
720-830	15.0			12.5
830-940	14.5			13.0
940-1050	13.5			14.5
1050-1160	12.0			13.0
1160-1270	14.0			15.5
1270-1380	13.0			13.5
1380-1490	12.5			16.5
1490-1600	10.0			14.0
1600-1710	12.0			14.0
1710-1820	10.0			14.0
1820-1930	10.0			15.0
1930-2040	12.0			14.0

PIBAL WIND DATA FOR BB I - 07

RUN NO. 1 DATE: 28 May, 1960 RELEASE TIME 0855 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-720	8.5			14.0
720-1380	13.5			14.0
1380-2040	11.0			15.0
2040-2700	12.0			17.5
2700-3360	13.0			20.5
3360-4020	13.0			23.5
4020-4680	11.5			22.5
4680-5340	14.0			32.0
RUN NO. 2			RELEASE TIME 0900 (CST)	
0-720	3.0			15.0
720-1380	4.0			13.0
1380-2040	6.0			14.0
2040-2700	7.0			14.5
2700-3360	6.0			23.0
3360-4020	11.0			20.5
4020-4680	5.5			24.5
4680-5340	6.5			32.0

PIBAL WIND DATA FOR BB I - 07

RUN NO. 2 DATE: 28 May, 1960 RELEASE TIME 0930 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120		1.0		10.0
120-240	4.5			13.0
240-360	4.0			15.5
360-480	4.0			15.0
480-600	4.0			15.0
600-720	3.5			14.0
720-830	4.0			12.0
830-940	5.0			12.0
940-1050	4.0			12.5
1050-1160	5.0			13.0
1160-1270	5.0			14.0
1270-1380	4.5			14.5
1380-1490	4.0			13.5
1490-1600	5.0			13.0
1600-1710	5.5			13.0
1710-1820	4.0			13.0
1820-1930	8.0			14.0
1930-2040	6.0			13.0

PIBAL WIND DATA FOR BB I - 07

RUN NO. 3 DATE: 28 May, 1960 RELEASE TIME 1030 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	6.5			8.0
120-240	7.5			10.0
240-360	6.0			9.5
360-480	4.0			8.5
480-600	3.5			11.0
600-720	1.5			10.0
720-830	0.5			8.5
830-940	0.5			10.5
940-1050	0			8.5
1050-1160	0.5			9.0
1160-1270		2.0		10.5
1270-1380	2.0			10.5
1380-1490	3.5			12.0
1490-1600	3.0			11.0
1600-1710	3.5			12.0
1710-1820	3.5			13.0
1820-1930	4.0			12.5
1930-2040	3.0			14.0

PIBAL WIND DATA FOR BB I - 07

RUN NO. 3 DATE: 28 May 1960 RELEASE TIME 1030 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-720	5.0			10.0
720-1380	4.5			9.5
1380-2040	4.0			12.5
2040-2700	7.0			14.0
2700-3360	8.5			15.5
3360-4020	9.0			18.0
4020-4680	7.0			21.5
4680-5340	8.5			35.5
RUN NO. 4				
0-720	9.5			7.0
720-1380	4.0			11.5
1380-2040		14.5		11.0
2040-2700	0			11.0
2700-3360	4.5			12.0
3360-4020		Balloon Lost in Cloud		
4020-4680		Back Ground.		
4680-5340				
1930-2040				

PIBAL WIND DATA FOR BB I - 07

RUN NO. 4 DATE: 28 May, 1960 RELEASE TIME 1050 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	5.0			6.5
120-240	6.0			8.0
240-360	6.0			11.0
360-480	4.0			10.5
480-600	3.0			10.0
600-720	2.0			11.0
720-830	0.5			11.0
830-940	1.0			11.0
940-1050	0			10.5
1050-1160		0.5		11.5
1160-1270		0		11.5
1270-1380	2.0			13.0
1380-1490	1.0			13.5
1490-1600	1.5			12.5
1600-1710	4.0			13.5
1710-1820	4.5			14.0
1820-1930	3.5			14.0
1930-2040	3.5			14.0

UNCLASSIFIED
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PIBAL WIND DATA FOR BB I - 07

RUN NO. 5 DATE: 28 May, 1960 RELEASE TIME 1115 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	5.0			10.0
120-240	6.0			8.0
240-360	6.0			12.0
360-480	4.5			12.0
480-600	3.5			11.5
600-720	0			13.5
720-830	1.0			10.5
830-940	2.5			13.0
940-1050	1.5			12.0
1050-1160		1.0		12.0
1160-1270		2.0		12.0
1270-1380		3.0		13.0
1380-1490		4.0		13.0
1490-1600		5.5		14.0
1600-1710		5.5		15.0
1710-1820		3.0		14.0
1820-1930		2.0		13.0
1930-2040		2.0		14.0

PIBAL WIND DATA FOR BB I - 07

RUN NO. 6 DATE: 28 May, 1960 RELEASE TIME 1200 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	9.0			5.0
120-240	9.5			7.0
240-360	9.0			7.0
360-480	9.5			9.0
480-600	6.0			8.0
600-720	6.0			11.0
720-830	4.0			10.0
830-940	2.5			9.5
940-1050	2.5			11.0
1050-1160	1.0			10.5
1160-1270	0			12.0
1270-1380		1.0		13.0
1380-1490		4.0		12.0
1490-1600		7.0		12.0
1600-1710		7.0		12.0
1710-1820		9.5		13.0
1820-1930		5.5		10.0
1930-2040		8.5		13.0

PIBAL WIND DATA FOR BB I - 07

RUN NO. 7 DATE: 28 May, 1960 RELEASE TIME 1212 (CST)

MEAN WIND COMPONENTS IN MPH

LAYERS IN FEET	N	S	E	W
0-120	8.5			5.0
120-240	8.0			2.5
240-360	11.0			6.0
360-480	8.5			9.0
480-600	7.5			11.0
600-720	7.5			11.5
720-830	3.5			10.0
830-940	3.0			10.0
940-1050	2.5			11.0
1050-1160		1.5		12.0
1160-1270		0.5		12.5
1270-1380		3.5		13.0
1380-1490		4.0		11.5
1490-1600		5.5		11.5
1600-1710		6.0		11.5
1710-1820		7.0		11.5
1820-1930		5.0		10.0
1930-2040		9.0		10.0

PIBAL WIND DATA FOR BB I - 07

RUN NO. 8 DATE: 28 May, 1960 RELEASE TIME 1230 (CST)

MEAN WIND COMPONENTS IN MPH

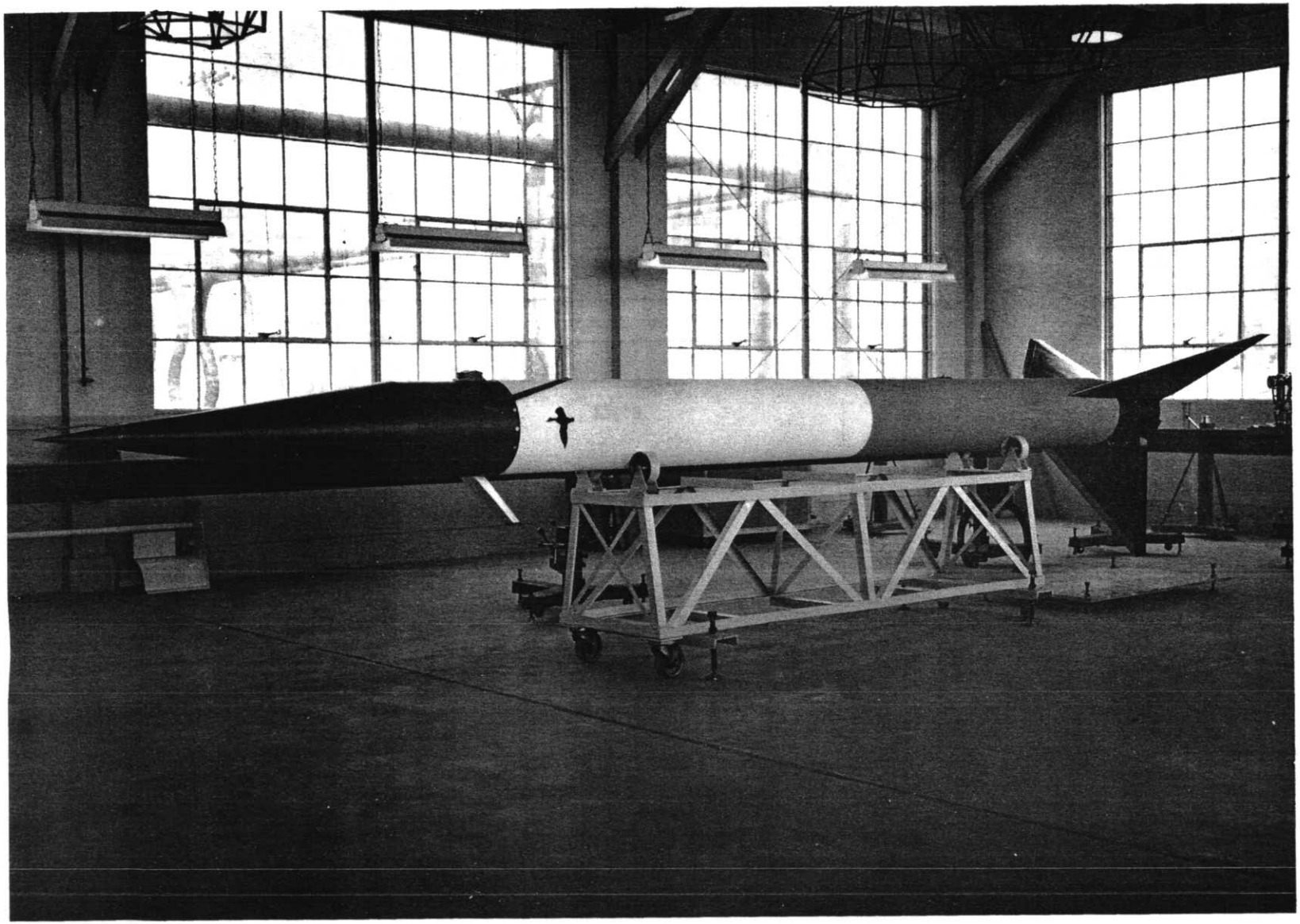
LAYERS IN FEET	N	S	E	W
0-120	8.5			3.0
120-240	10.0			3.0
240-360	10.5			5.5
360-480	10.5			8.0
480-600	9.5			10.0
600-720	8.5			11.5
720-830	6.5			12.0
830-940	4.5			9.5
940-1050	2.0			10.0
1050-1160	3.0			10.5
1160-1270	1.5			10.0
1270-1380		0.5		12.5
1380-1490		2.5		13.0
1490-1600		5.0		10.0
1600-1710		5.5		10.5
1710-1820		4.5		10.5
1820-1930		6.0		10.0
1930-2040		7.5		11.0

IMPACT PREDICTION

ROCKET BB I - 07

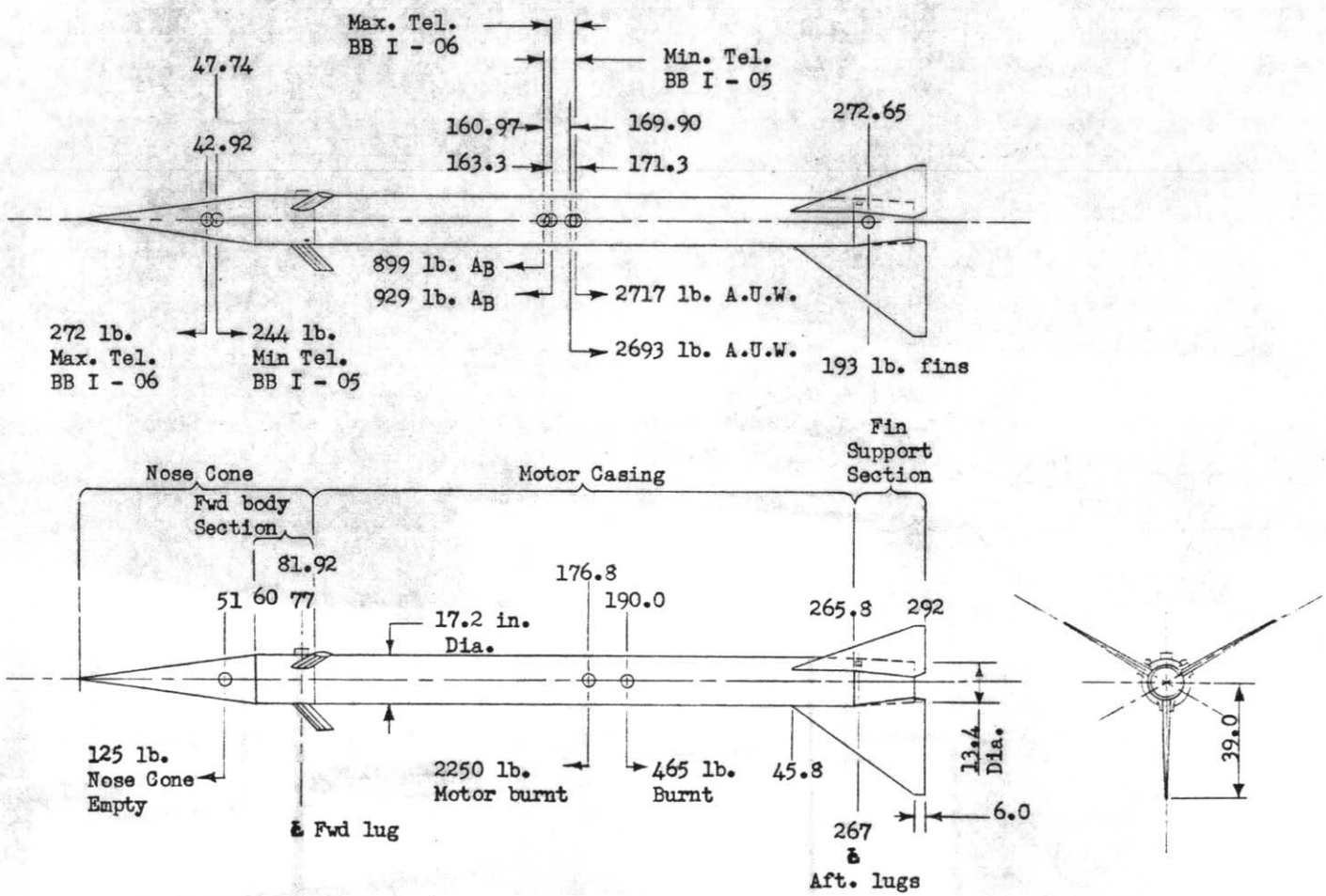
DATE: 28 May, 1960

Release Time (CST)		Ballistic Wind Disp. of Impact CARDE K Factor			LAUNCHER SETTING			Theoretical Calculations		Predicted Impact	
Radio-sonde	Pibal	20 Ft. to 2040 Ft.	2040 Ft. to 100,000 Ft.	20 Ft. to 100,000 Ft.	Compo-nents in mils	TOTAL TILT Degrees	TOTAL TILT Azimuth in Degrees	Range in miles	Azimuth in Degrees	Range in miles	Azimuth in Degrees
	0850	N 3.0 W 6.0	N 0.5 W 0.7	N 3.5 W 6.7		81°	093°	30	071	30	071
	0900	N 1.0 W 6.2	N 0.3 W 0.4	N 1.3 W 6.6		81°		28	086		
*0609		N 1.0 W 6.2	N 1.9 W 3.5	N 2.9 W 3.7		80°		17	059		
	1030	N 1.9 W 3.4		N 3.8 W 6.9				36	070		
	1050	N 0.6 W 4.1		N 2.5 W 7.6				32	078		
	1115	S 0.1 W 4.9		N 1.8 W 8.4				24	081		
	1200	N 1.2 W 3.3		N 3.1 W 6.8				38	075		
	1212	N 1.2 W 3.2		N 3.1 W 6.7				38	075	35	075
	1230	N 1.8 W 2.9		N 3.7 W 6.4				40	075		



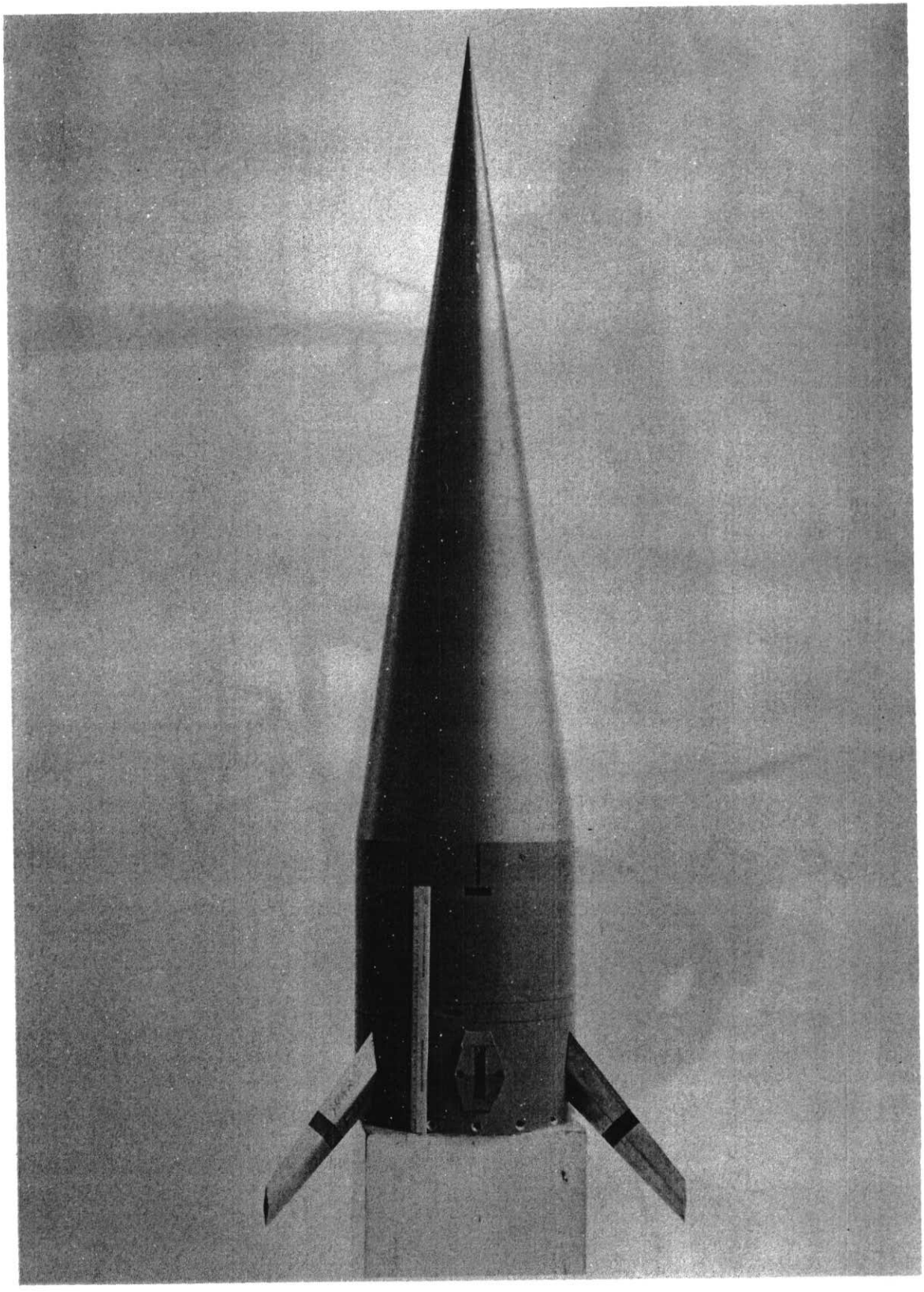
Black Brant I rocket vehicle.

Figure 1



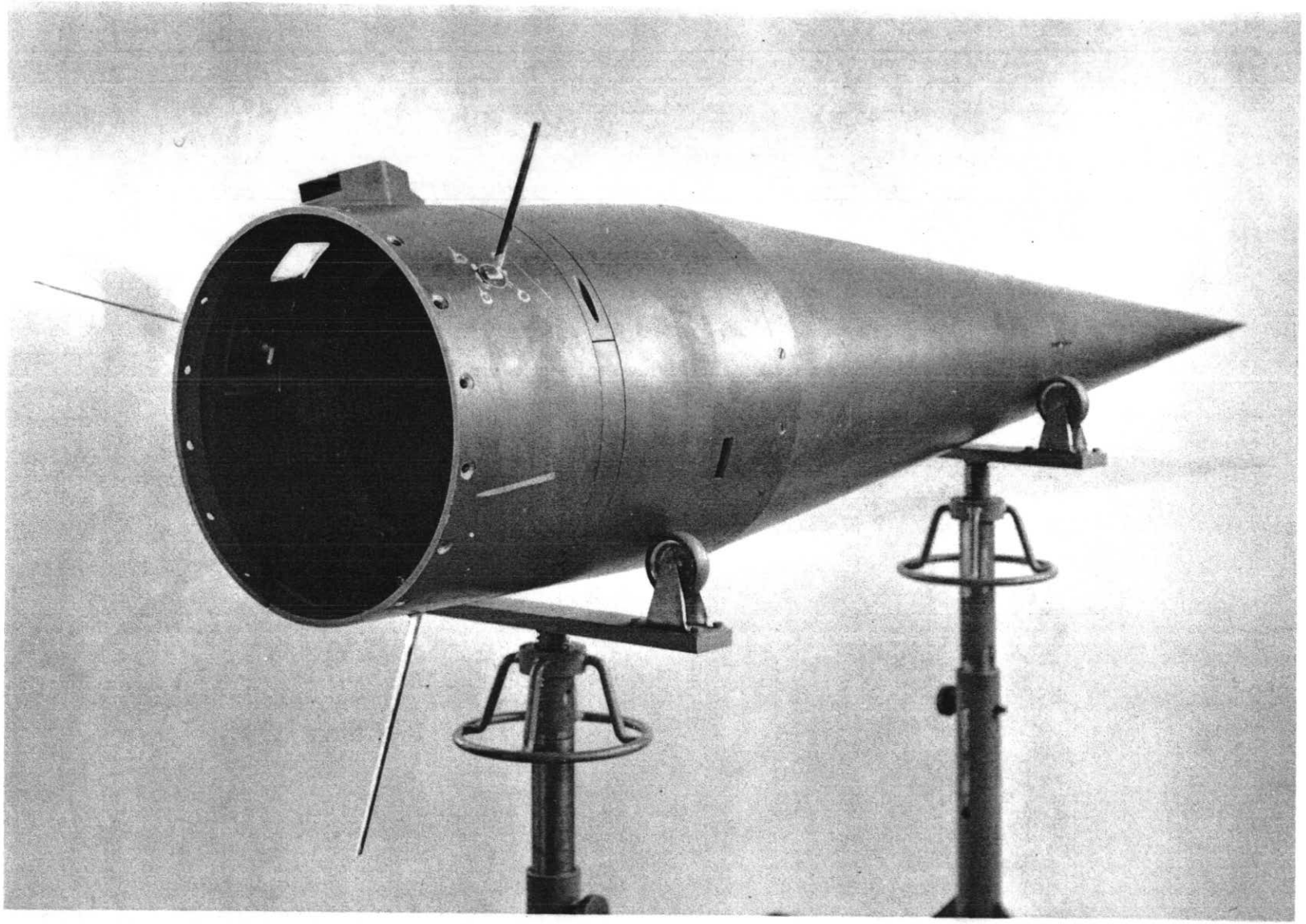
Black Brant I configuration.

Figure 2



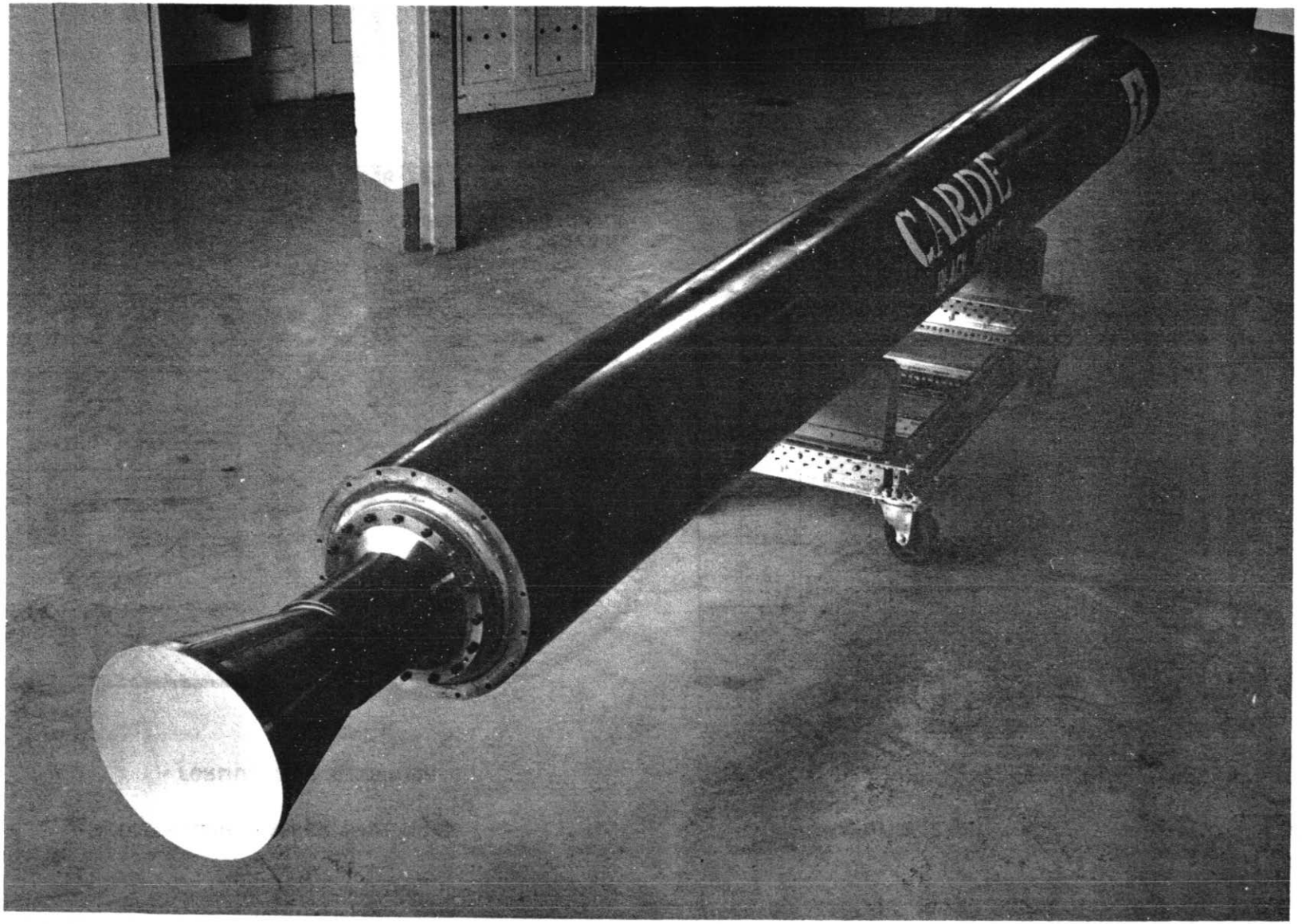
Black Brant I nose cone with large telemetry antennas.

Figure 3A



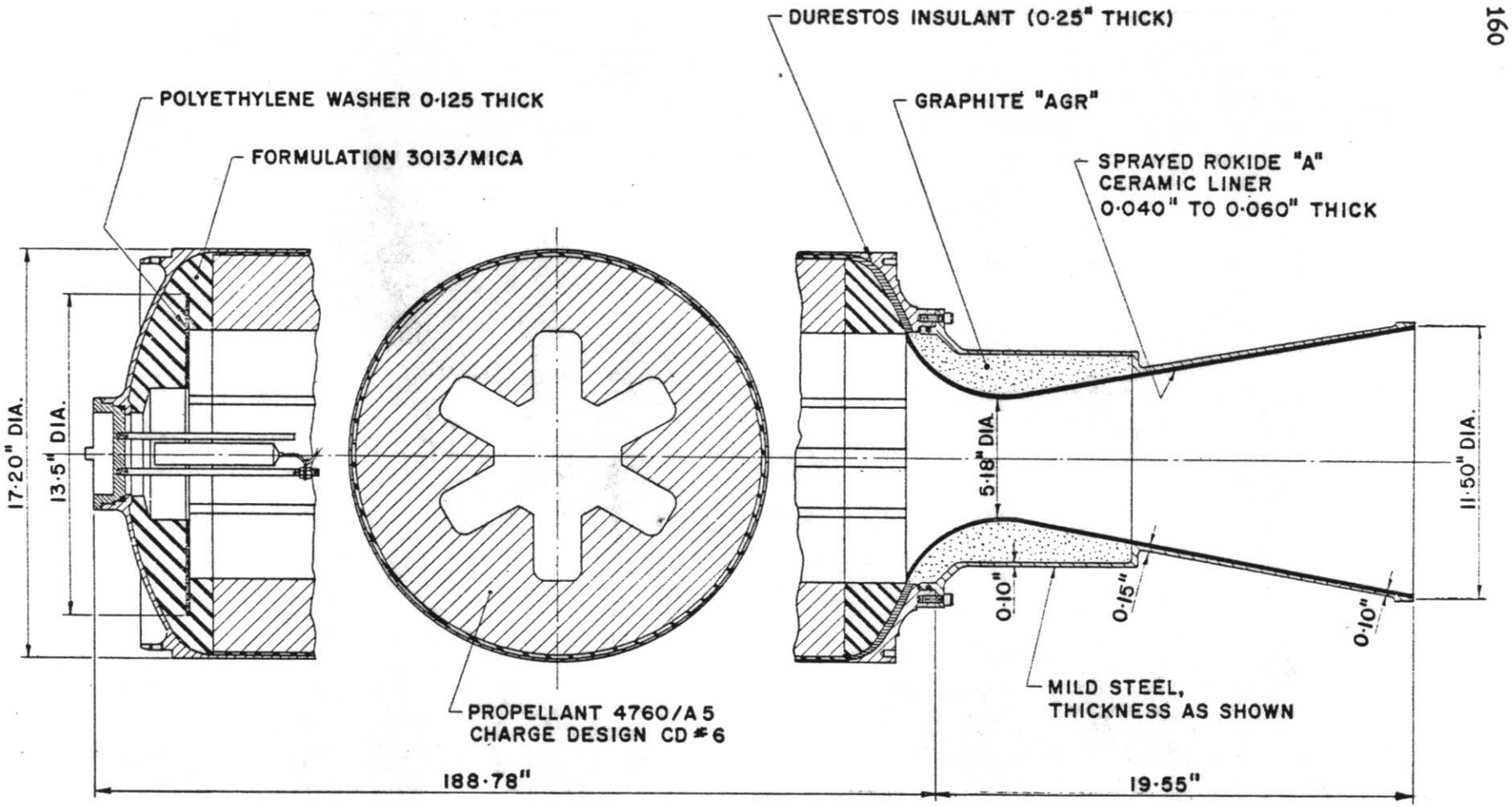
Black Brant I nose cone with small telemetry antennas.

Figure 3B



17 in. rocket engine and nozzle.

Figure 4A

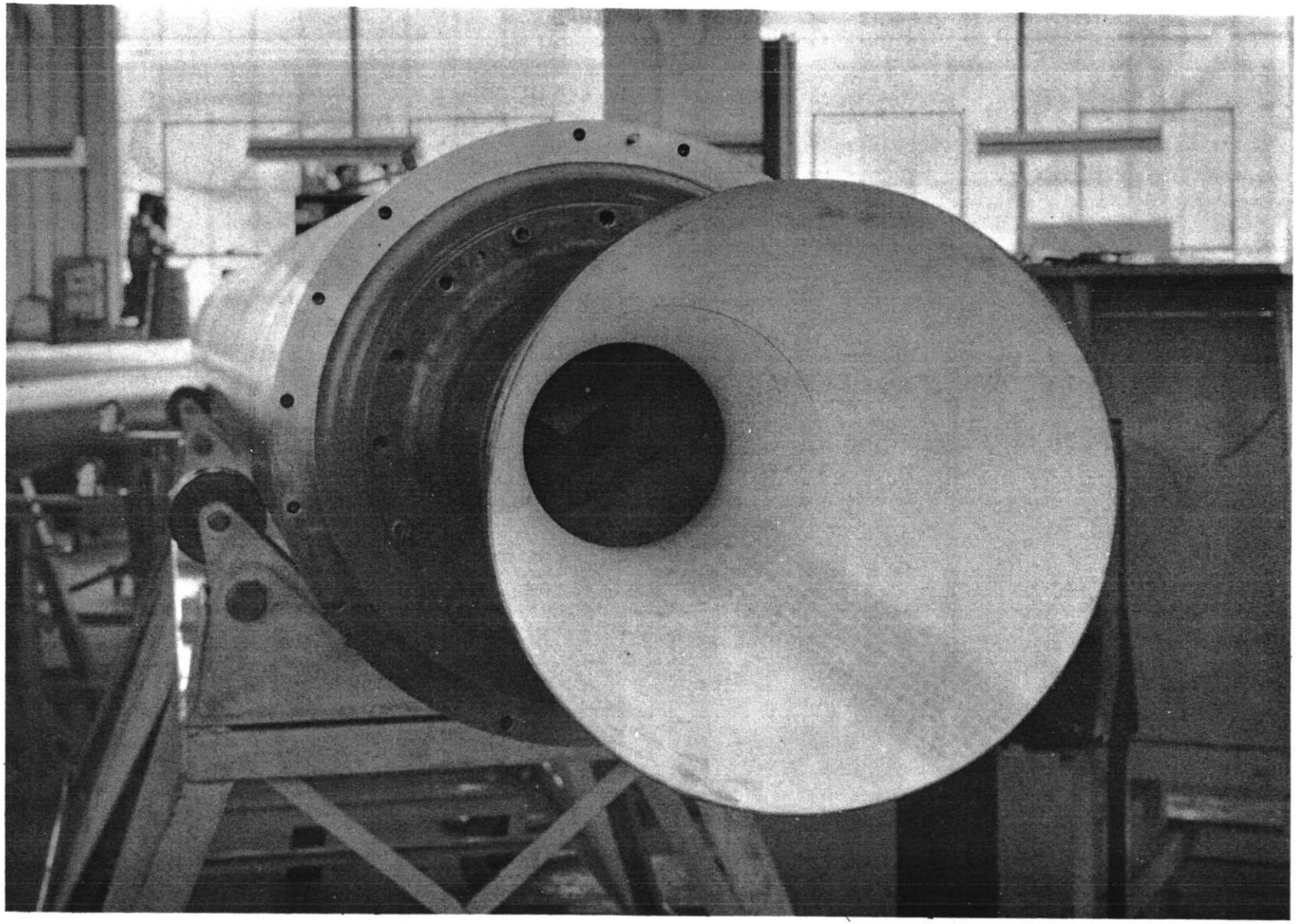


15KS25000 Black Brant I engine layout

Figure 4B

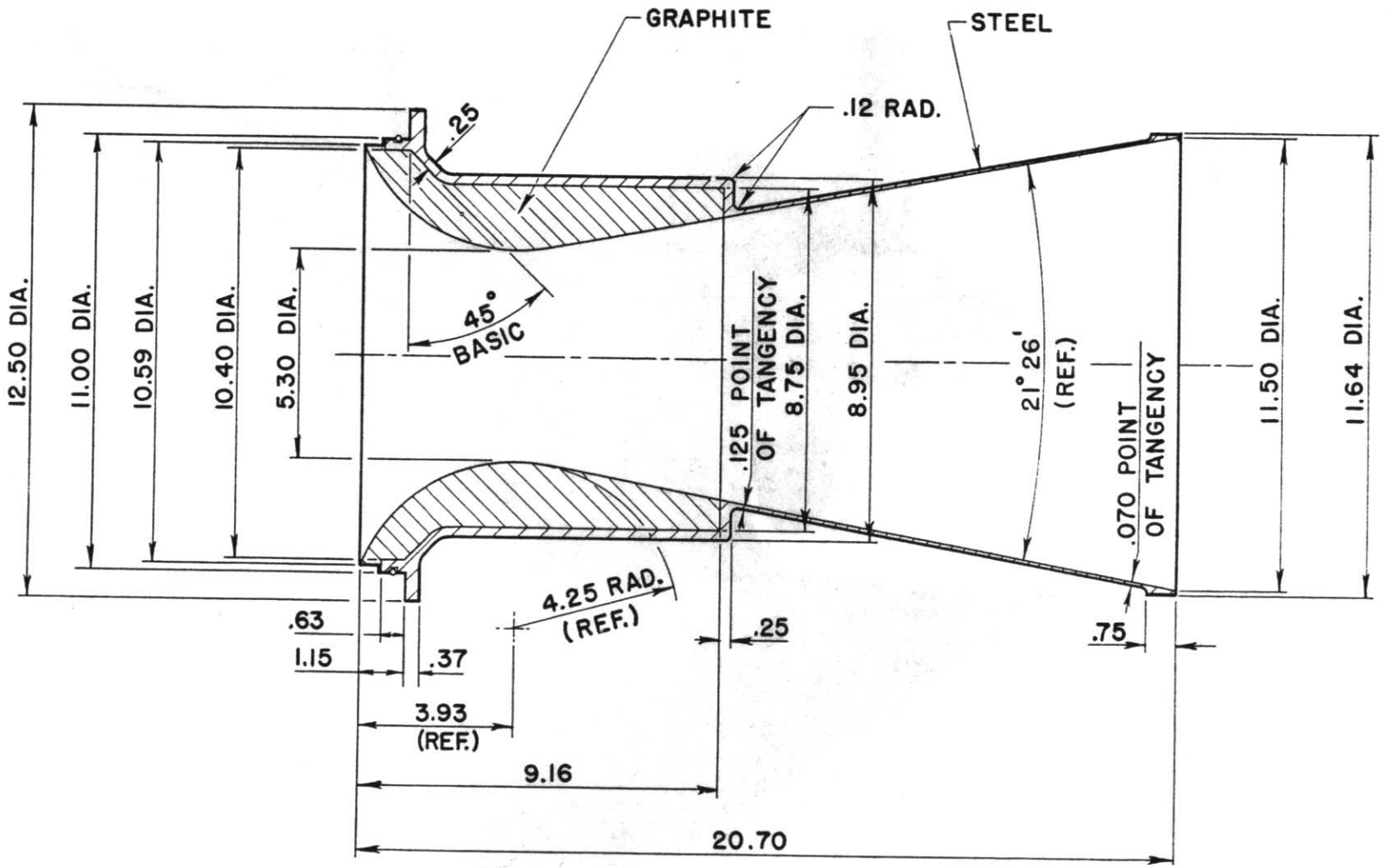
Igniter assembly.

Figure 5A

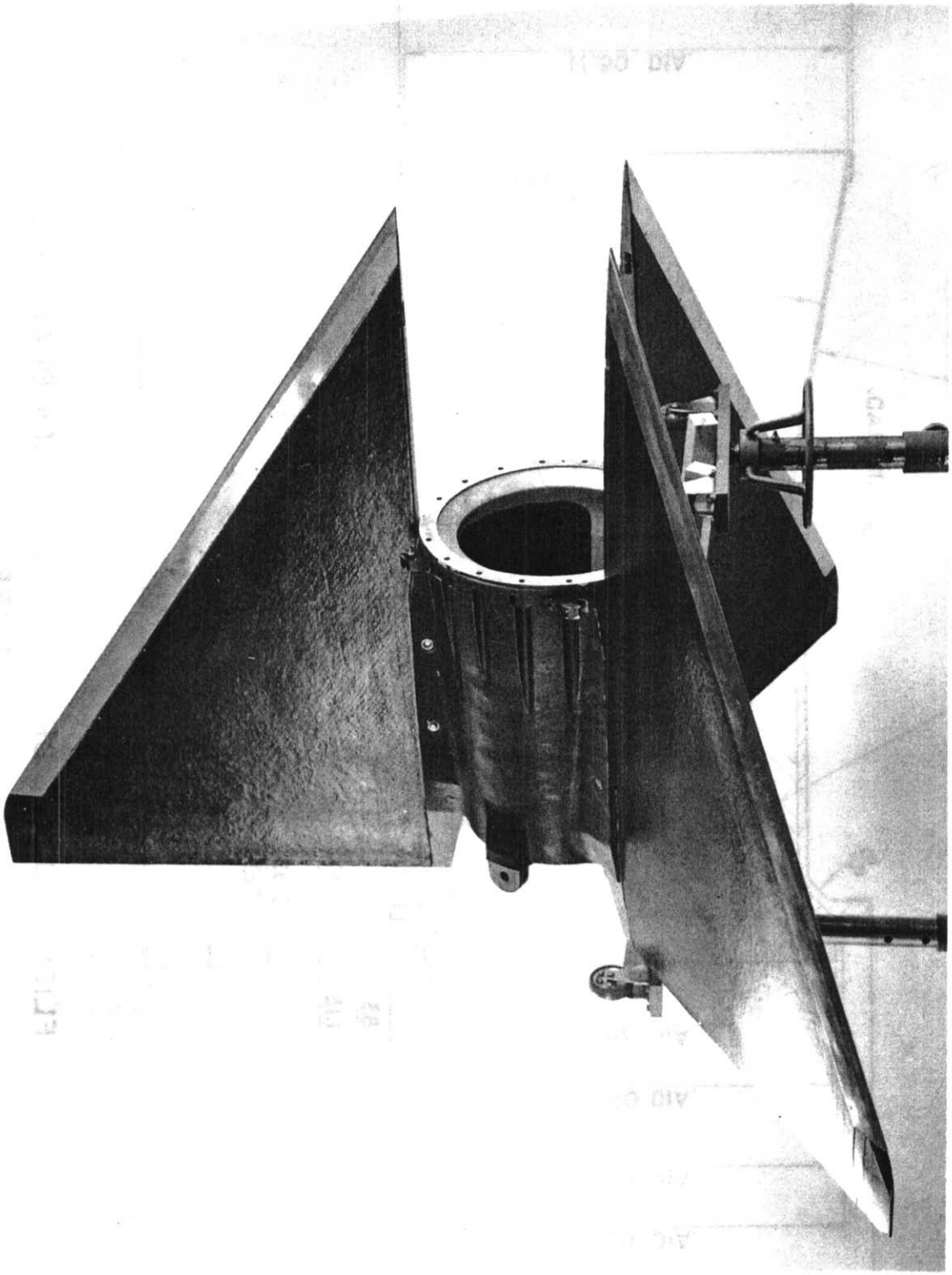


Interior view of Black Brant I nozzle.

Figure 5B

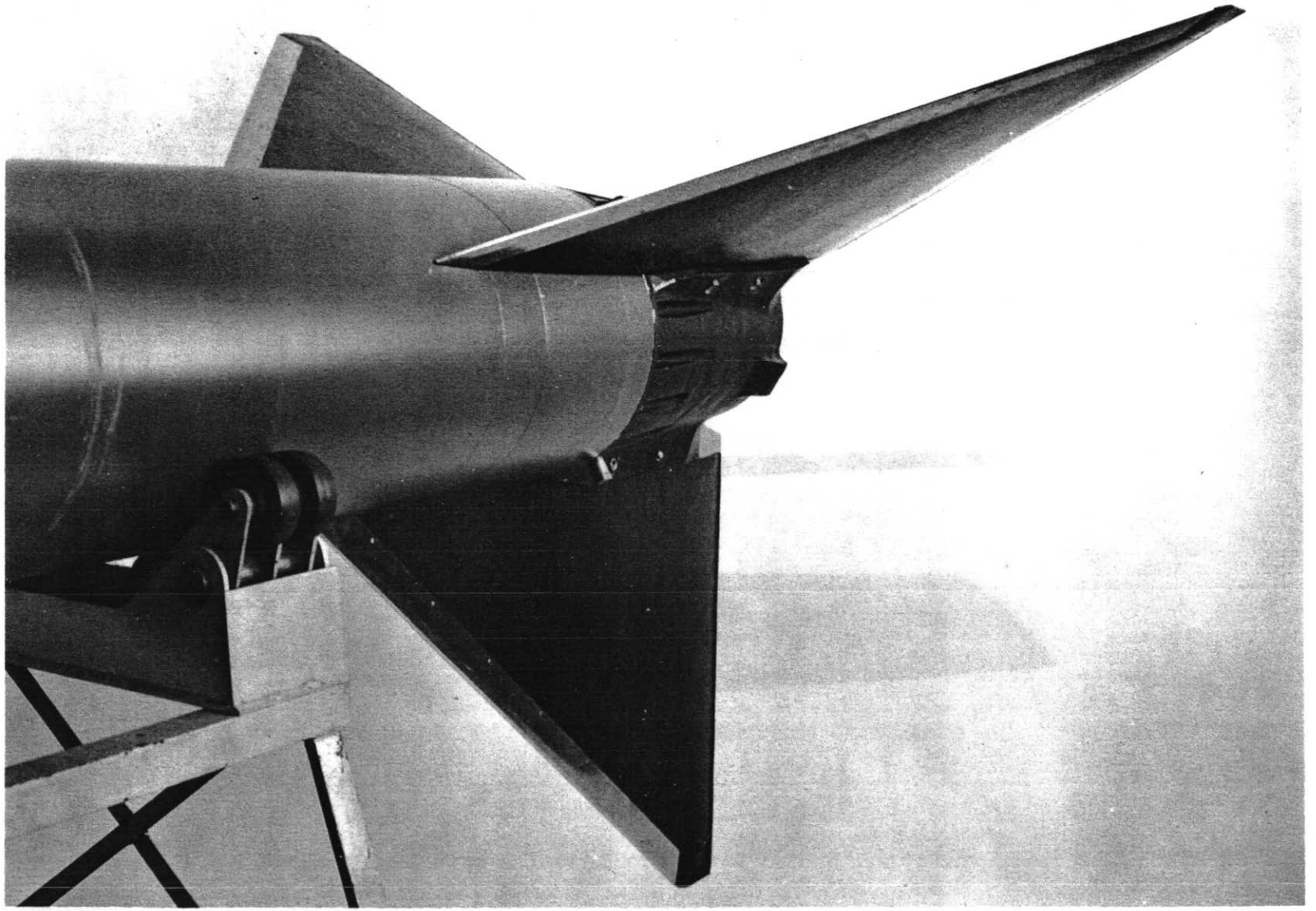


FLIGHT NOZZLE OF 15KS 25000 BLACK BRANT I ENGINE
FIGURE 5 C



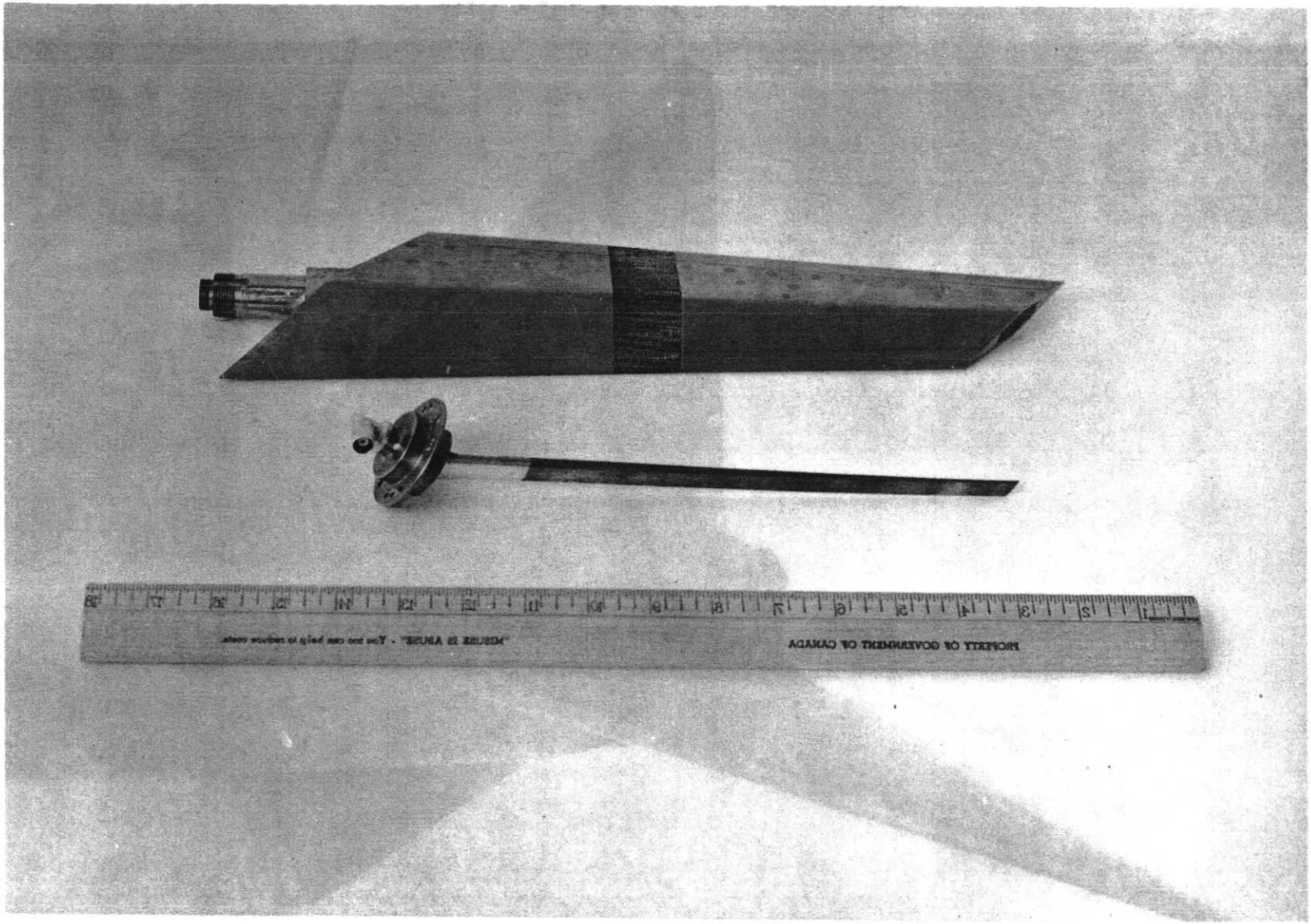
Black Brant I fin assembly.

Figure 6A



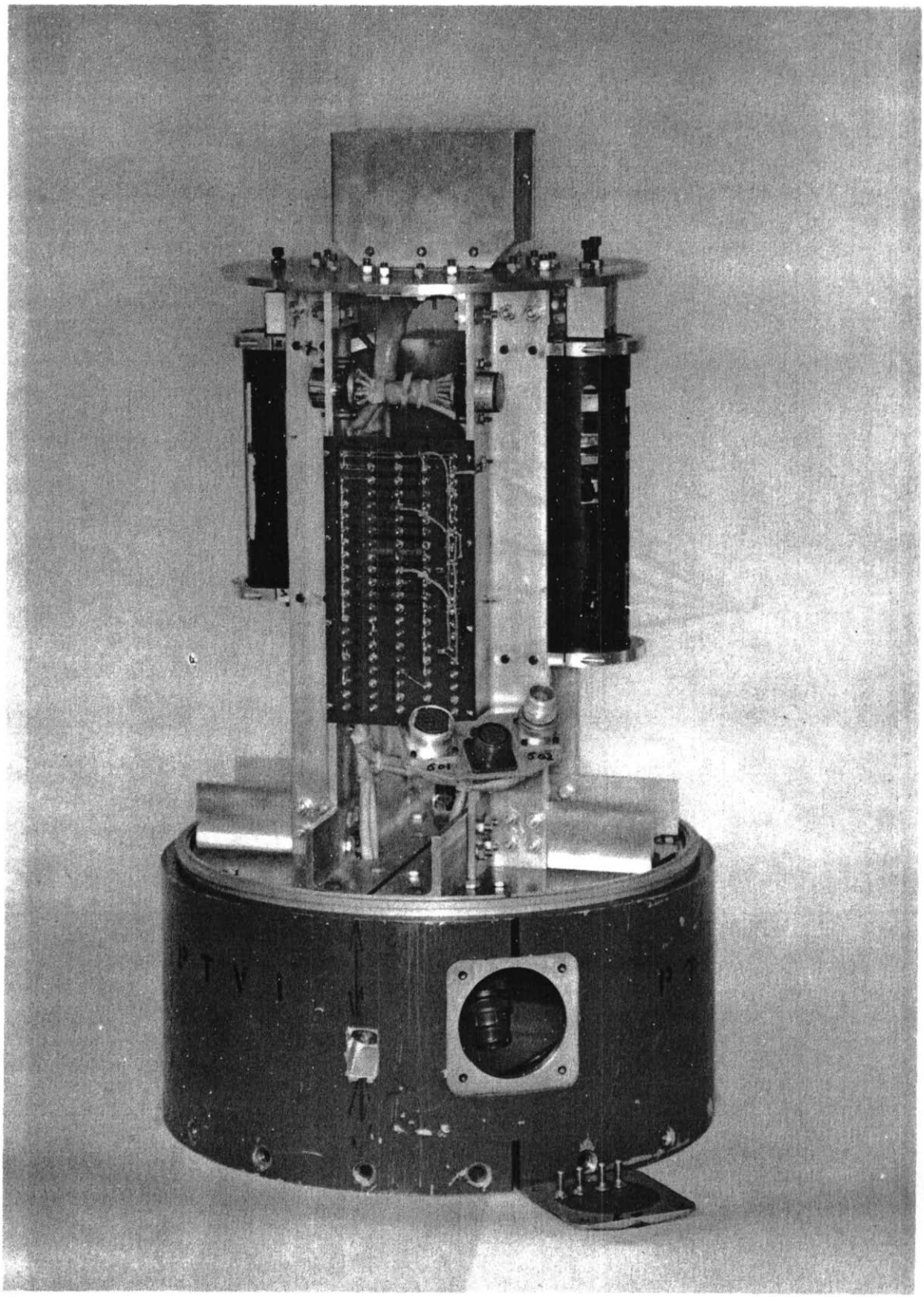
Black Brant I engine and fin assembly.

Figure 6B



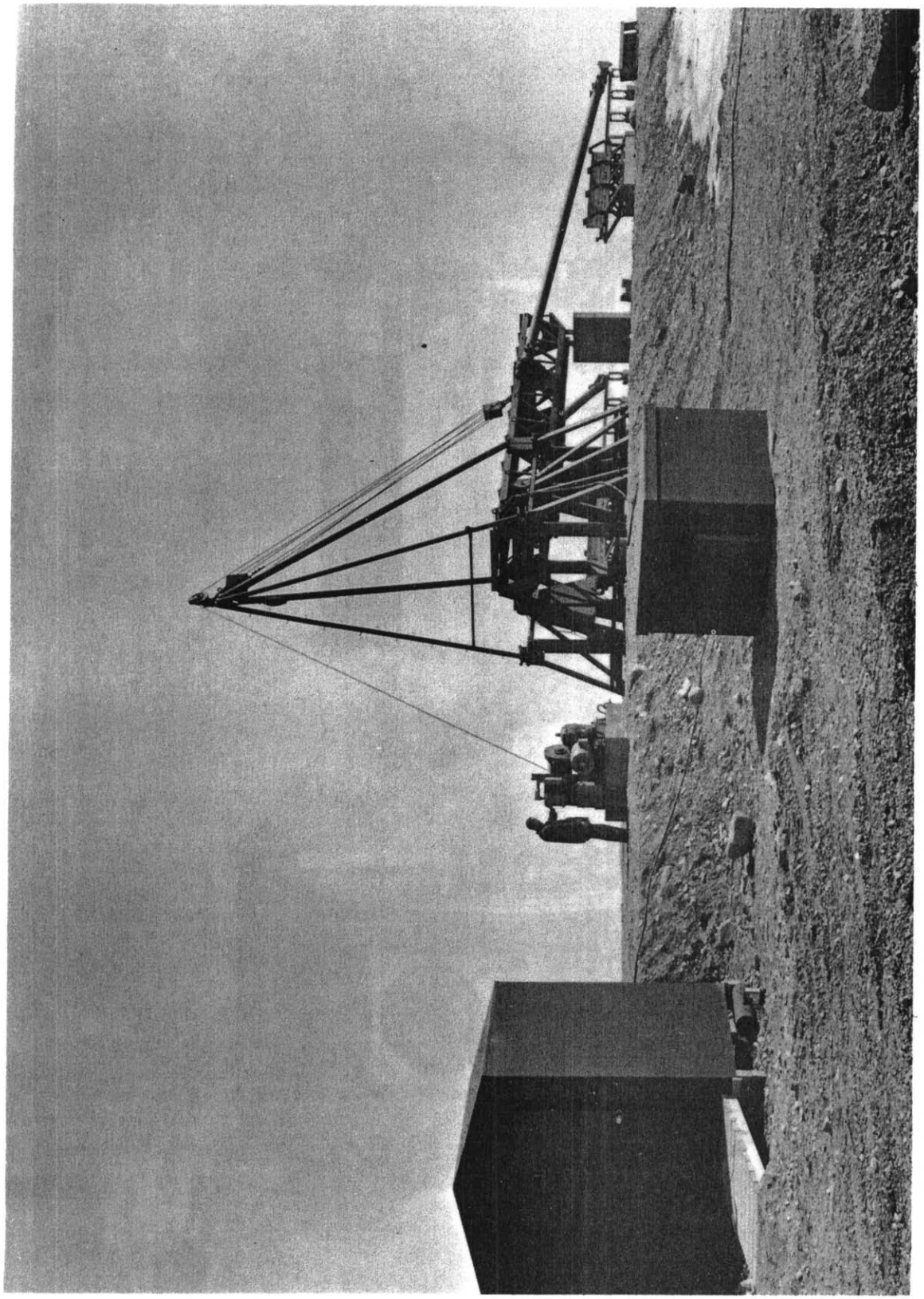
Black Brant I telemetry antennas.

Figure 7



Black Brant I instrumentation.

Figure 8

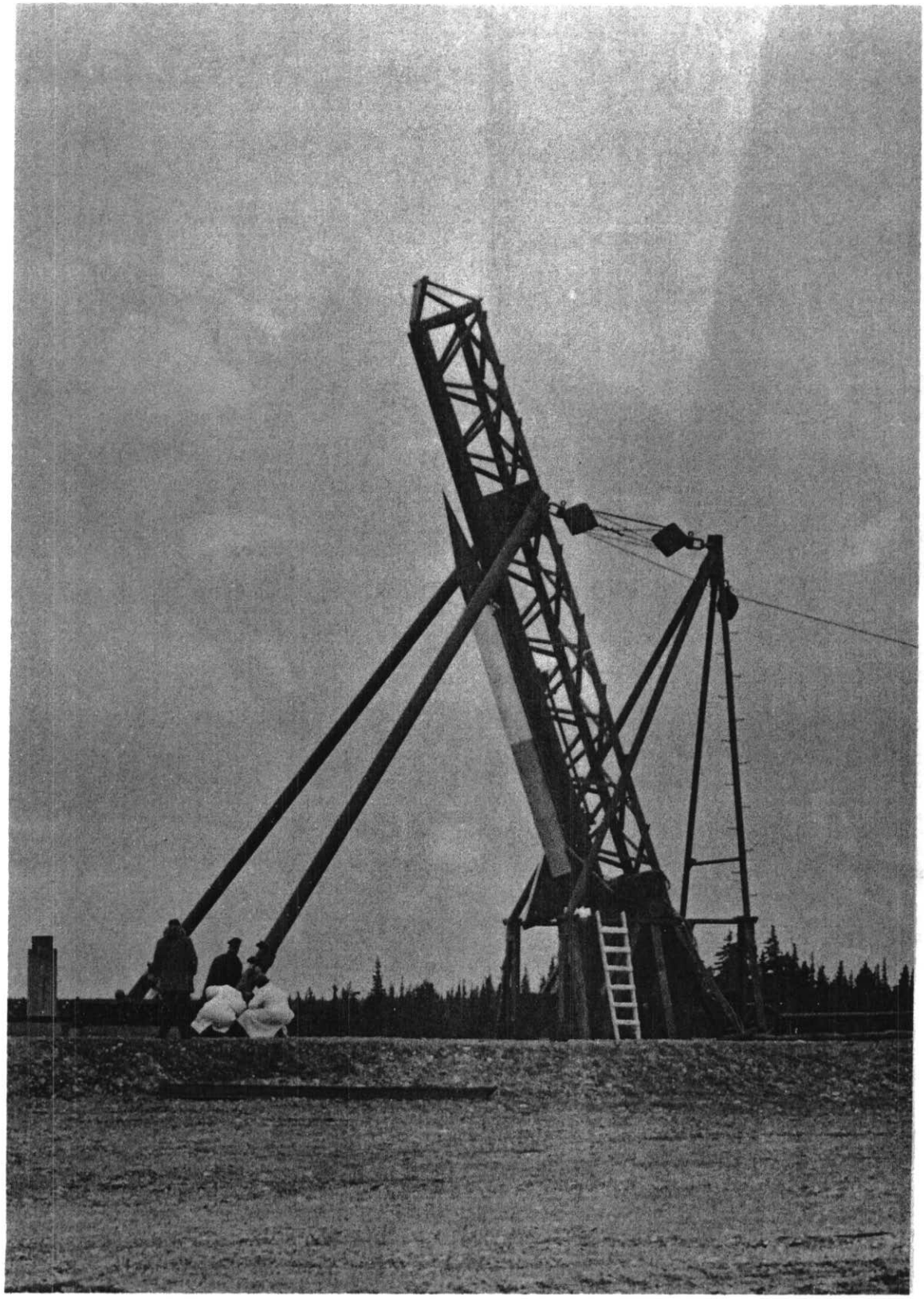


Black Brant launcher.

Figure 9

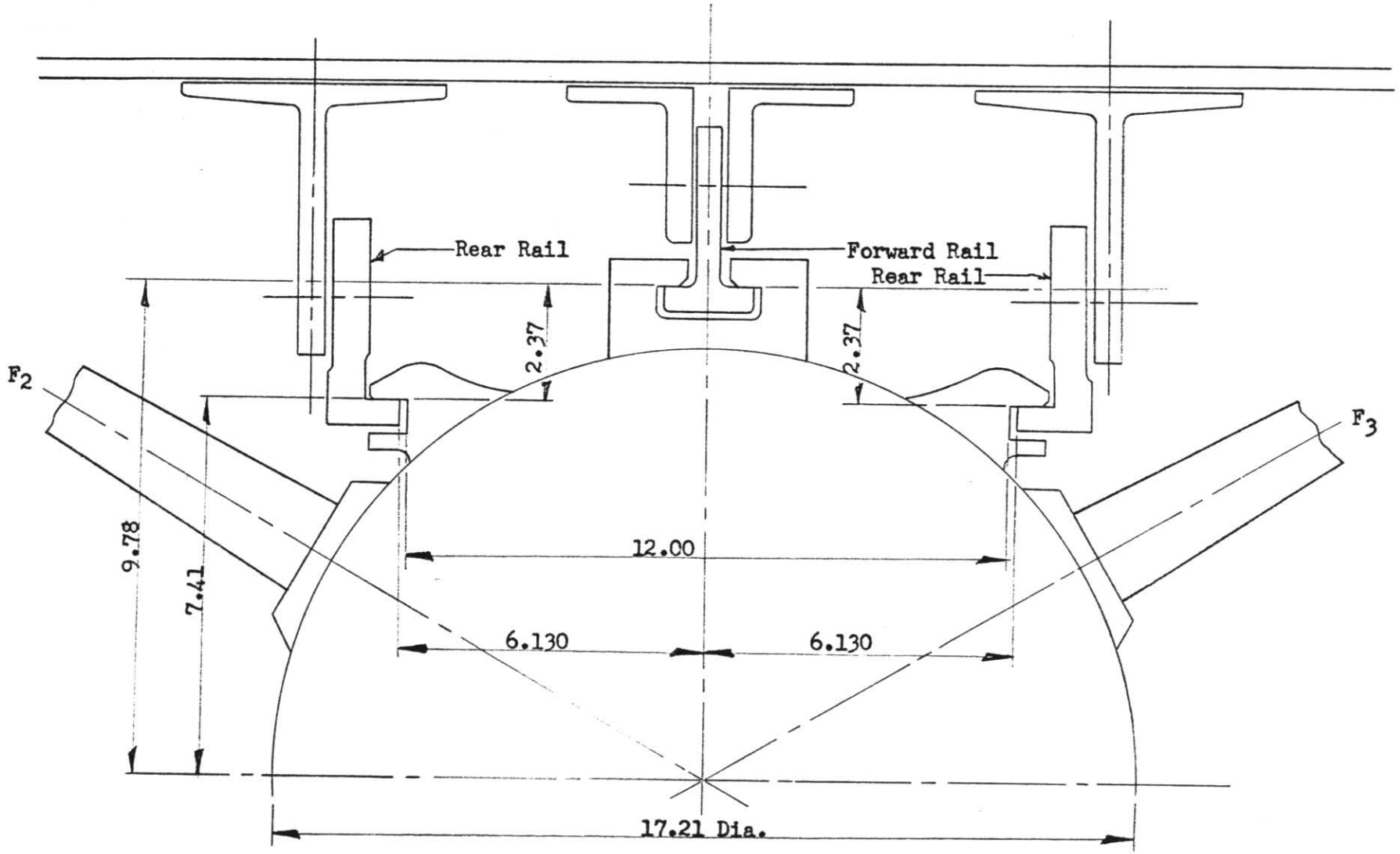
Installation of Black Brant I on the launcher.

Figure 10



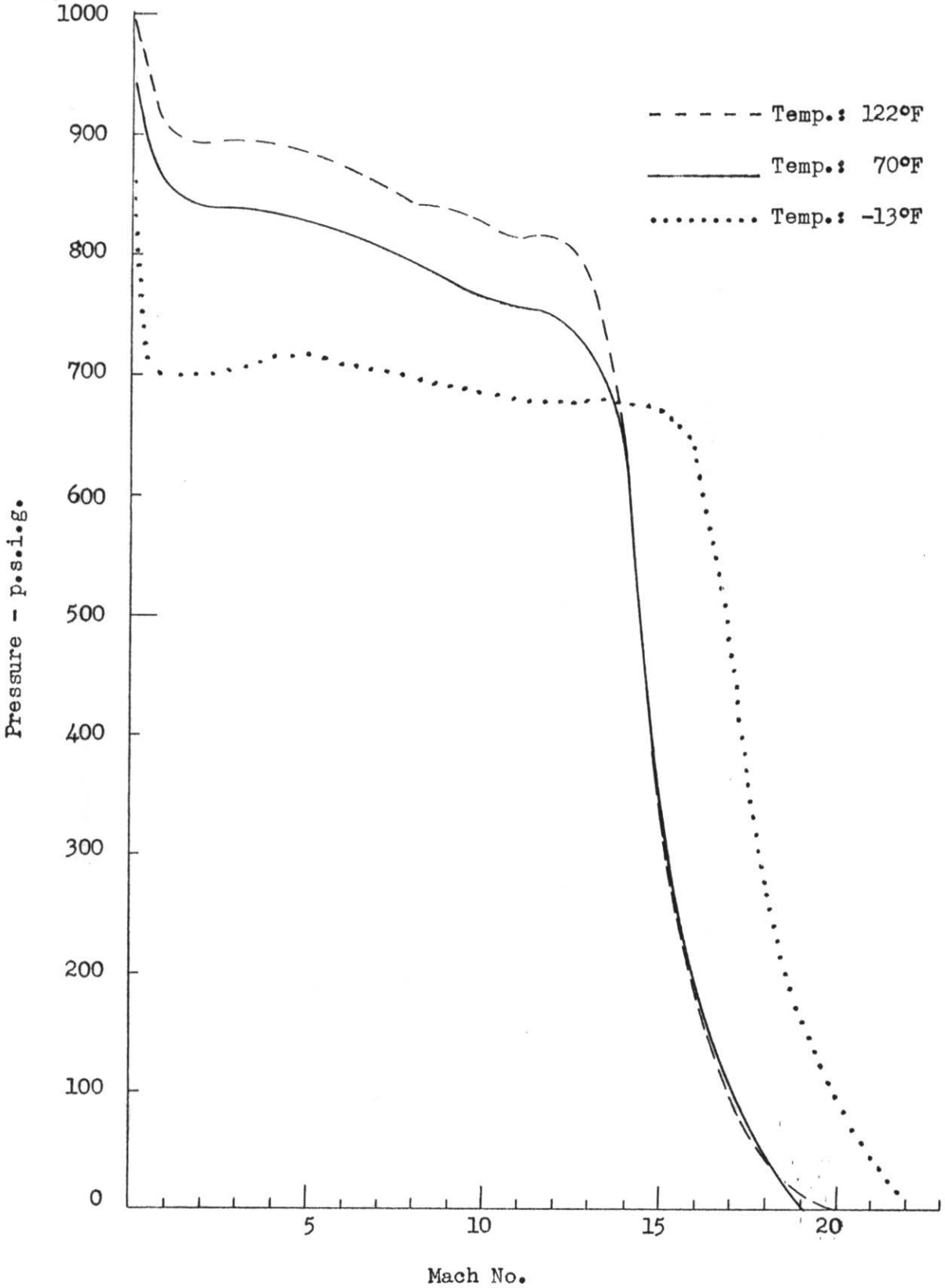
Black Brant launcher in elevated position.

Figure 11



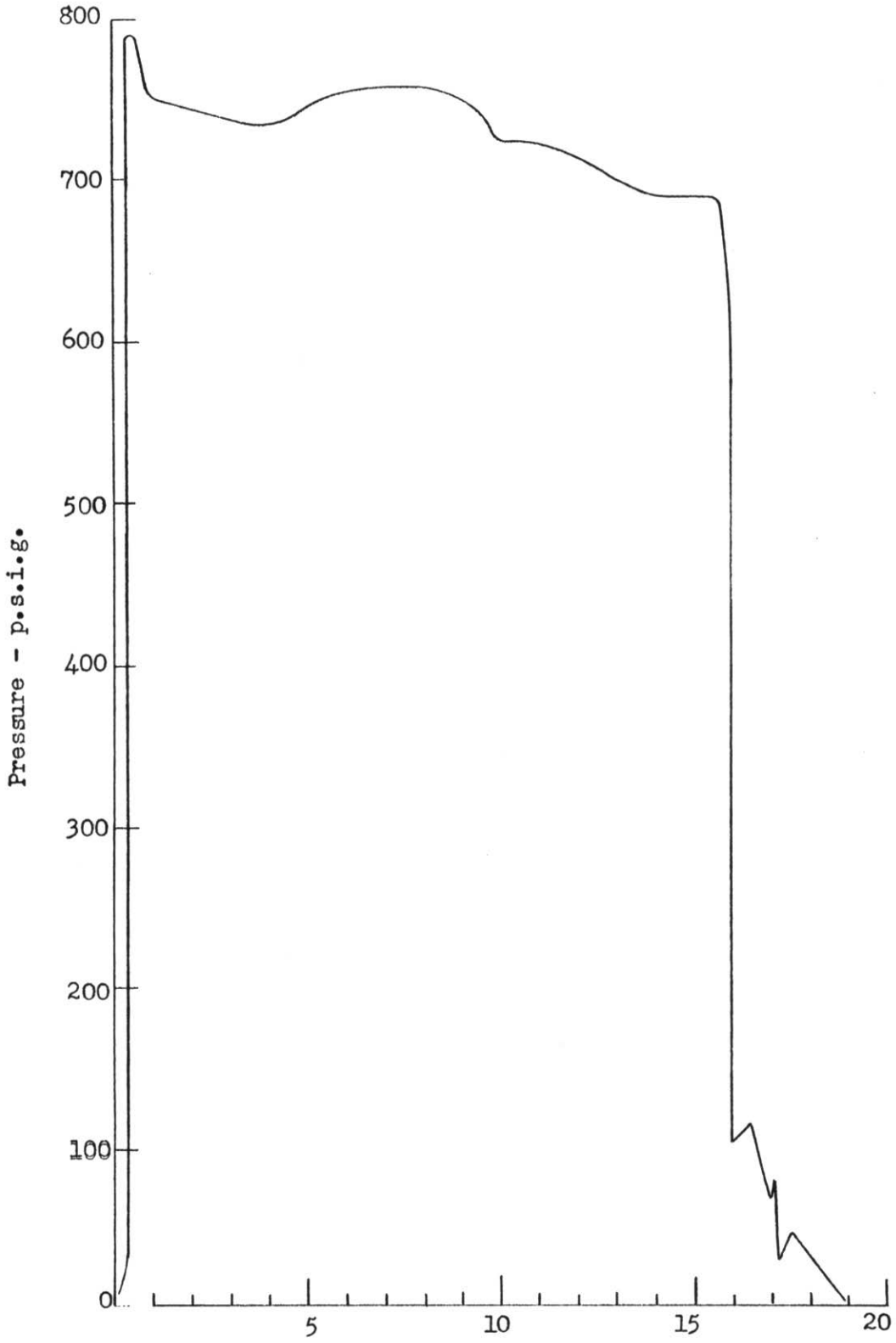
End view arrangement of launching rails.

Figure 12



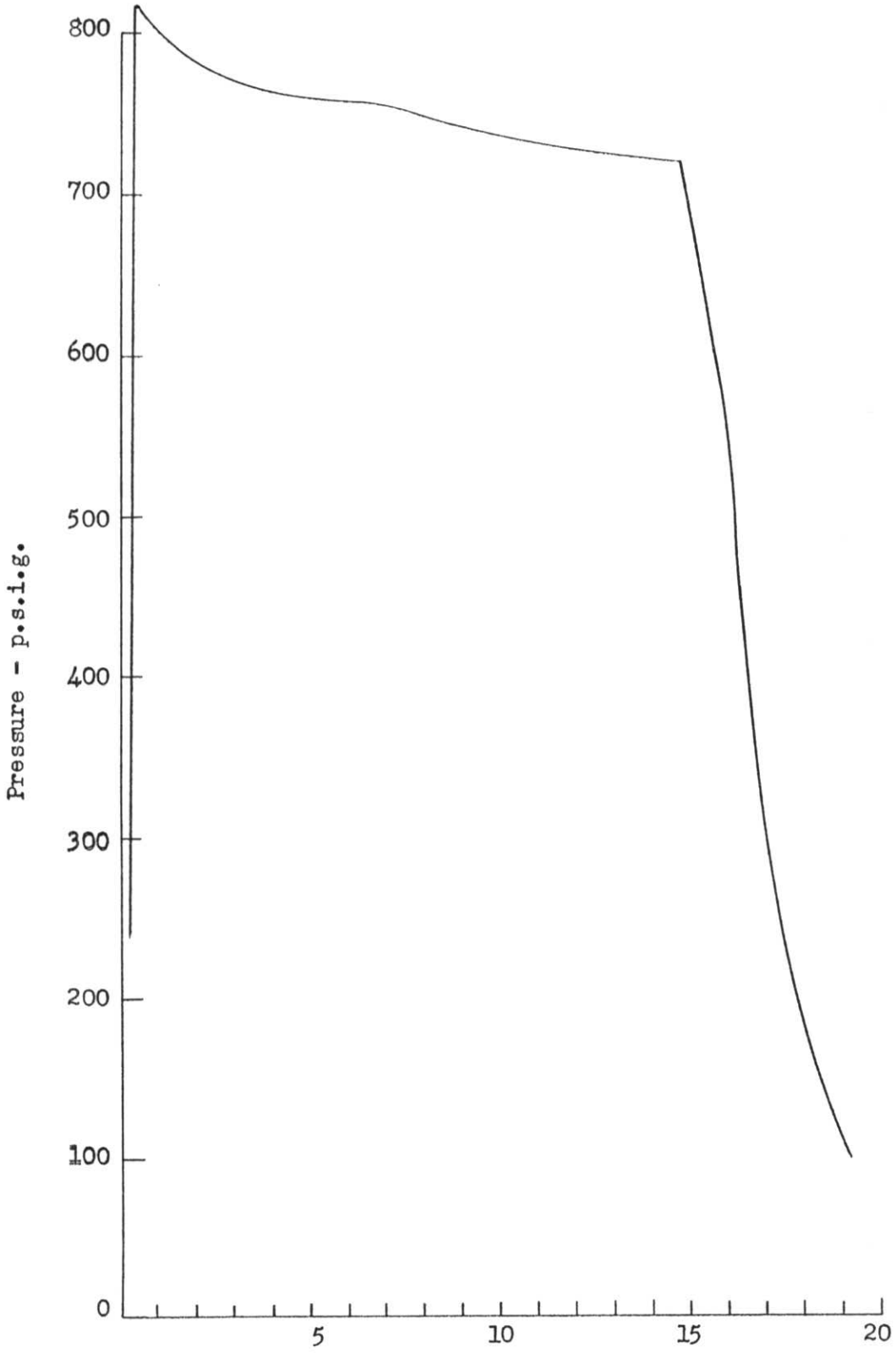
Temperature effect on sea-level pressure-time curves for Black Brant I engine.

Figure 13A



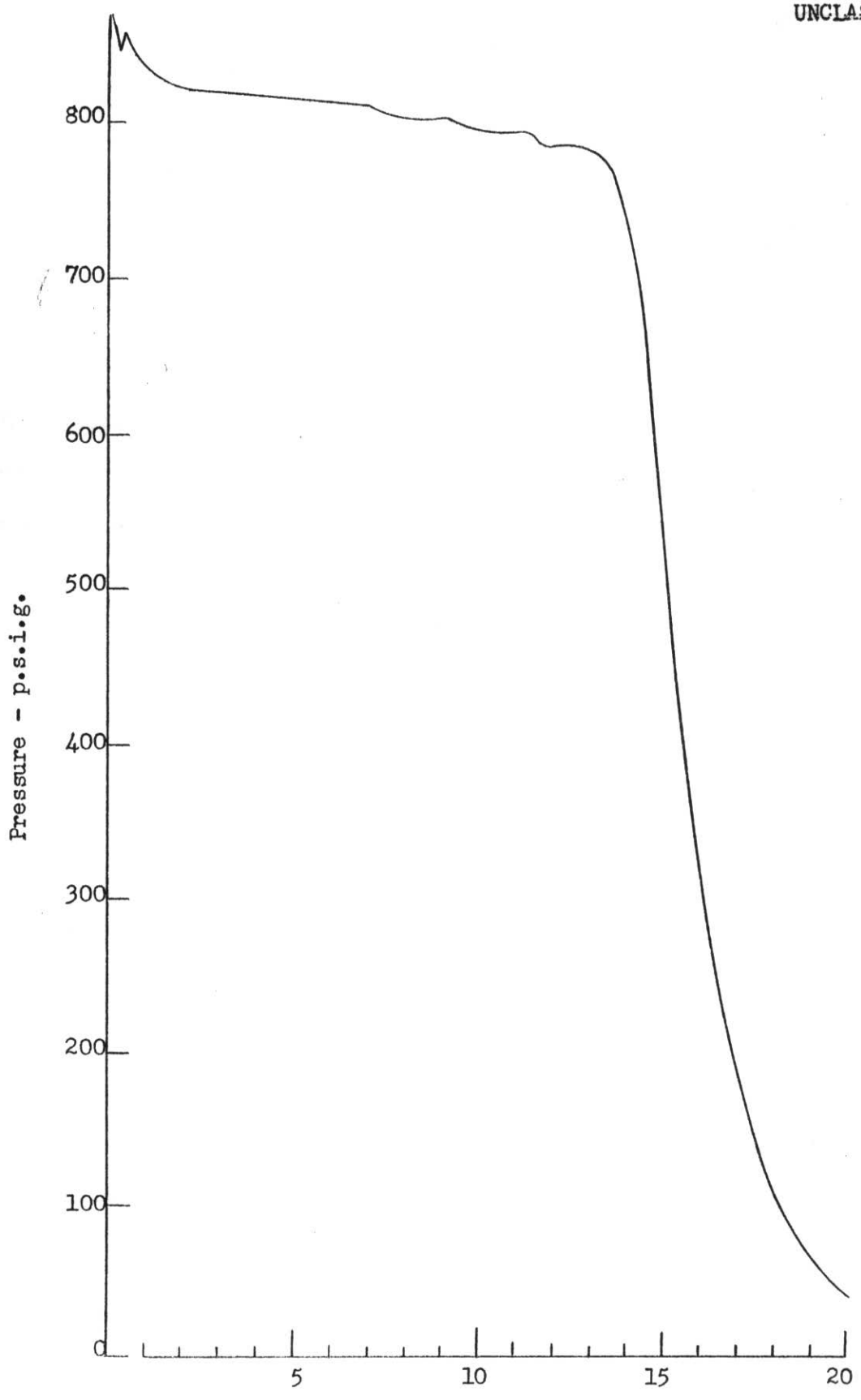
Measured pressure-time curve BB I - 05.

Figure 13B



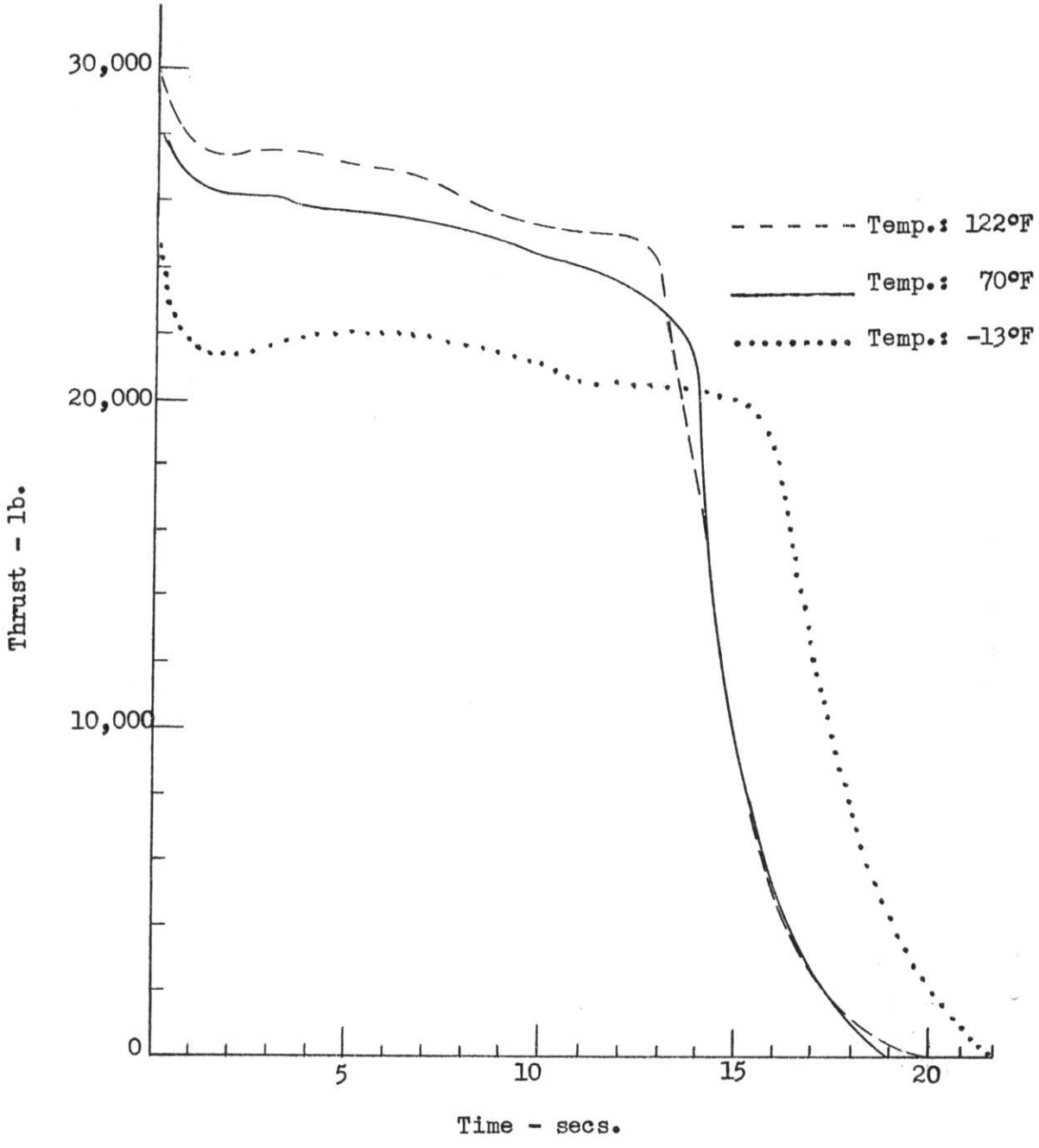
Measured pressure-time curve BB I - 06.

Figure 13C



Measured pressure-time curve BB I - 07.

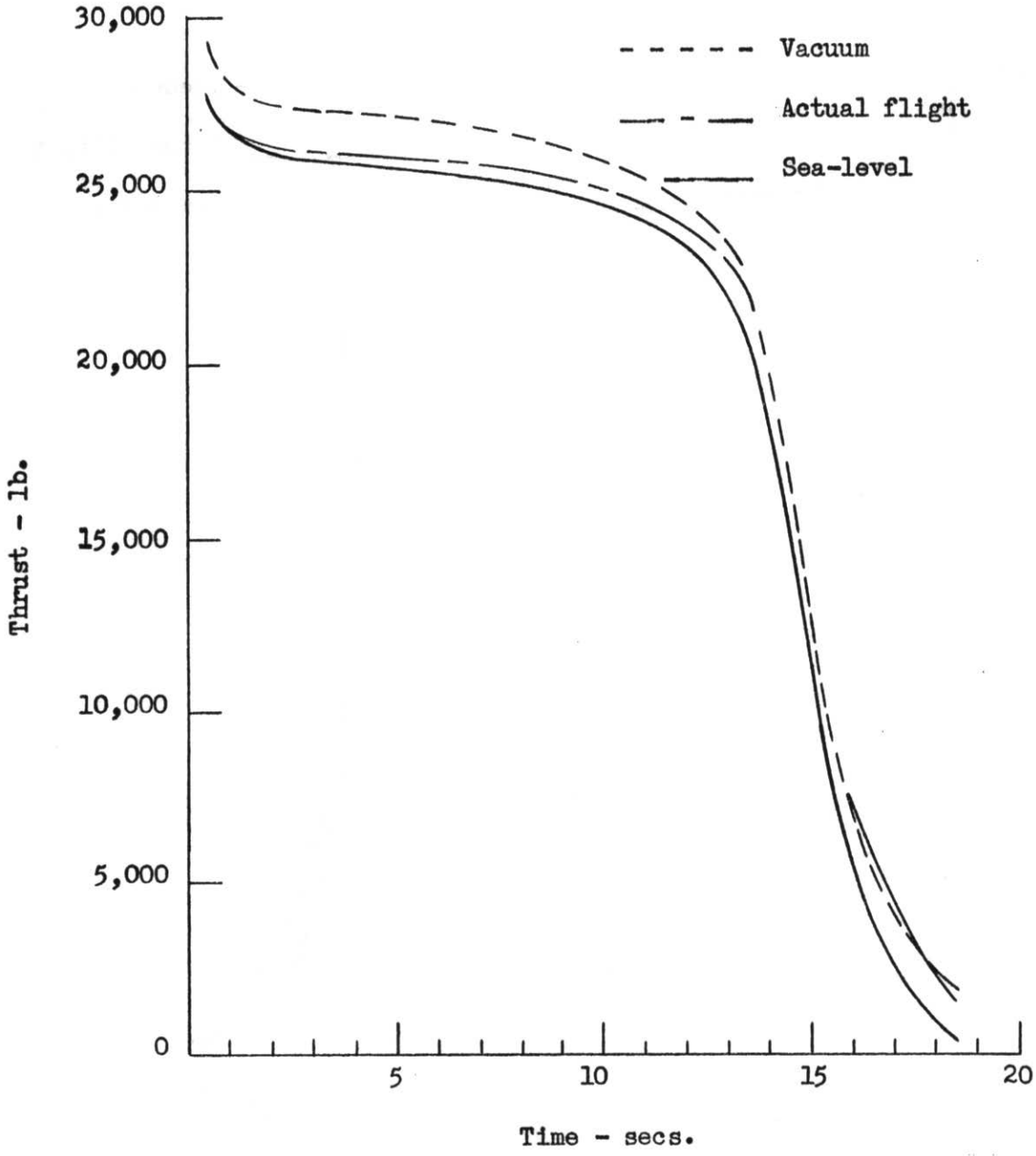
Figure 13D



Temperature effect on sea-level thrust-time curves for Black Brant I engine.

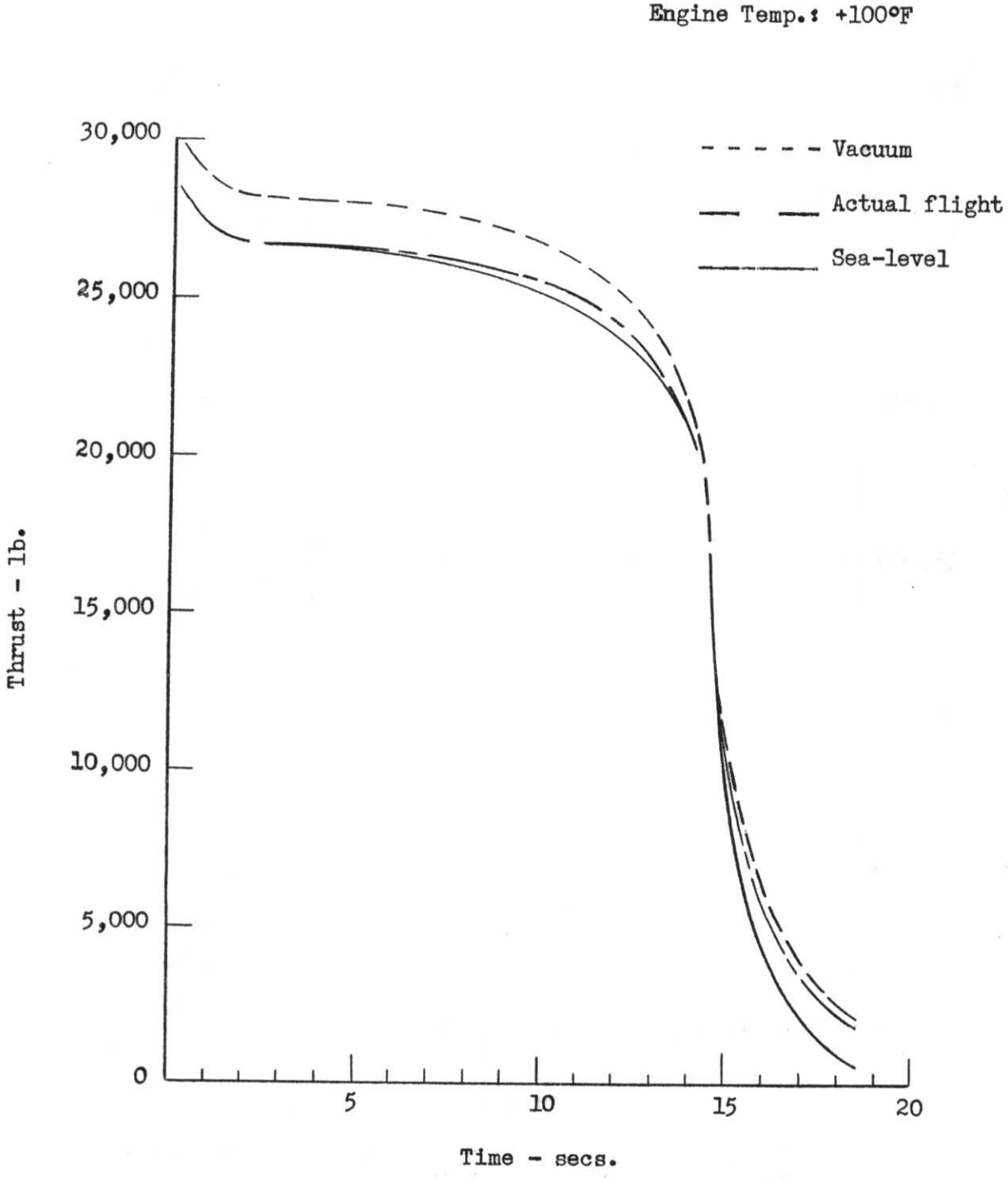
Figure 14A

Engine Temp.: +73°F



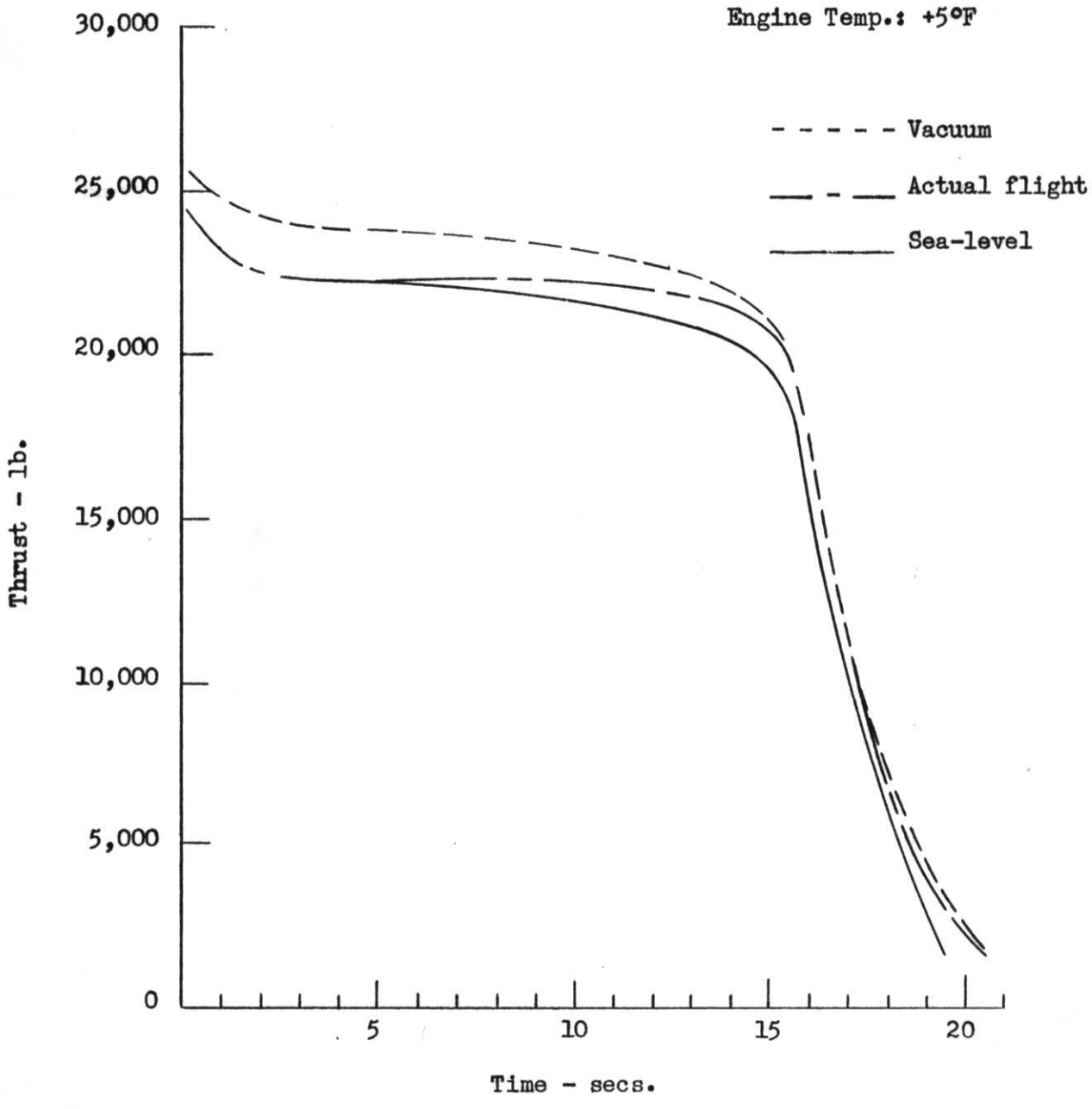
Sea-level, vacuum and flight thrust-time curves for 01.
BB I - (01 and 02)

Figure 14B



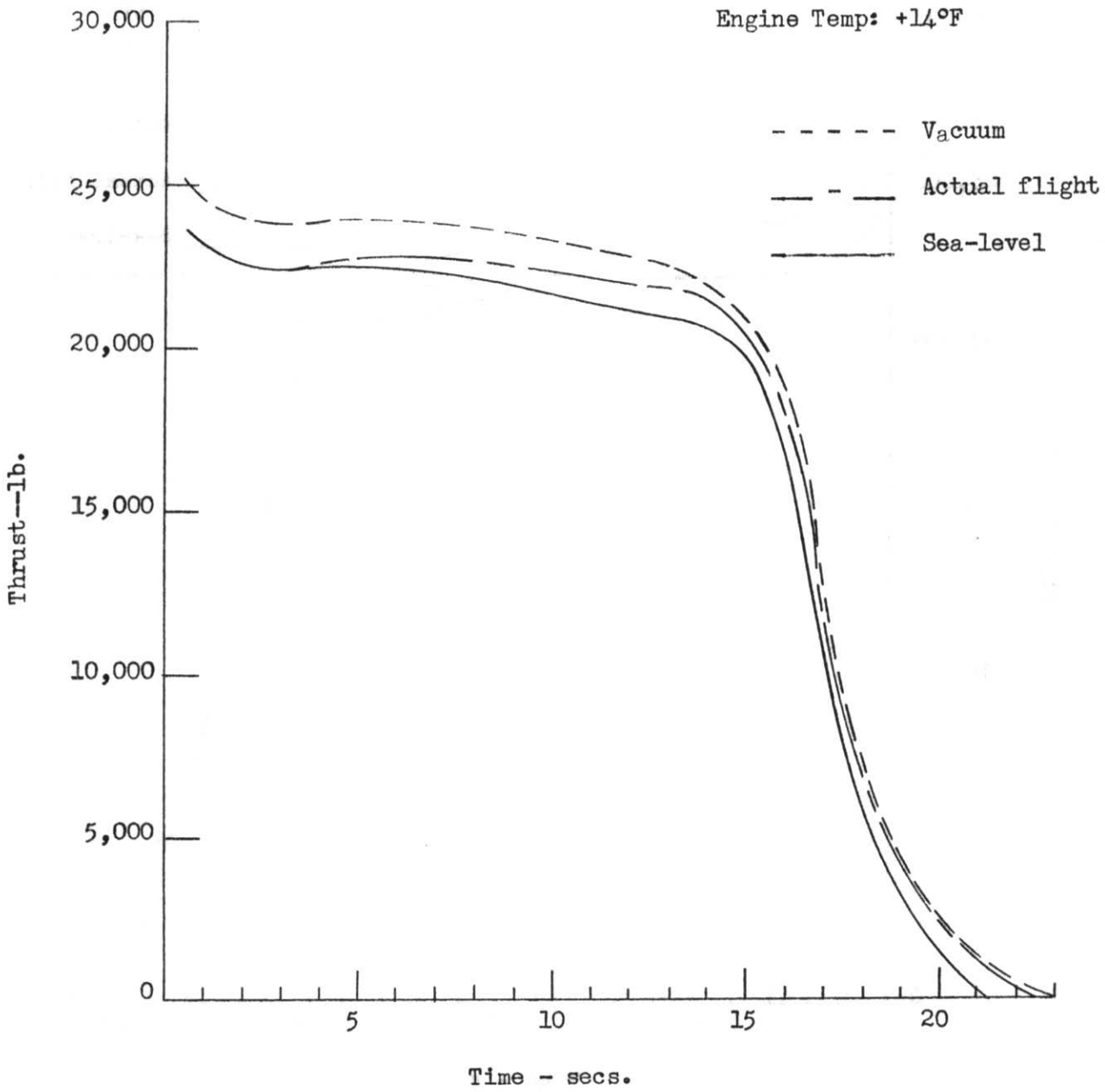
Sea-level, vacuum and flight thrust-time curves for 03.
BB I - (03 and 04)

Figure 14C



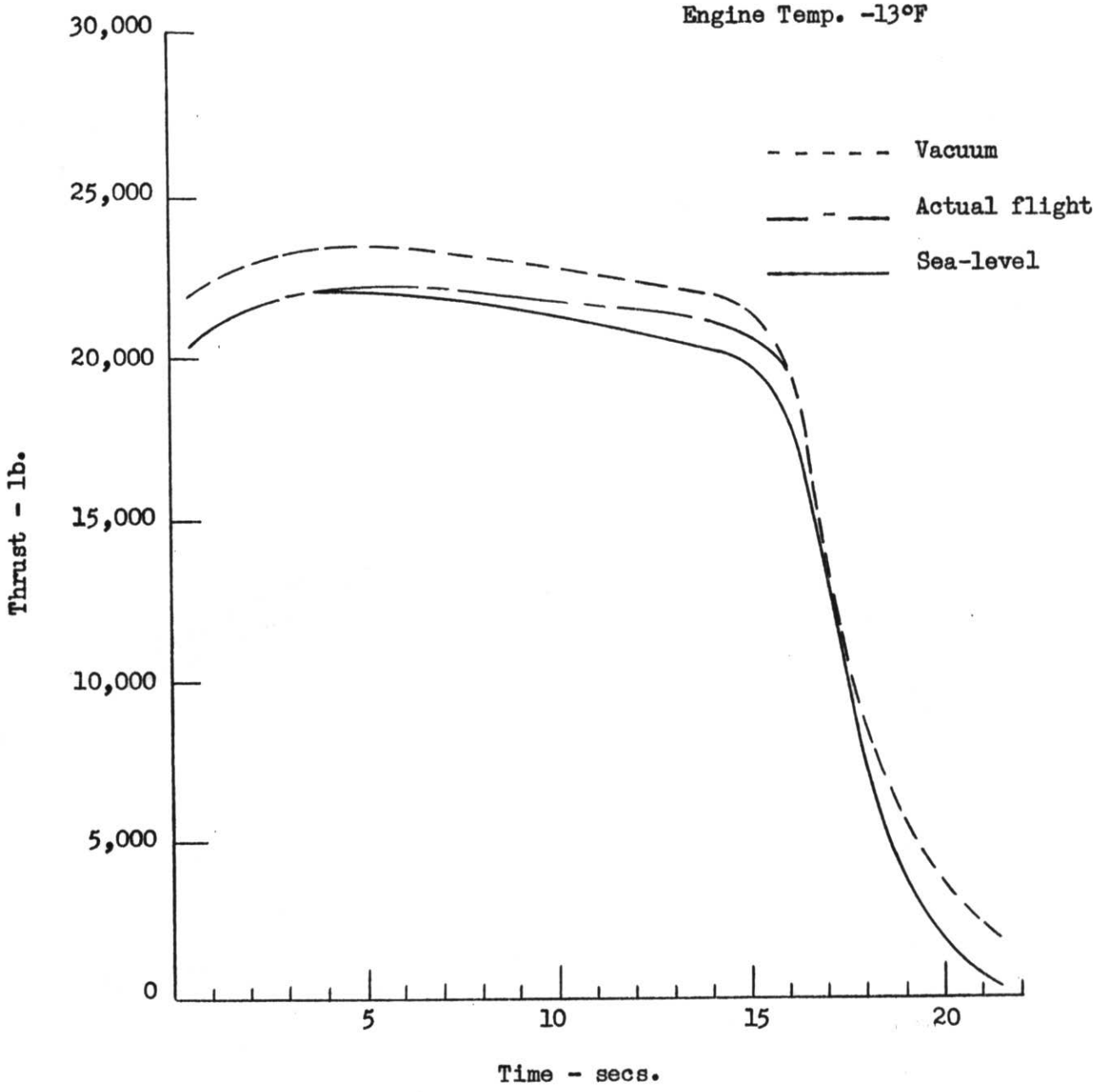
Sea-level, vacuum and flight thrust-time curves for BB I - 05.

Figure 14D



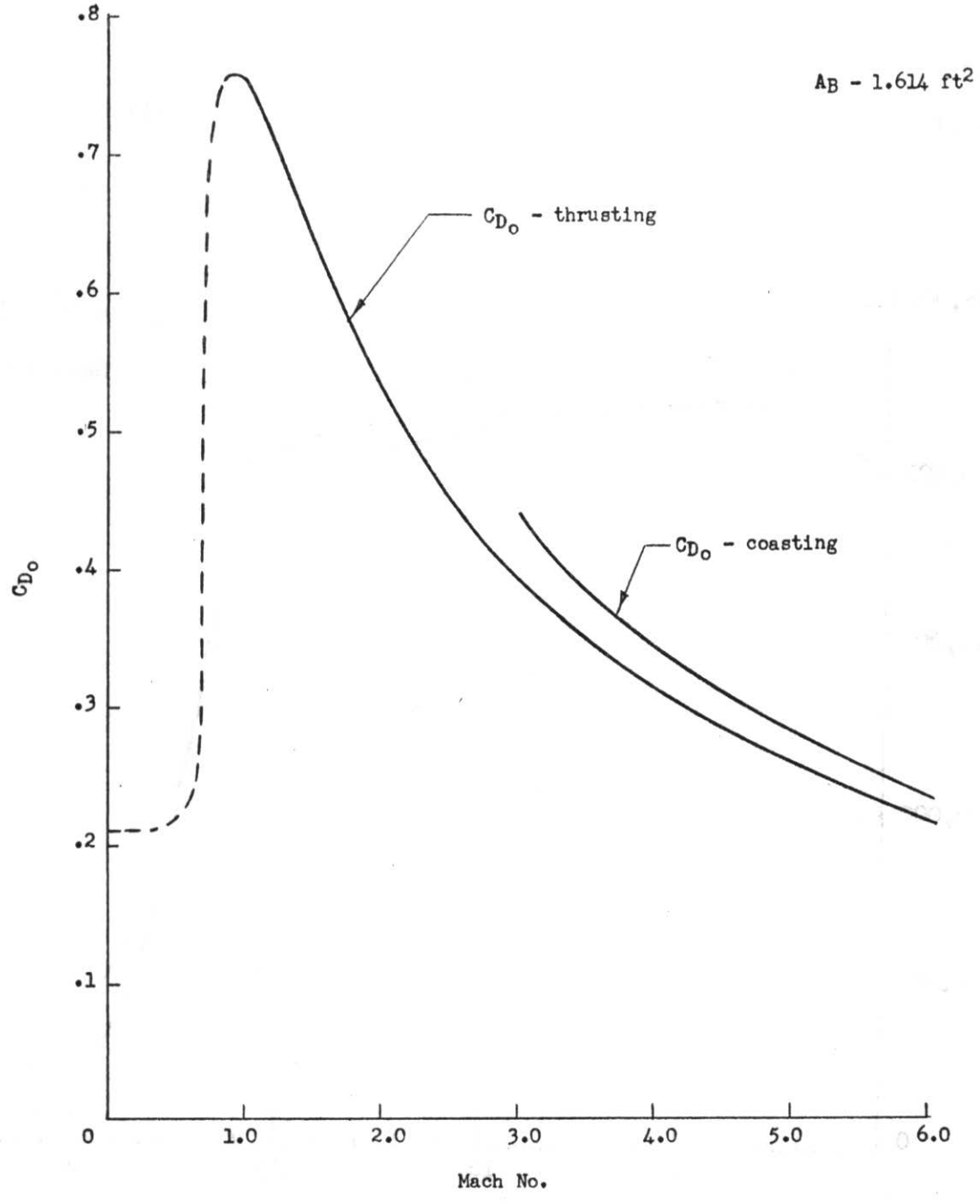
Sea-level, vacuum and flight thrust-time curves for BB I - 06.

Figure 14E



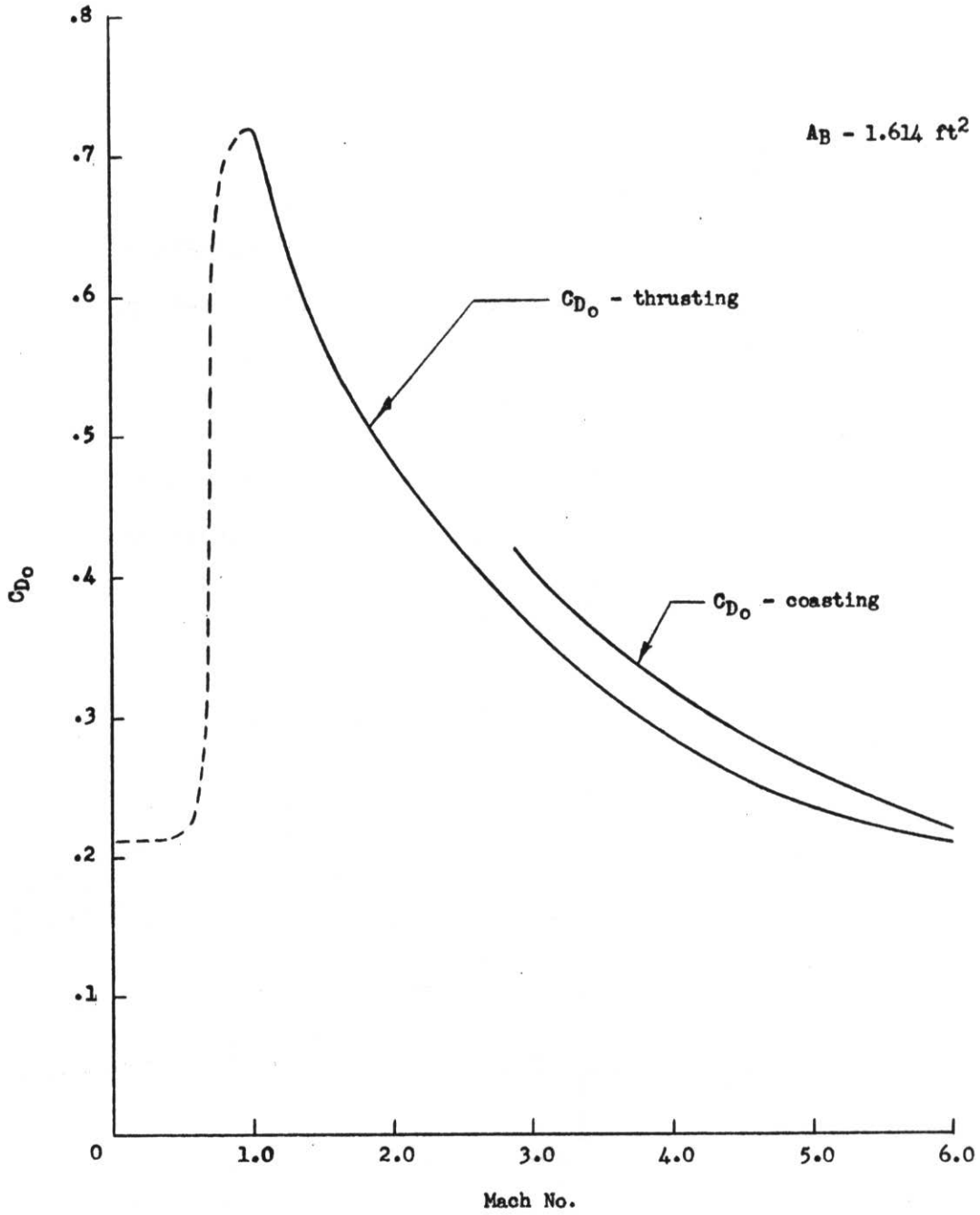
Sea-level, vacuum and flight thrust-time curves for BB I - 07.

Figure 14F



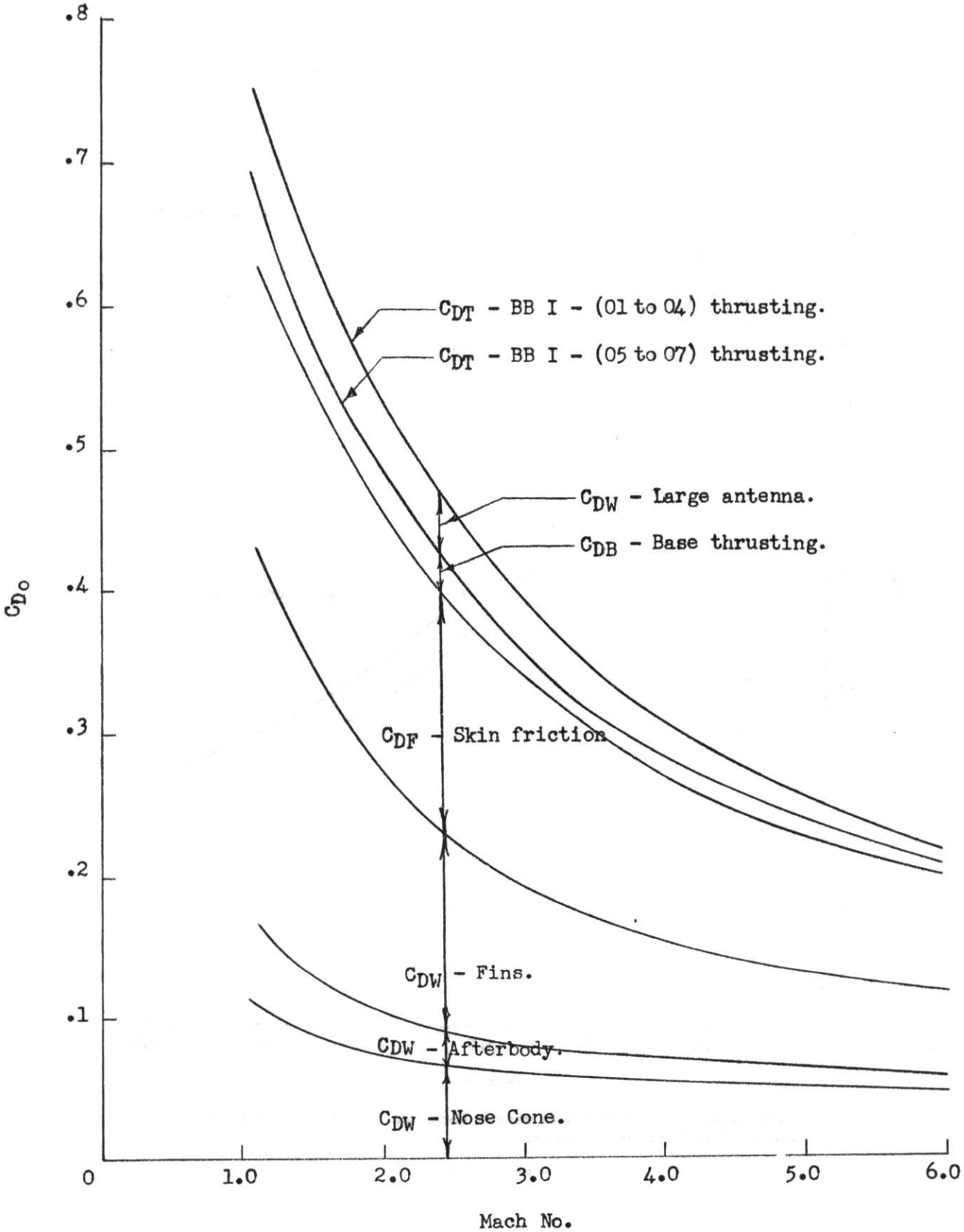
Calculated drag coefficient versus Mach No. for BB I - (01 to 04), rocket thrusting and coasting.

Figure 15A



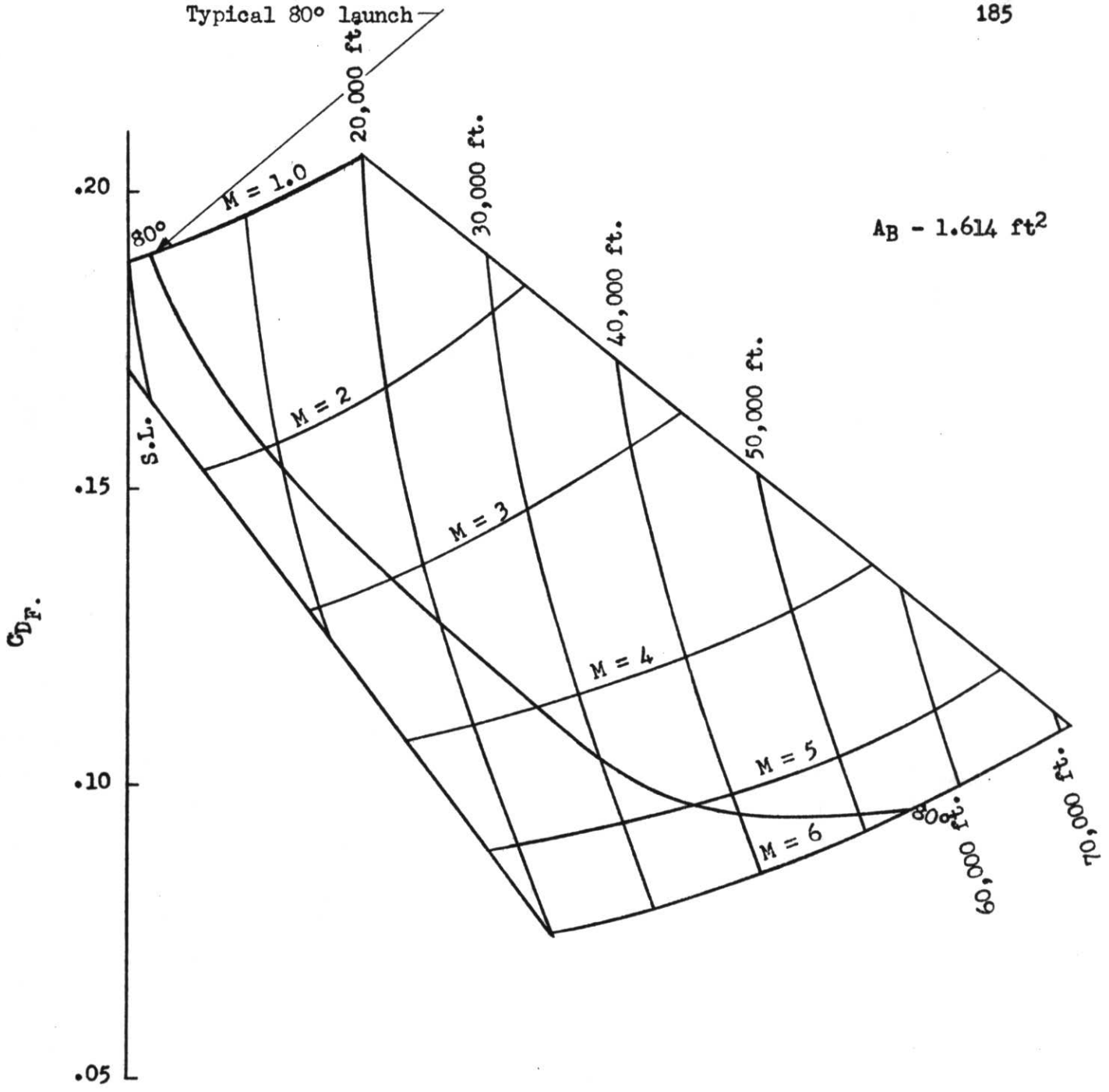
Calculated drag coefficient versus Mach No. for BB I - (05 to 07), rocket thrusting and coasting.

Figure 15B



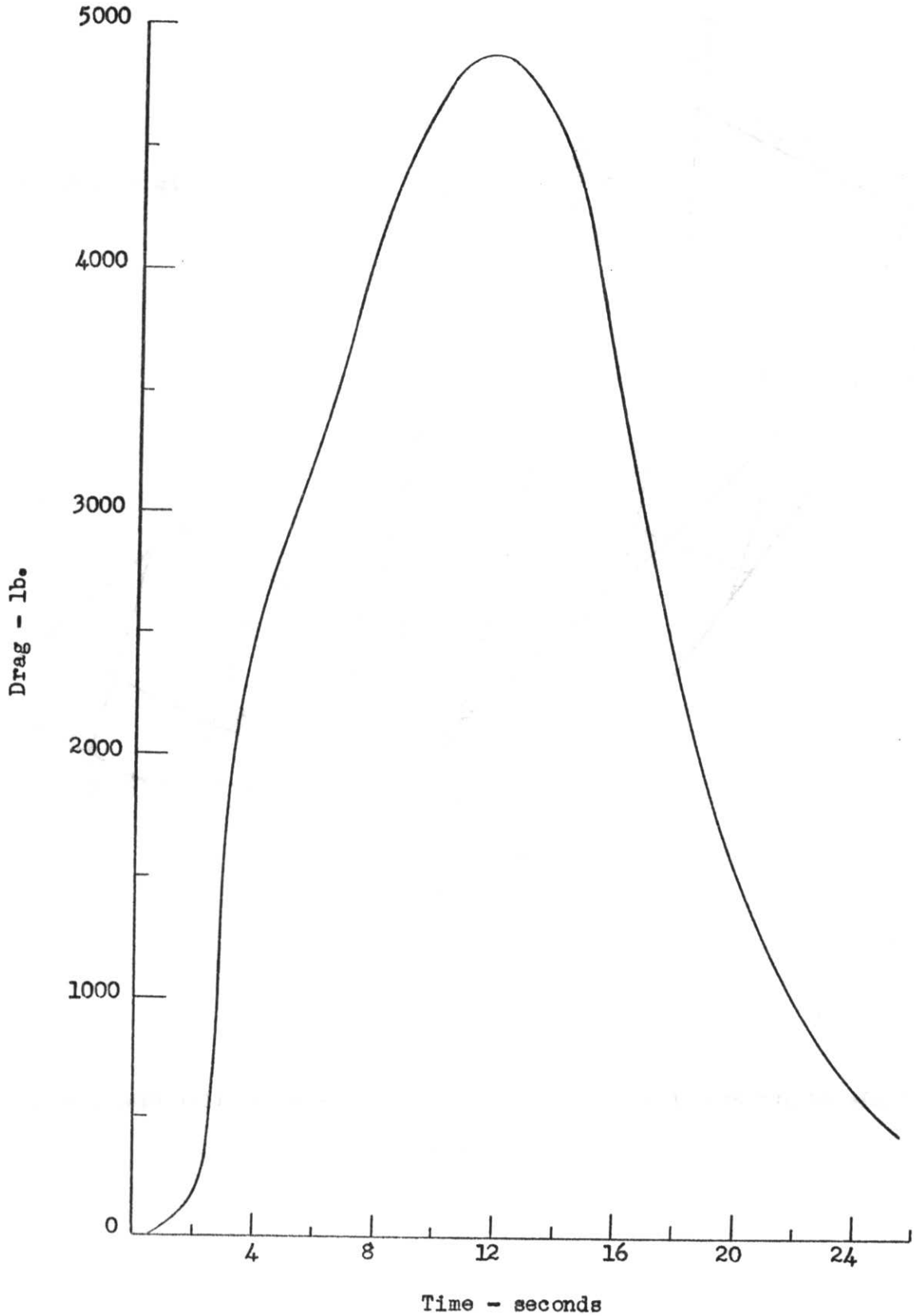
Breakdown of drag coefficients versus Mach No.

Figure 15C



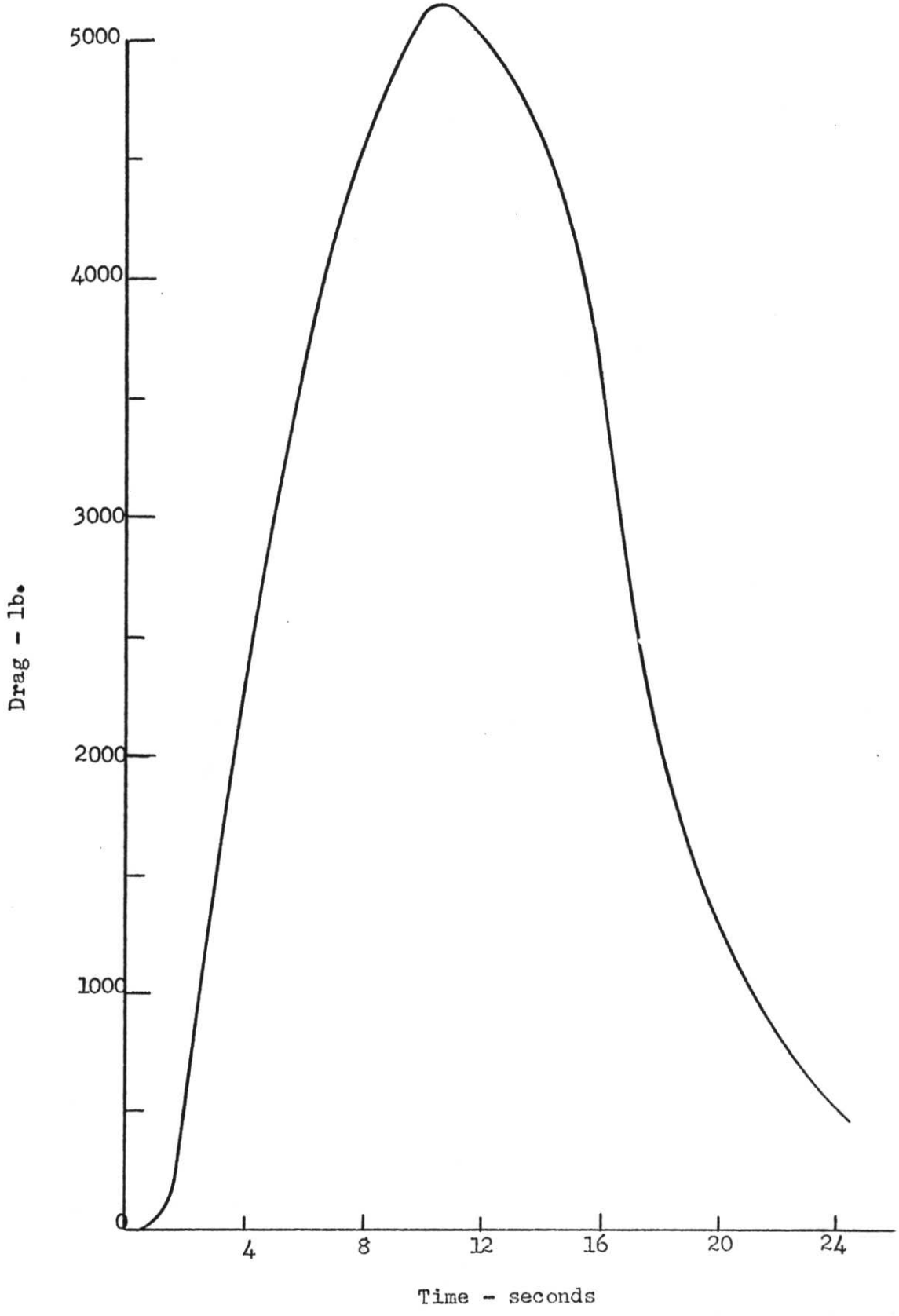
Calculated effects of altitude and Mach No. on skin friction drag coefficient.

Figure 15D



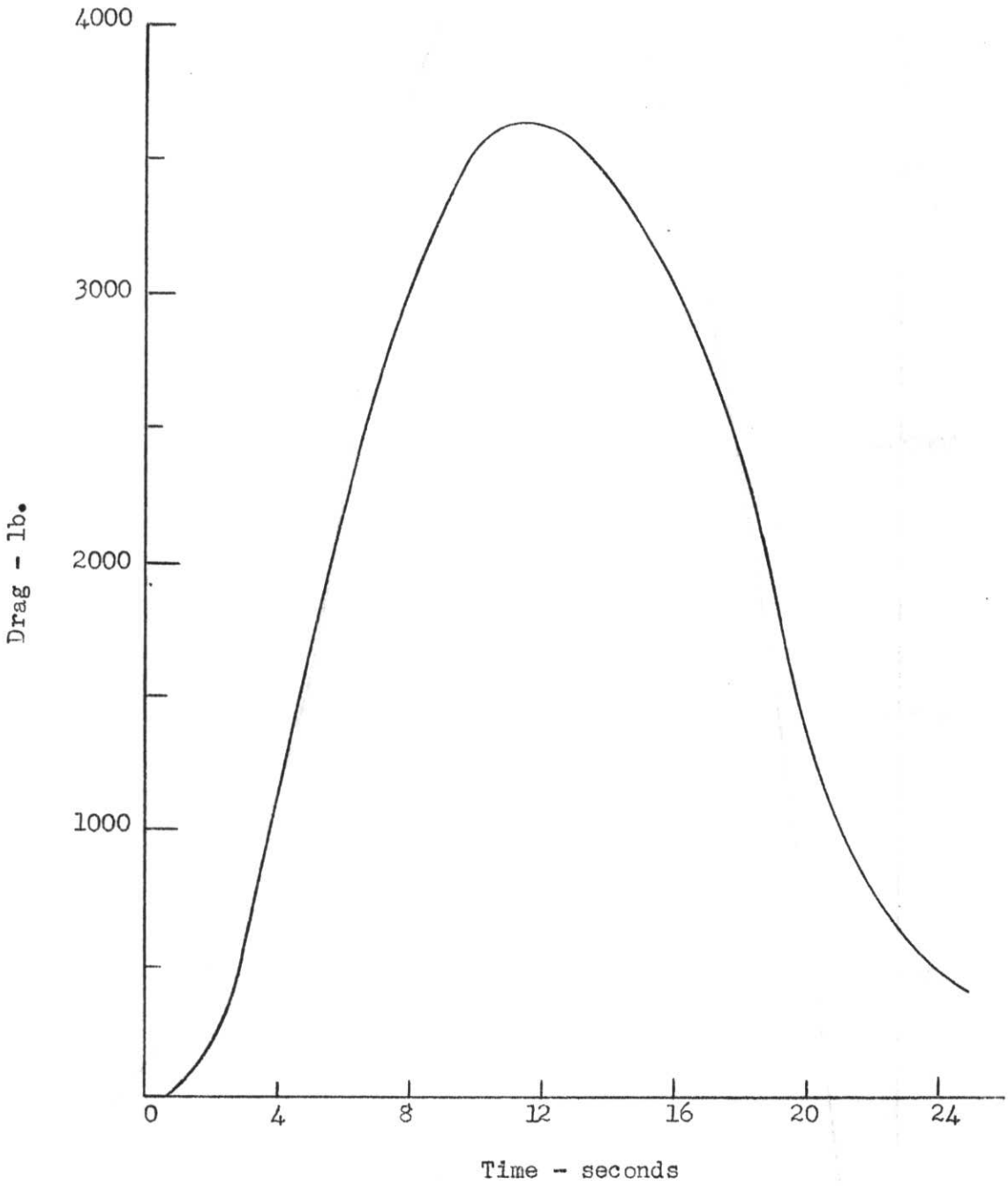
Calculated variation of drag versus time for BB I - (01 and 02)

Figure 16A



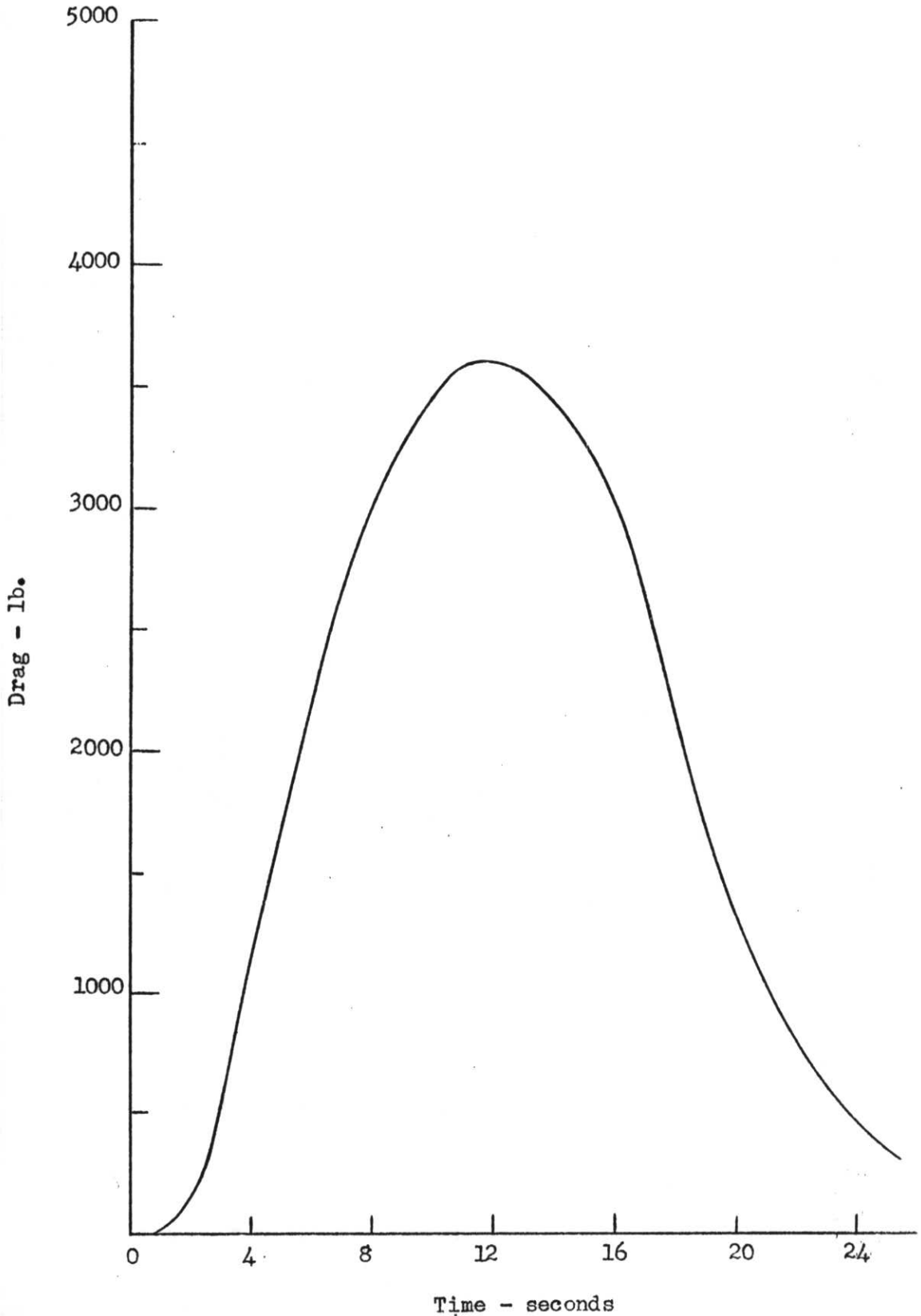
Calculated variation of drag versus time for BB I - (03 and 04)

Figure 16B



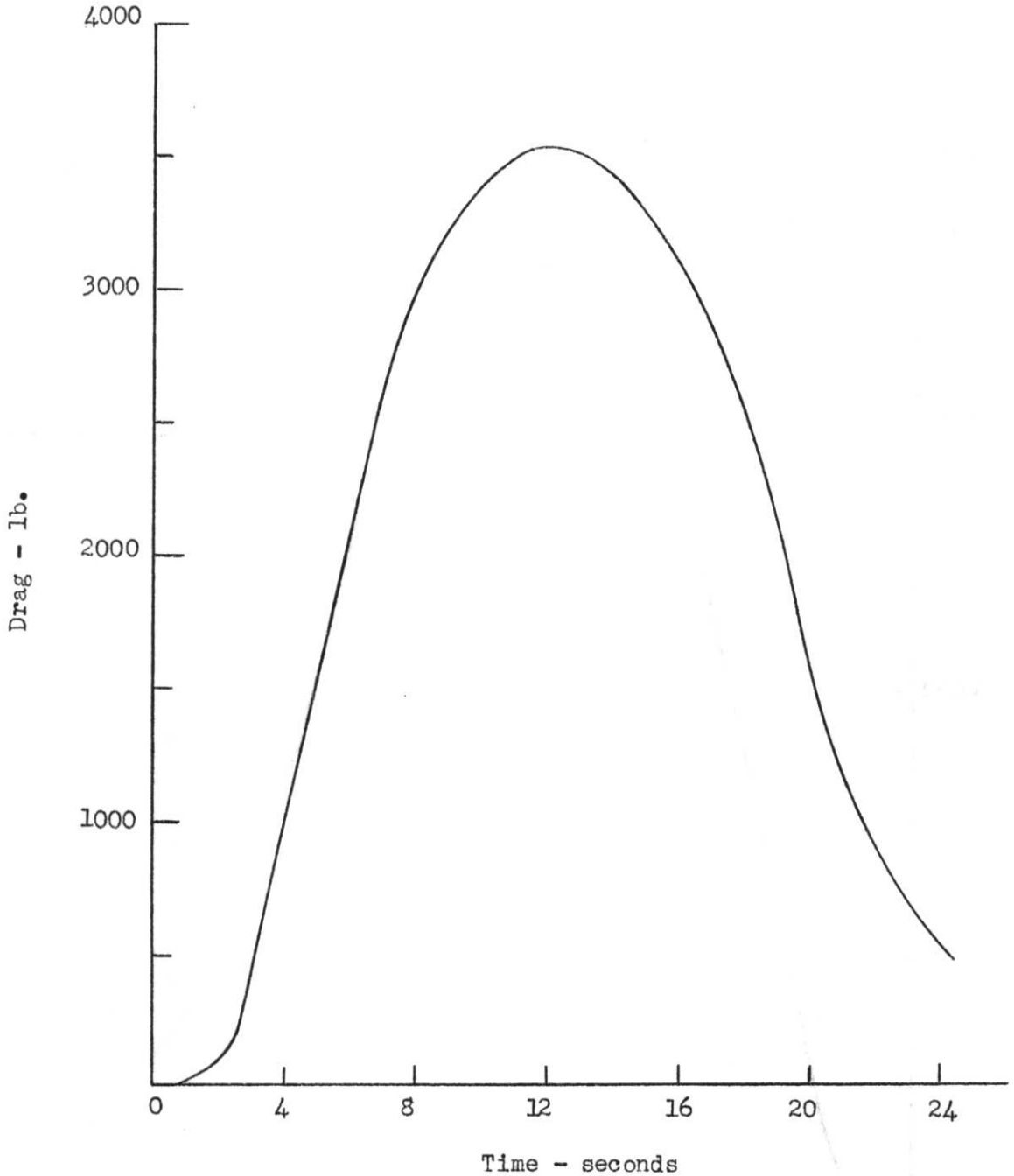
Calculated variation of drag versus time for BB I - 05.

Figure 16C



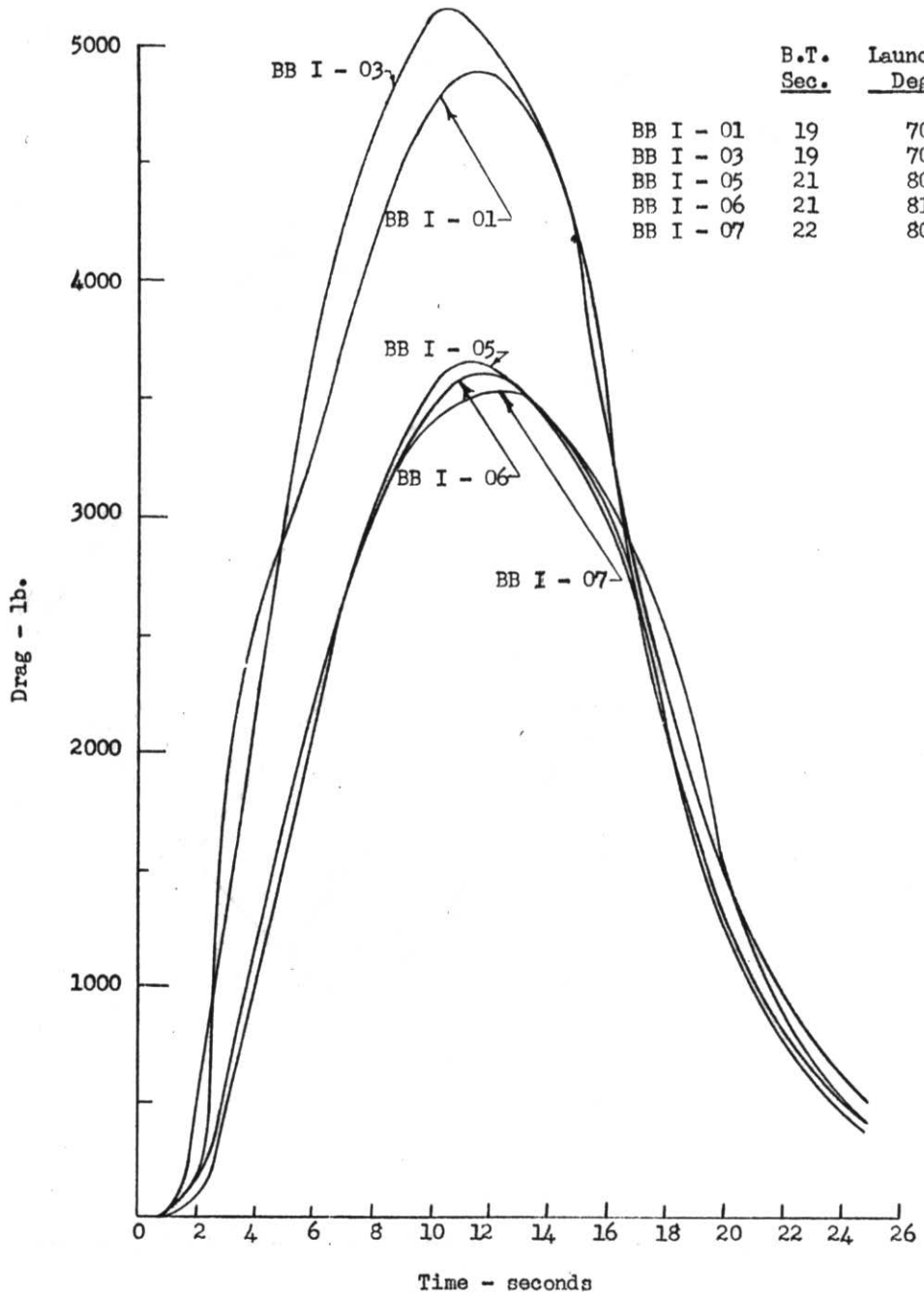
Calculated variation of drag versus time for BB I - 06.

Figure 16D



Calculated variation of drag versus time for BB I - 07.

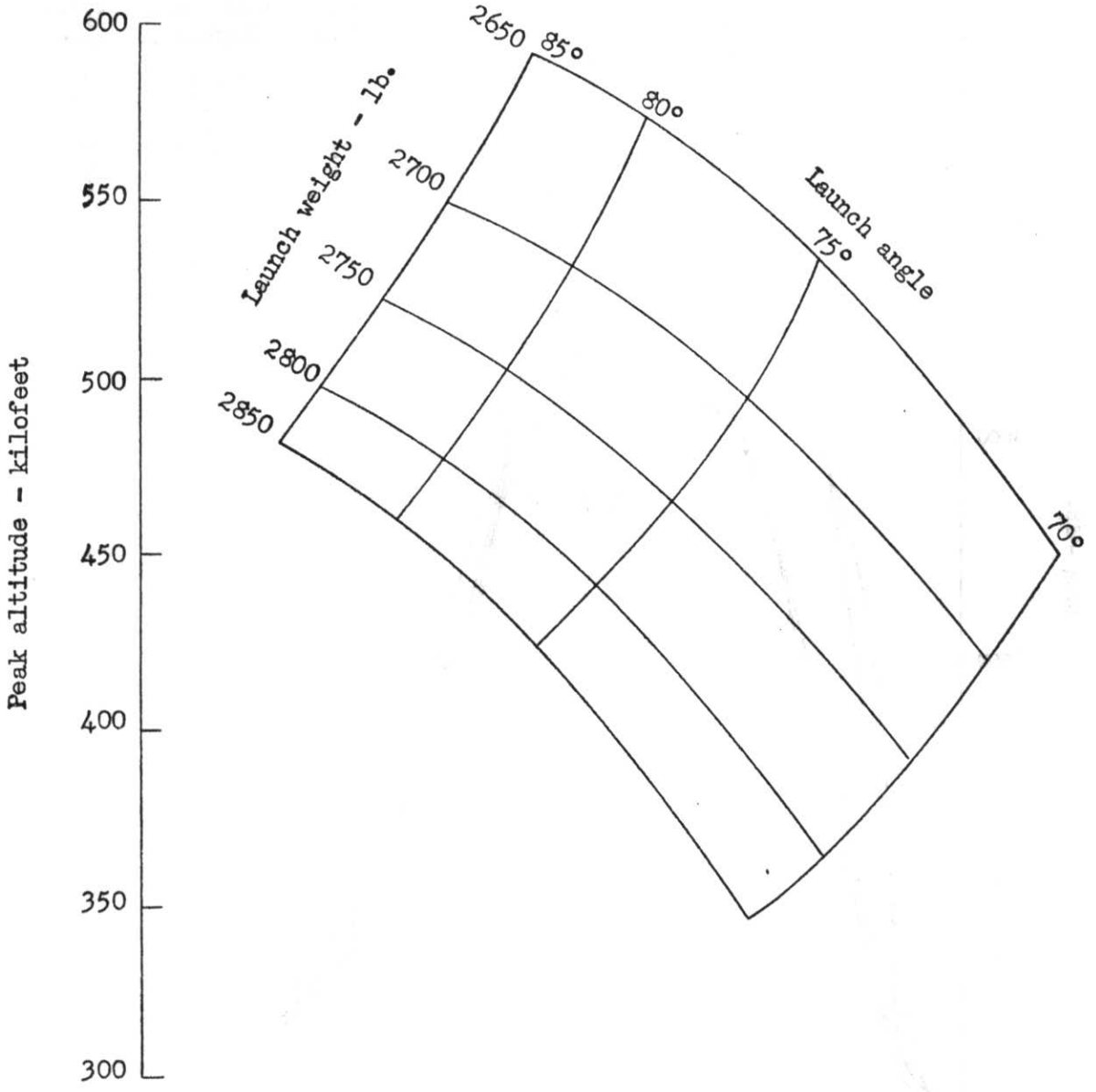
Figure 16E



	B.T. Sec.	Launch Angle Degrees	A.U.W. lb.
BB I - 01	19	70.43	2799
BB I - 03	19	70.48	2689
BB I - 05	21	80.0	2683
BB I - 06	21	81.0	2717
BB I - 07	22	80.0	2700

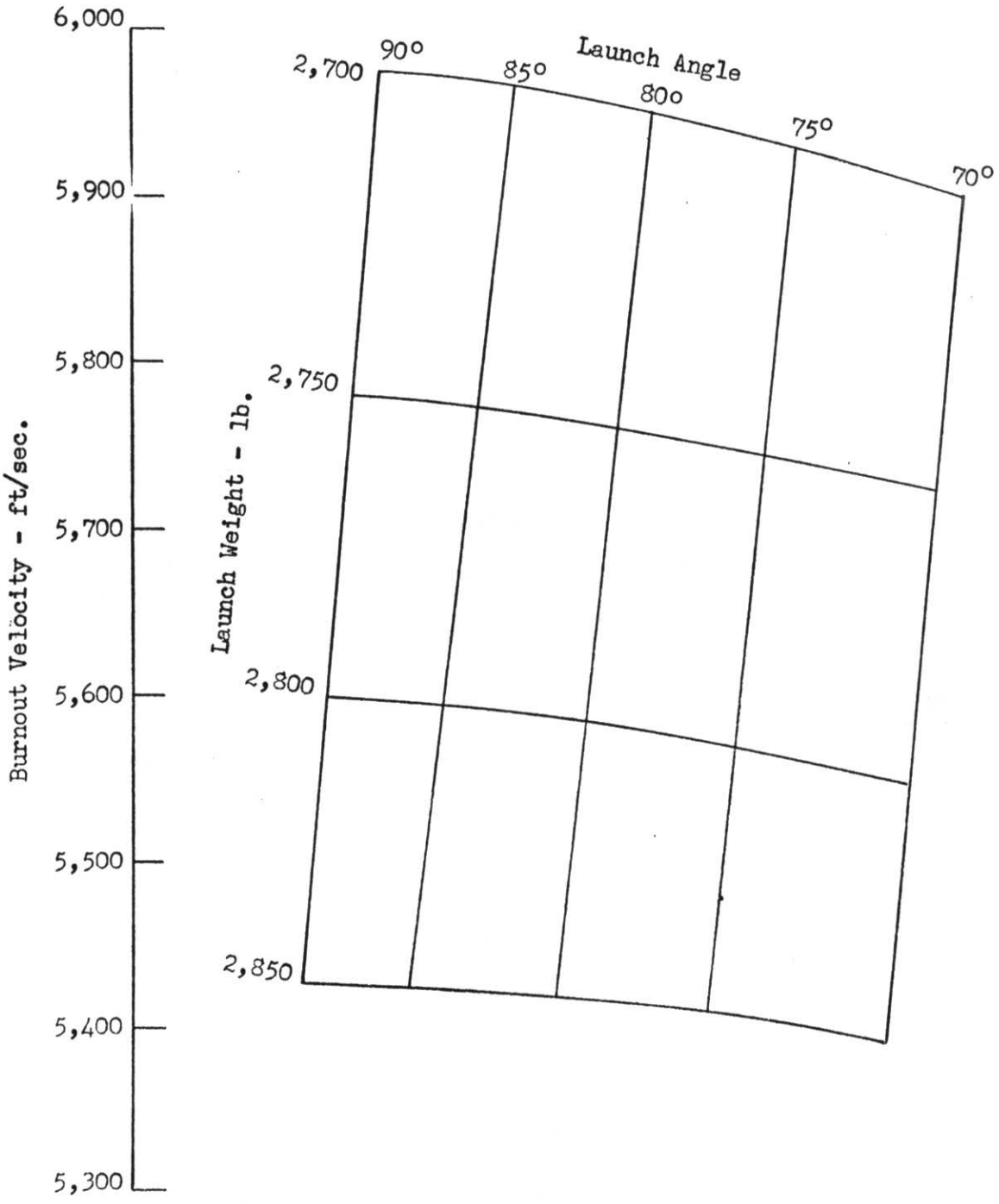
Calculated variation of drag versus time for BB I - (01 to 07).

Figure 16F



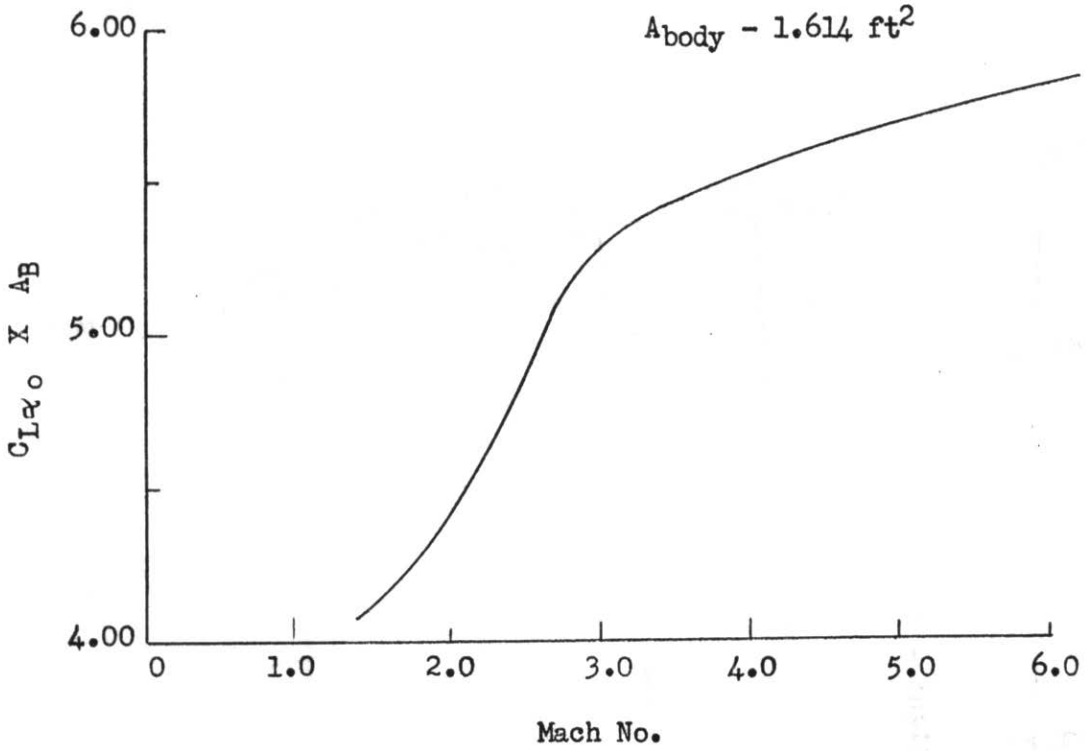
Calculated effects of launch weight and launch angle on peak altitude.

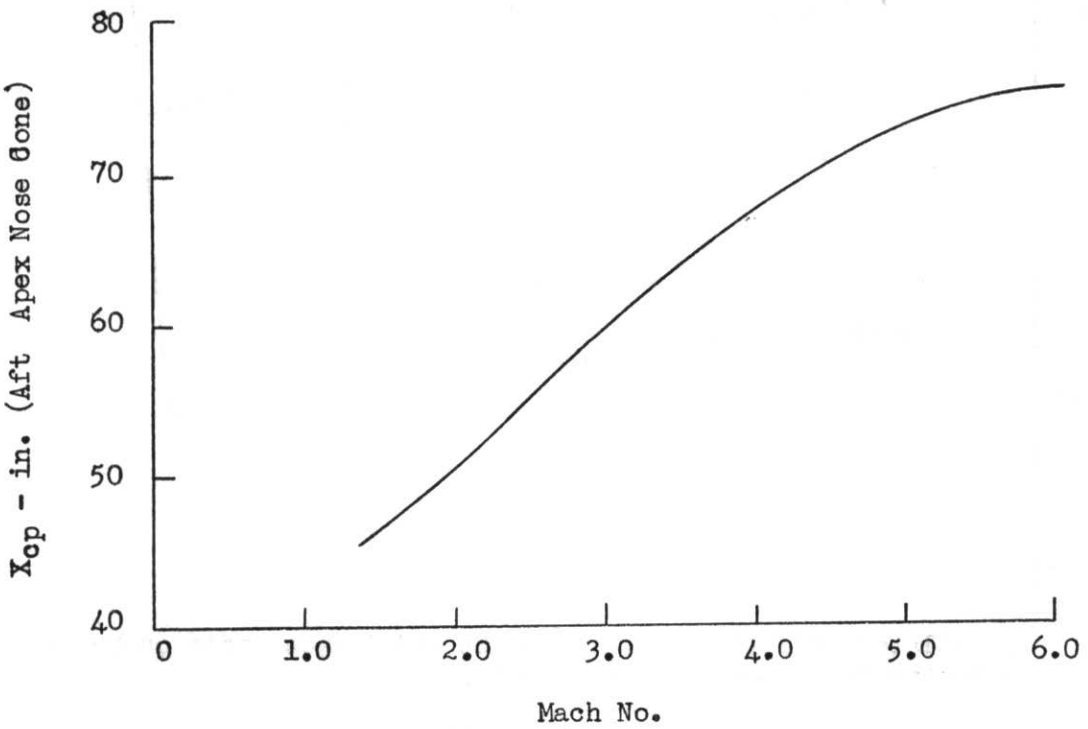
Figure 17



Calculated effects of launch weight and launch angle on burnout velocity for Black Brant I rockets.

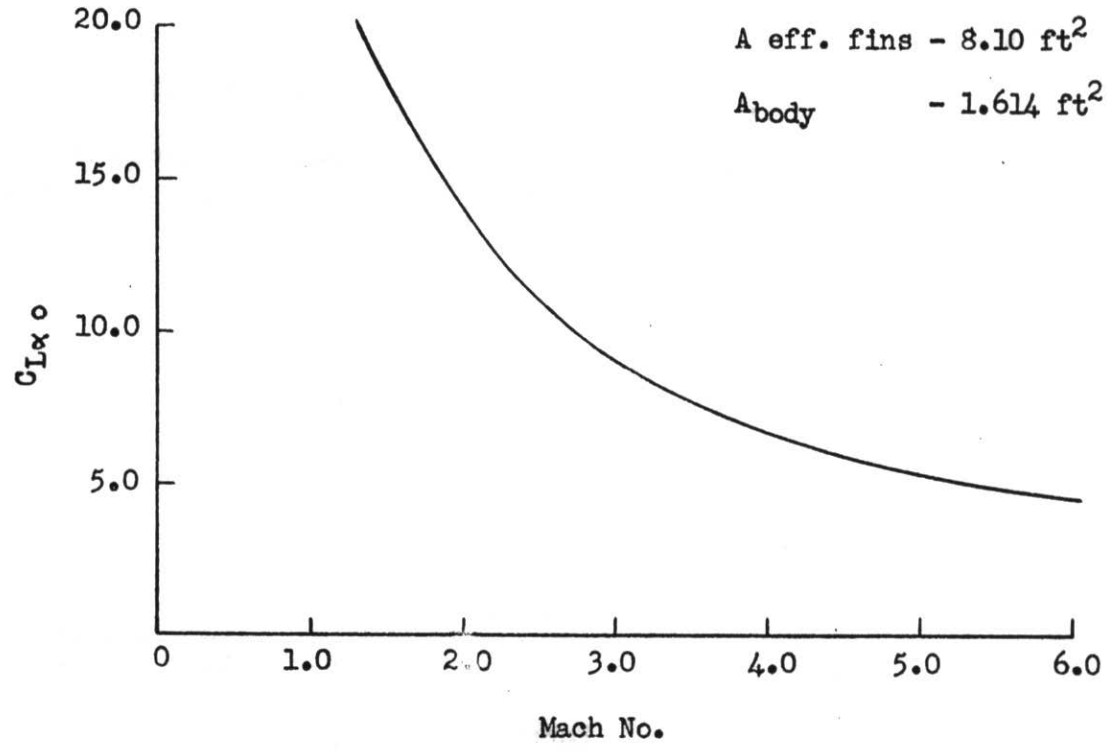
Figure 18

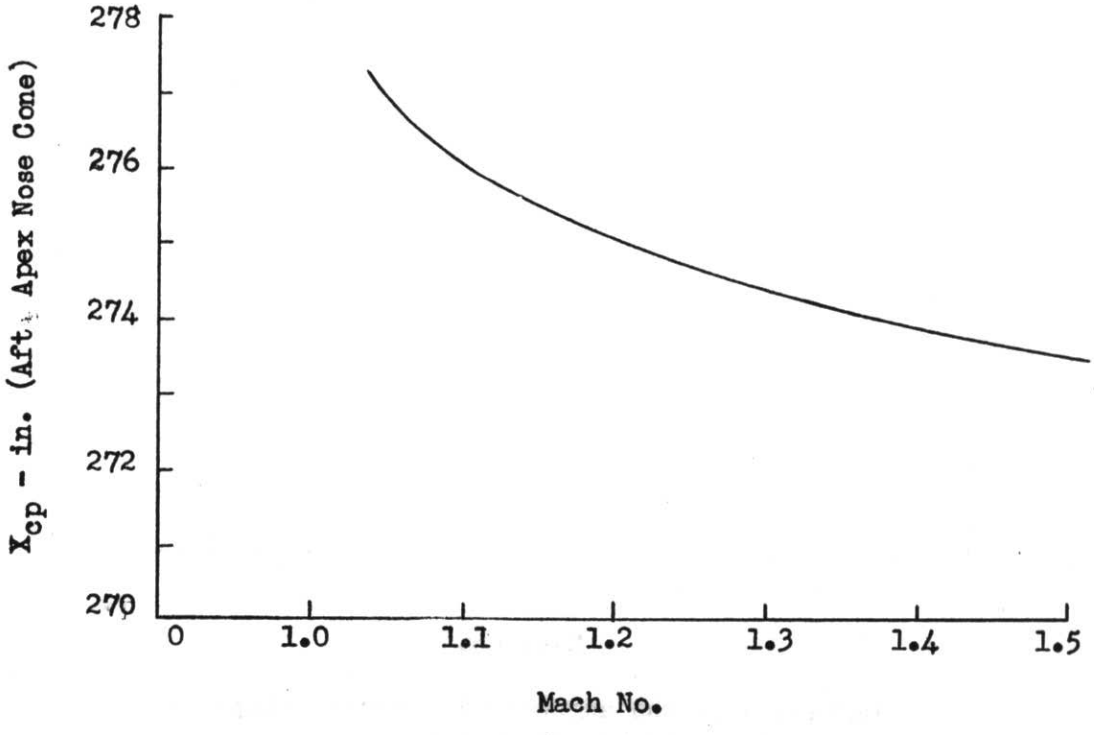




Variation of the product of lift-curve slope times area and of the calculated centre of pressure versus Mach No. for nose and body.

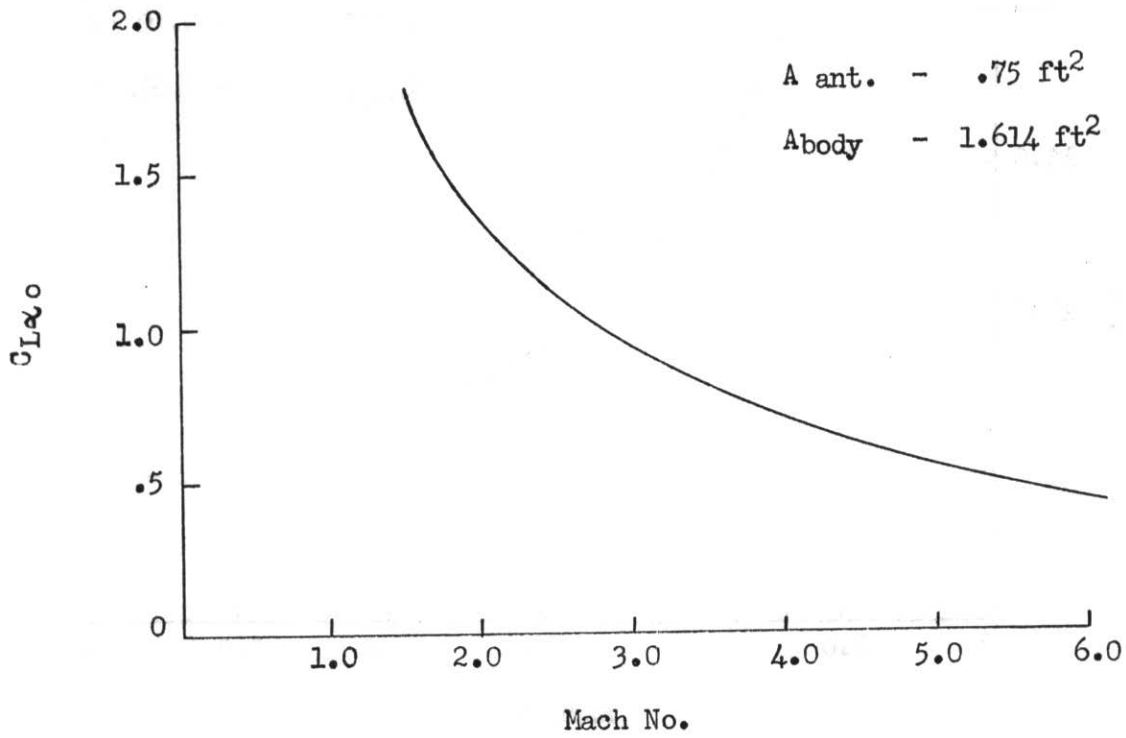
Figure 19A

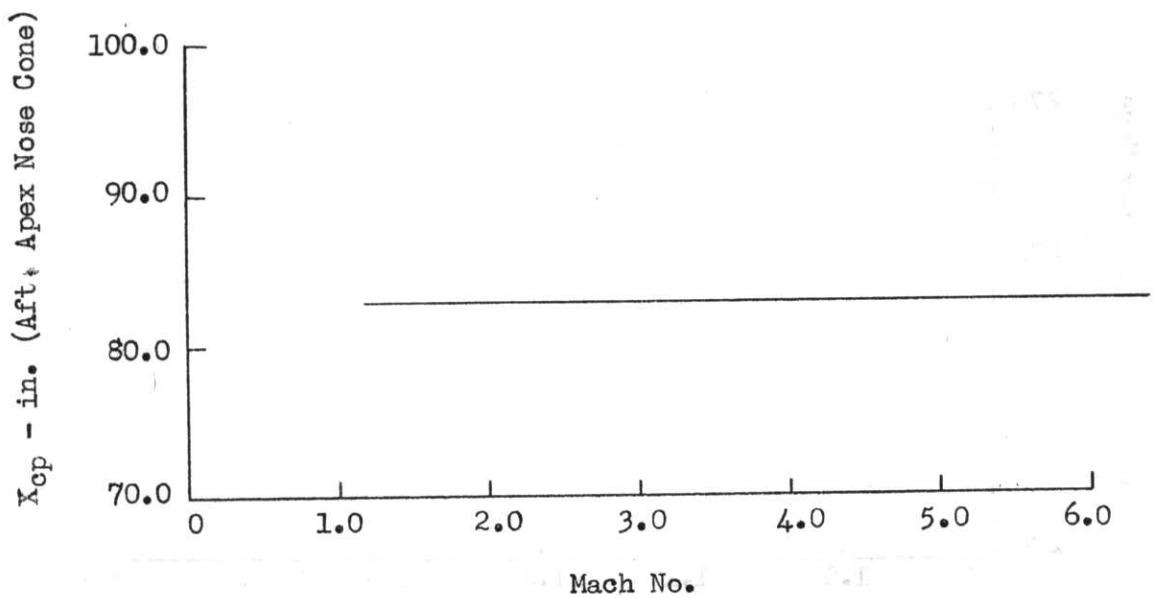




Variation of the fins lift-curve slope and centre of pressure versus Mach No.

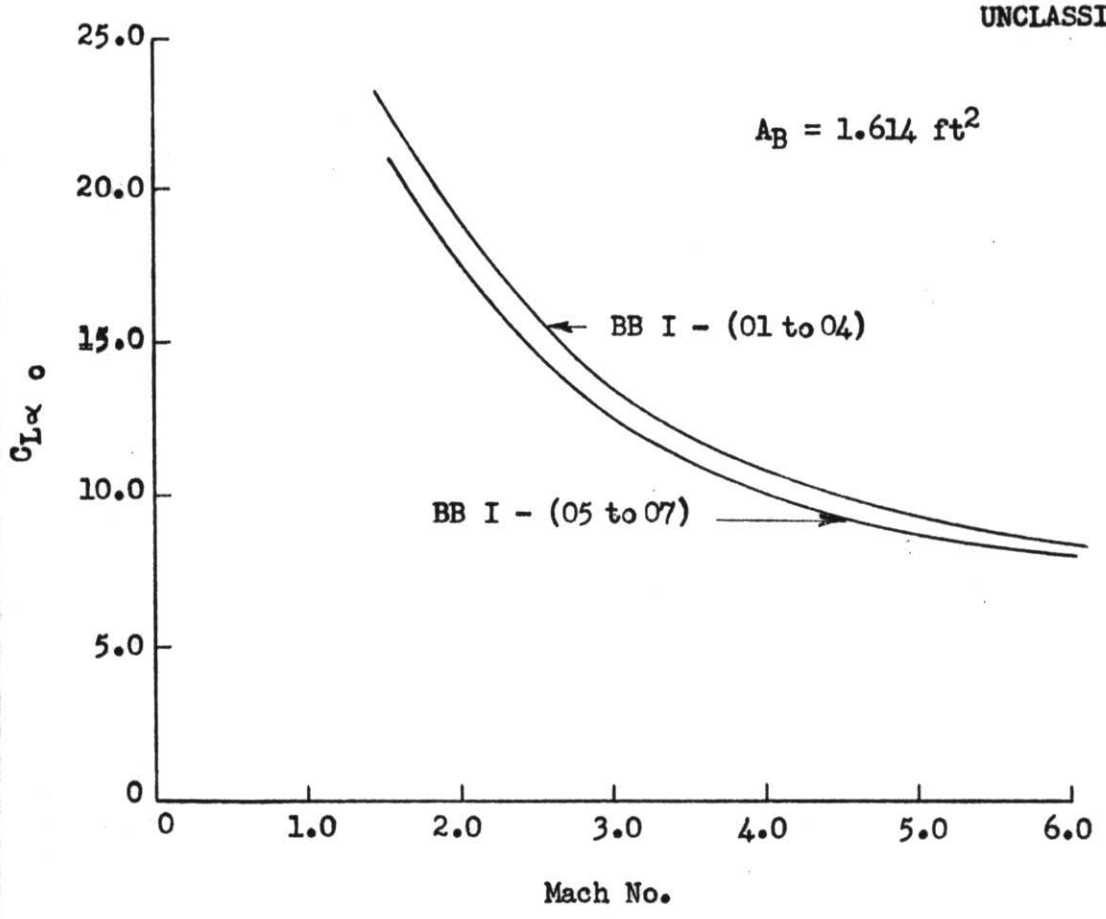
Figure 198

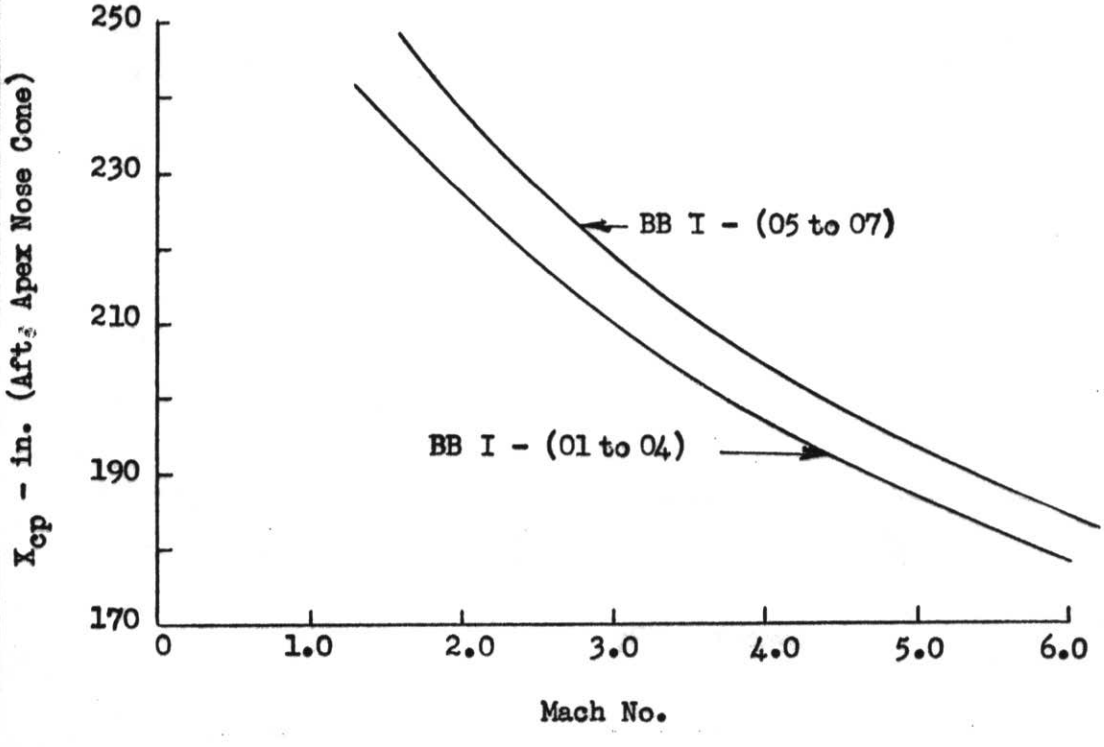




Variation of the antennas lift-curve slope and centre of pressure versus Mach No.

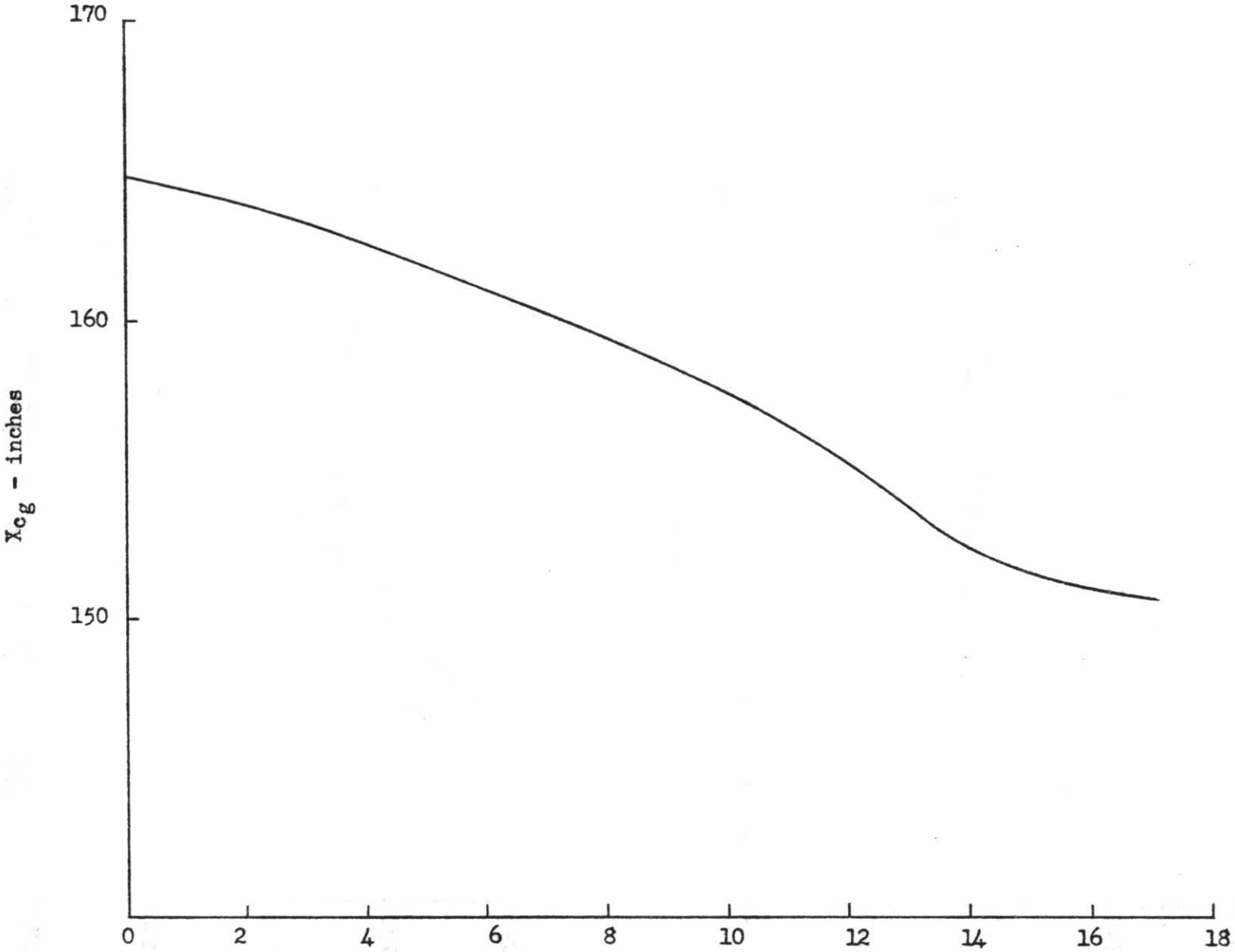
Figure 19C





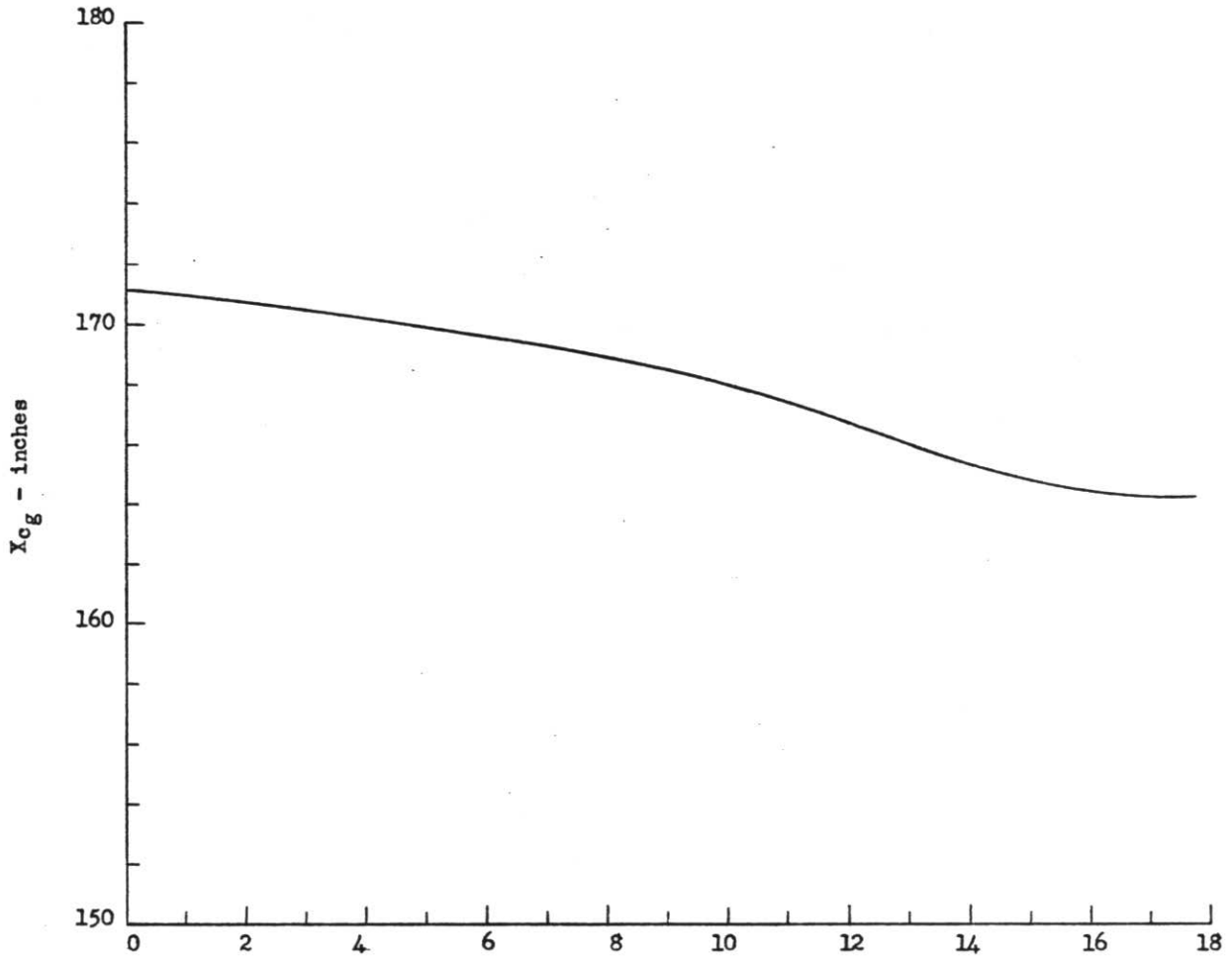
Variation of the combined lift-curve slopes and the combined centres of pressure versus Mach No. for BB I - (01 to 07).

Figure 20



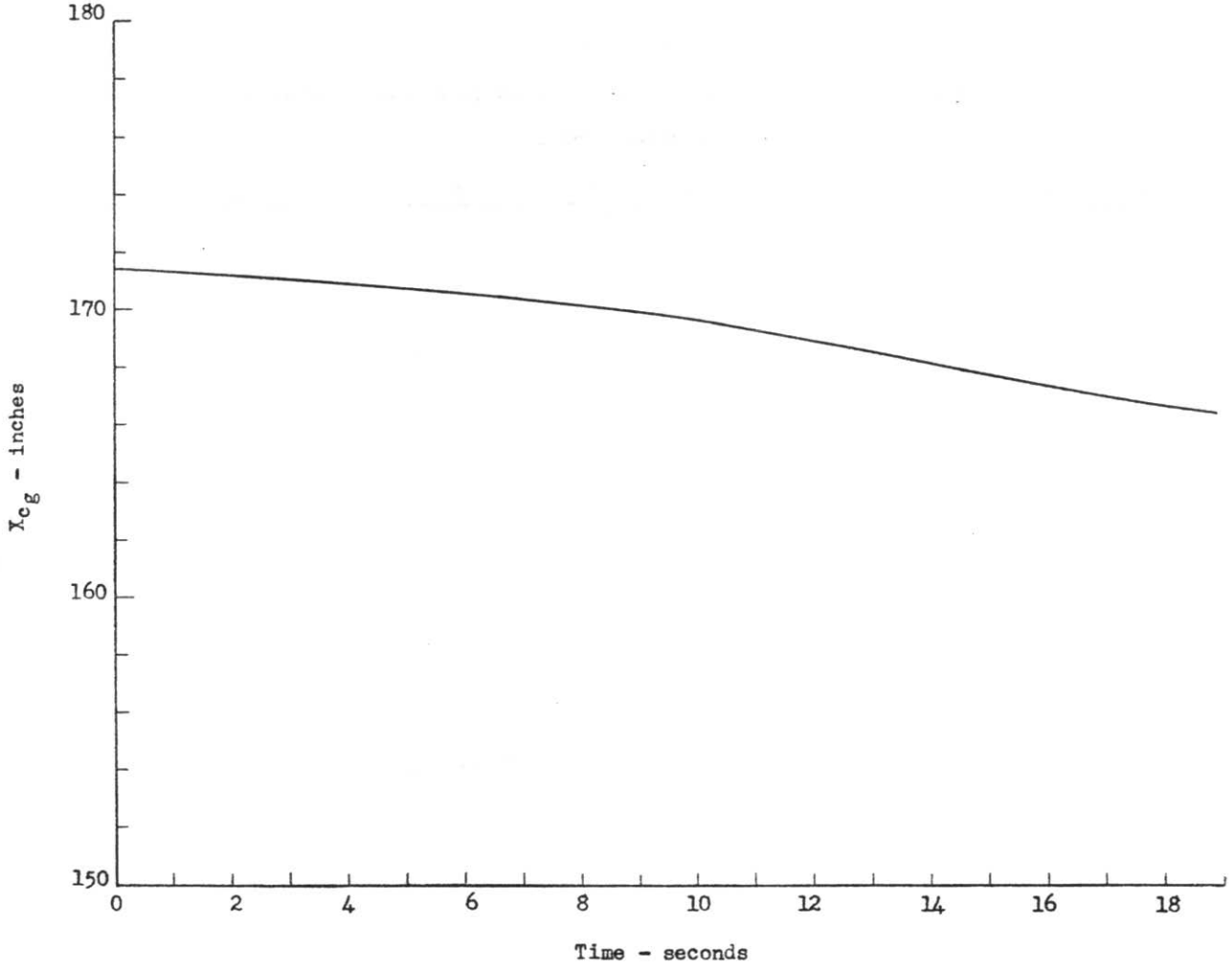
Calculated centre of gravity versus time for BB I - (01 and 02)

Figure 21A



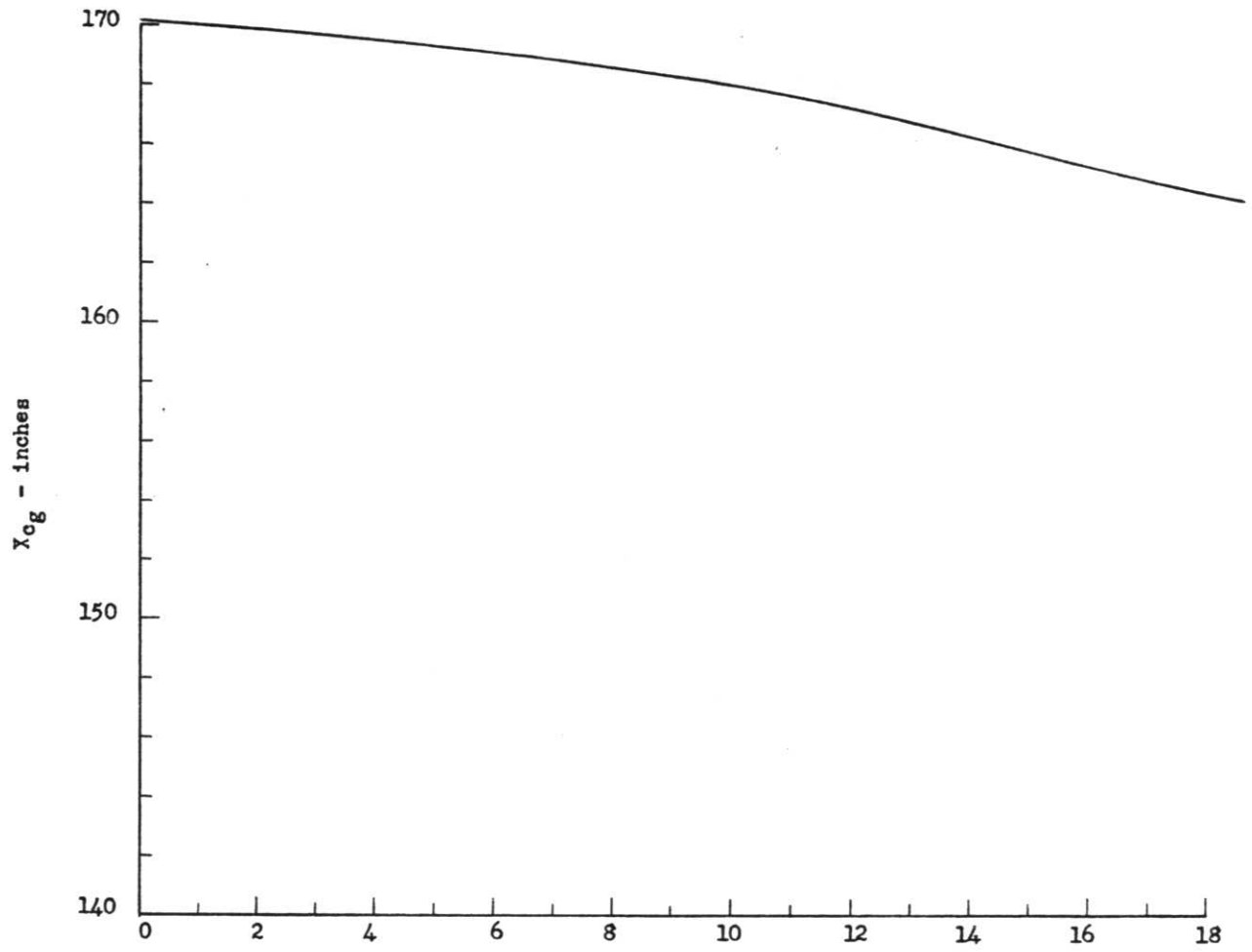
Calculated centre of gravity versus time for BB I - (03 and 04)

Figure 21B



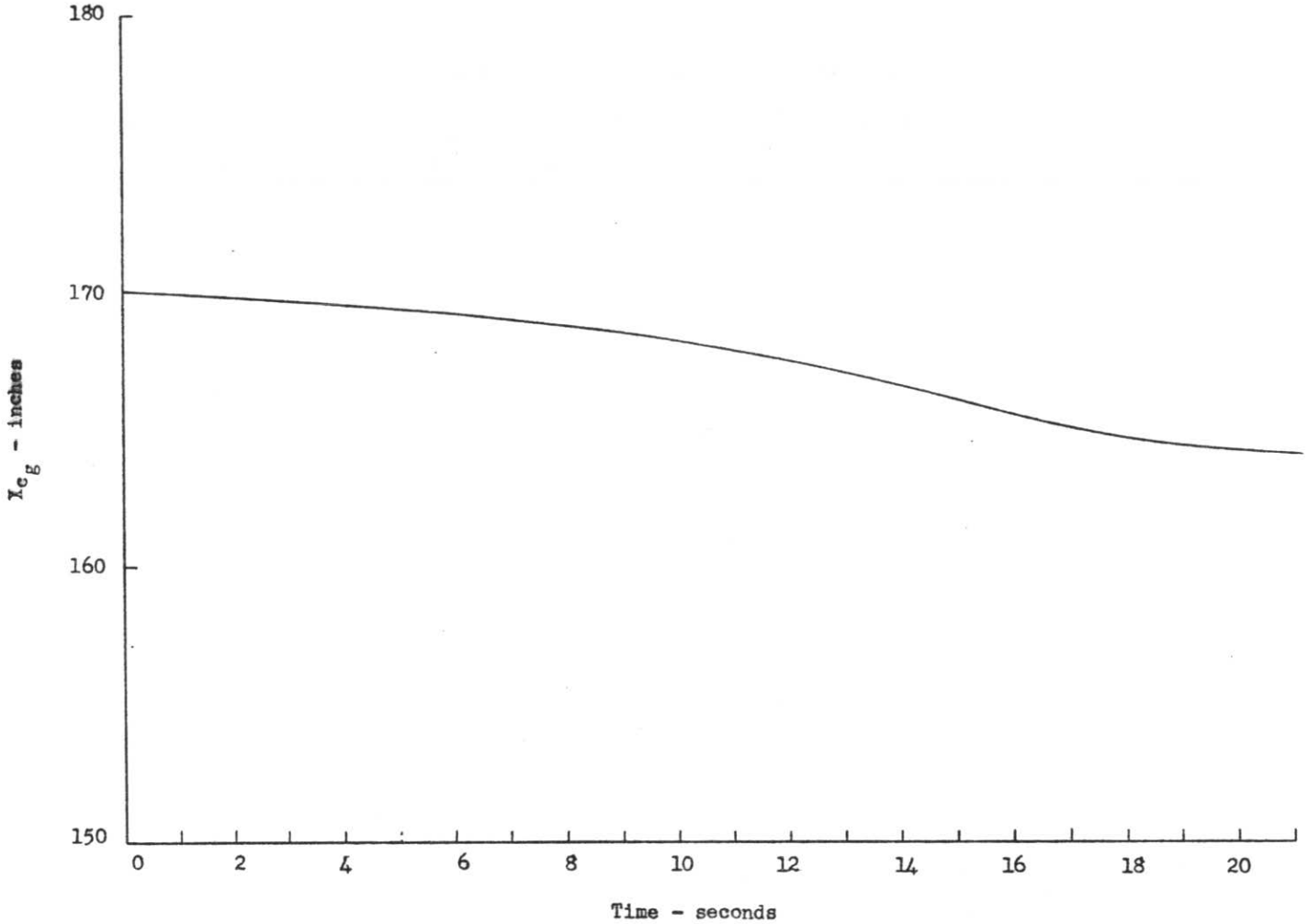
Calculated centre of gravity versus time for BB I - 05.

Figure 21C



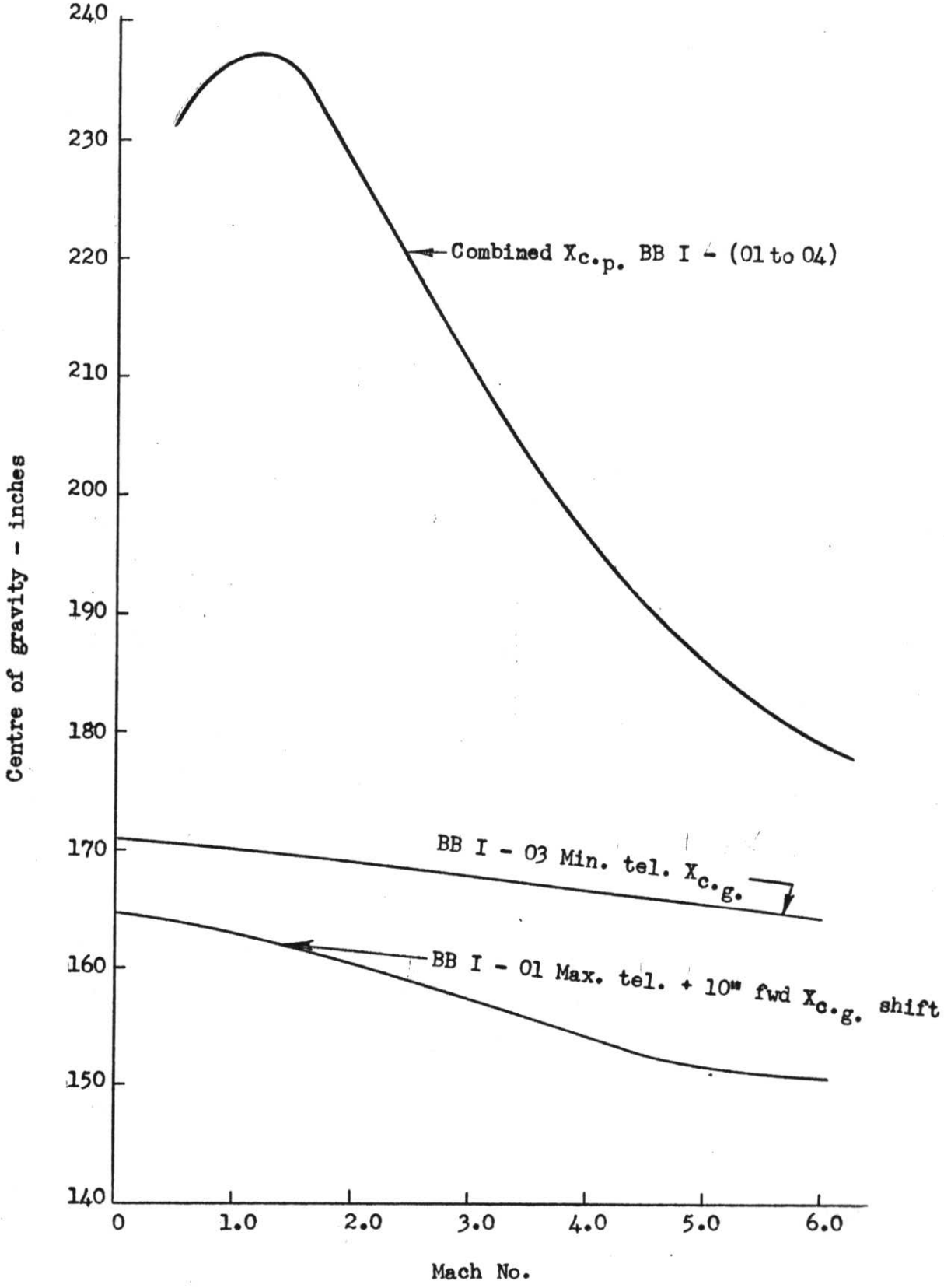
Calculated centre of gravity versus time for BB I - 06.

Figure 21D



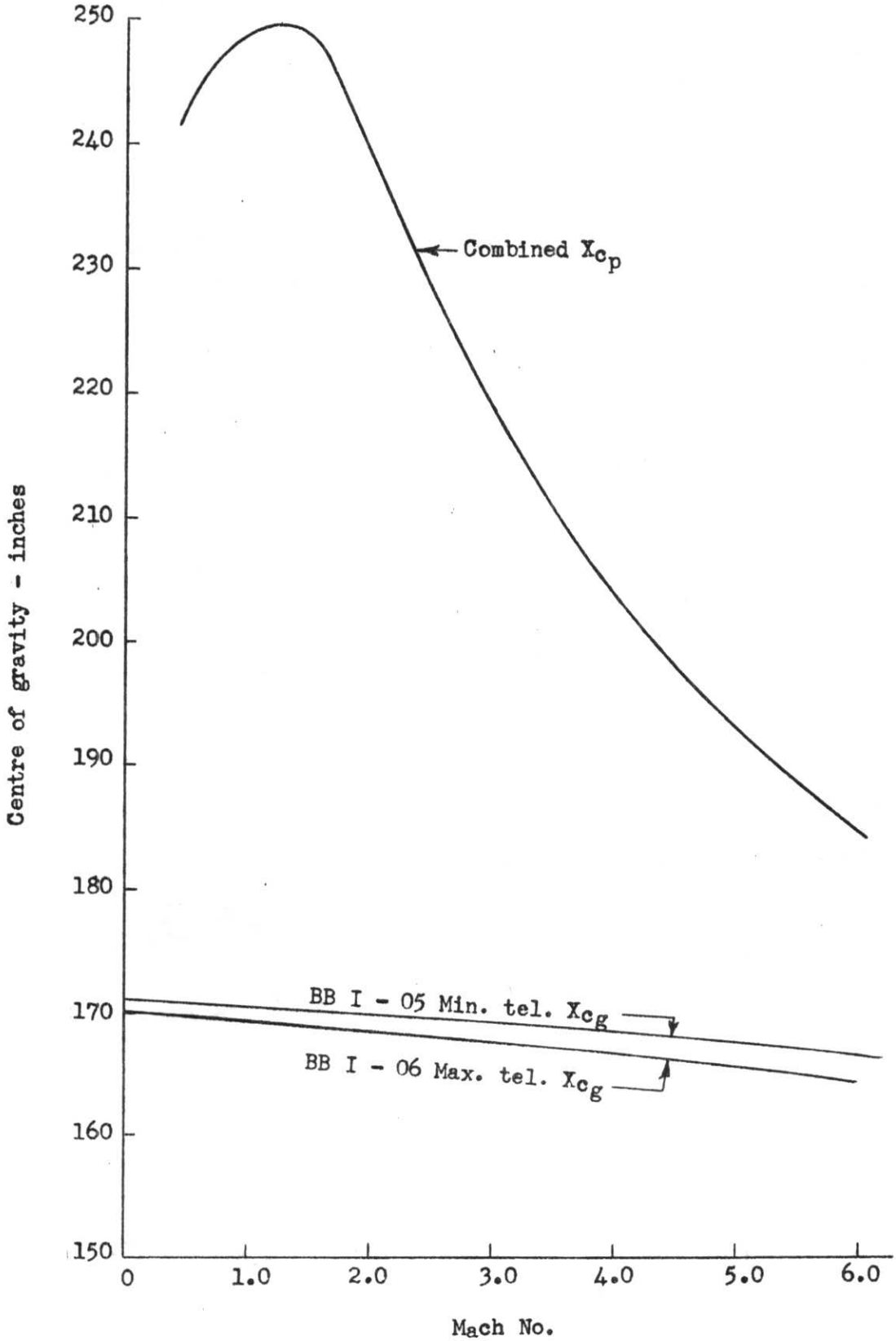
Calculated centre of gravity versus time for BB I - 07.

Figure 21E



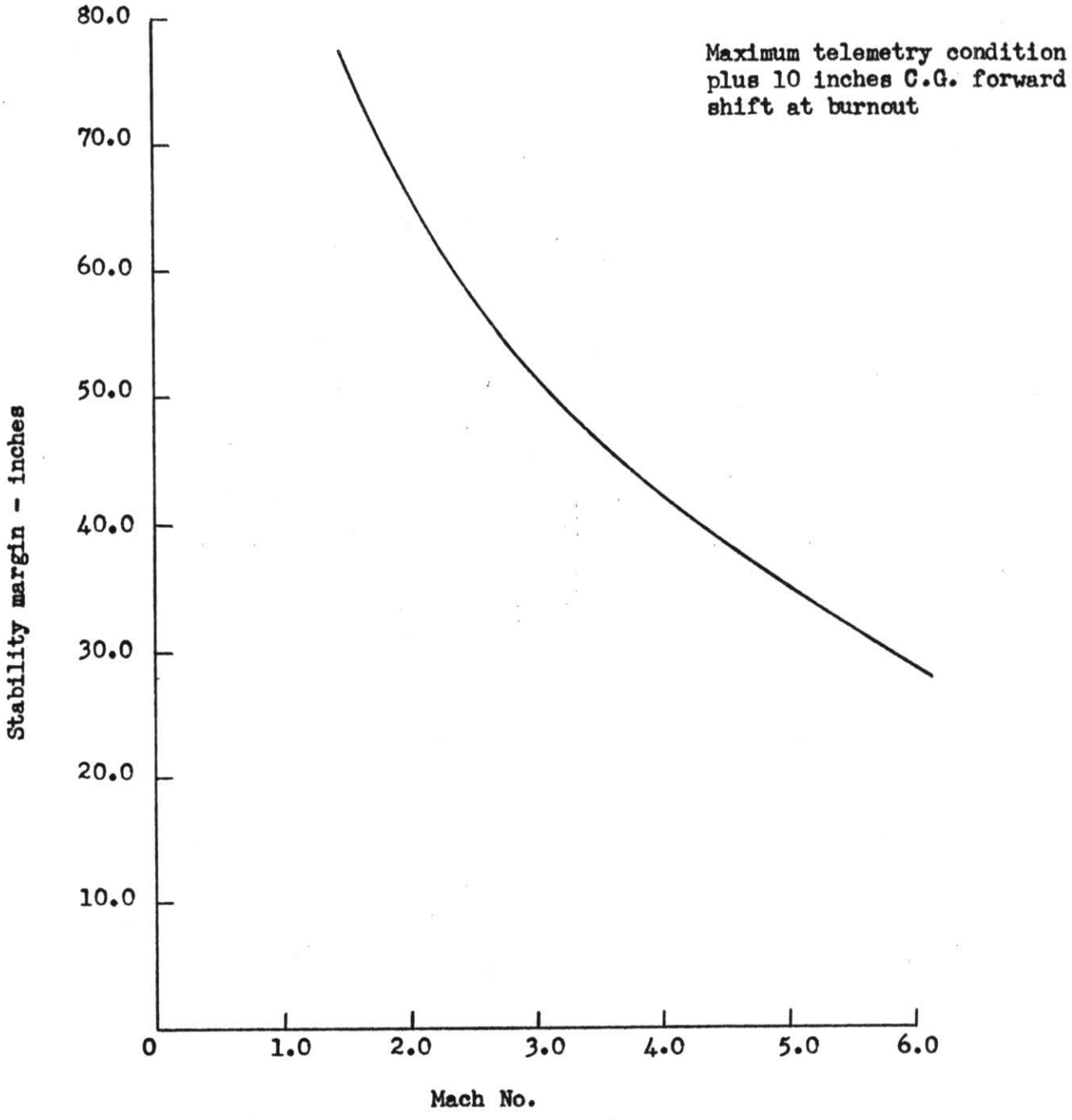
Calculated variation of centre of gravity and combined centre of pressure for BB I - (01 to 04).

Figure 22A



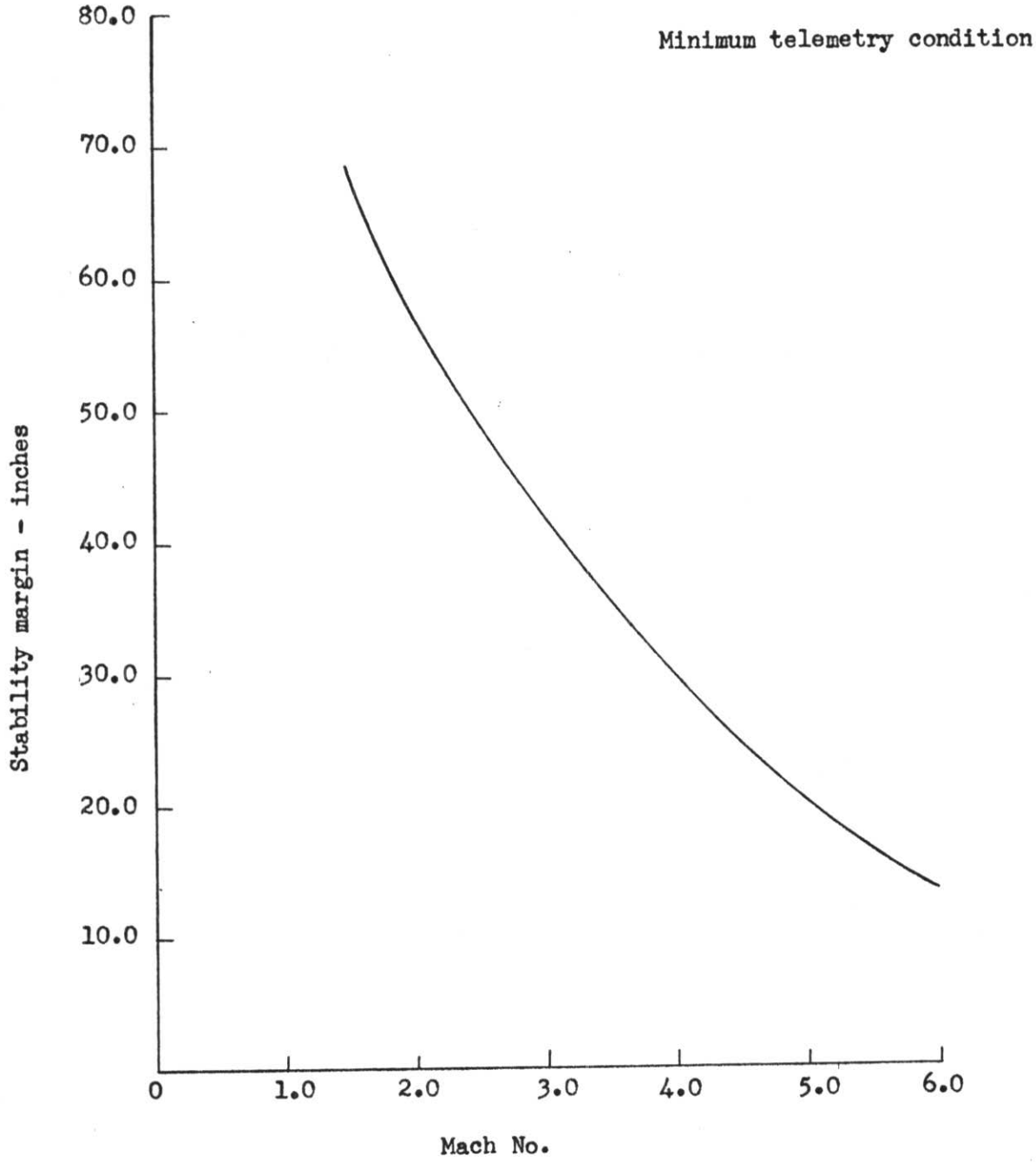
Calculated variation of centre of gravity and combined centre of pressure for BB I - (05 to 07).

Figure 22B



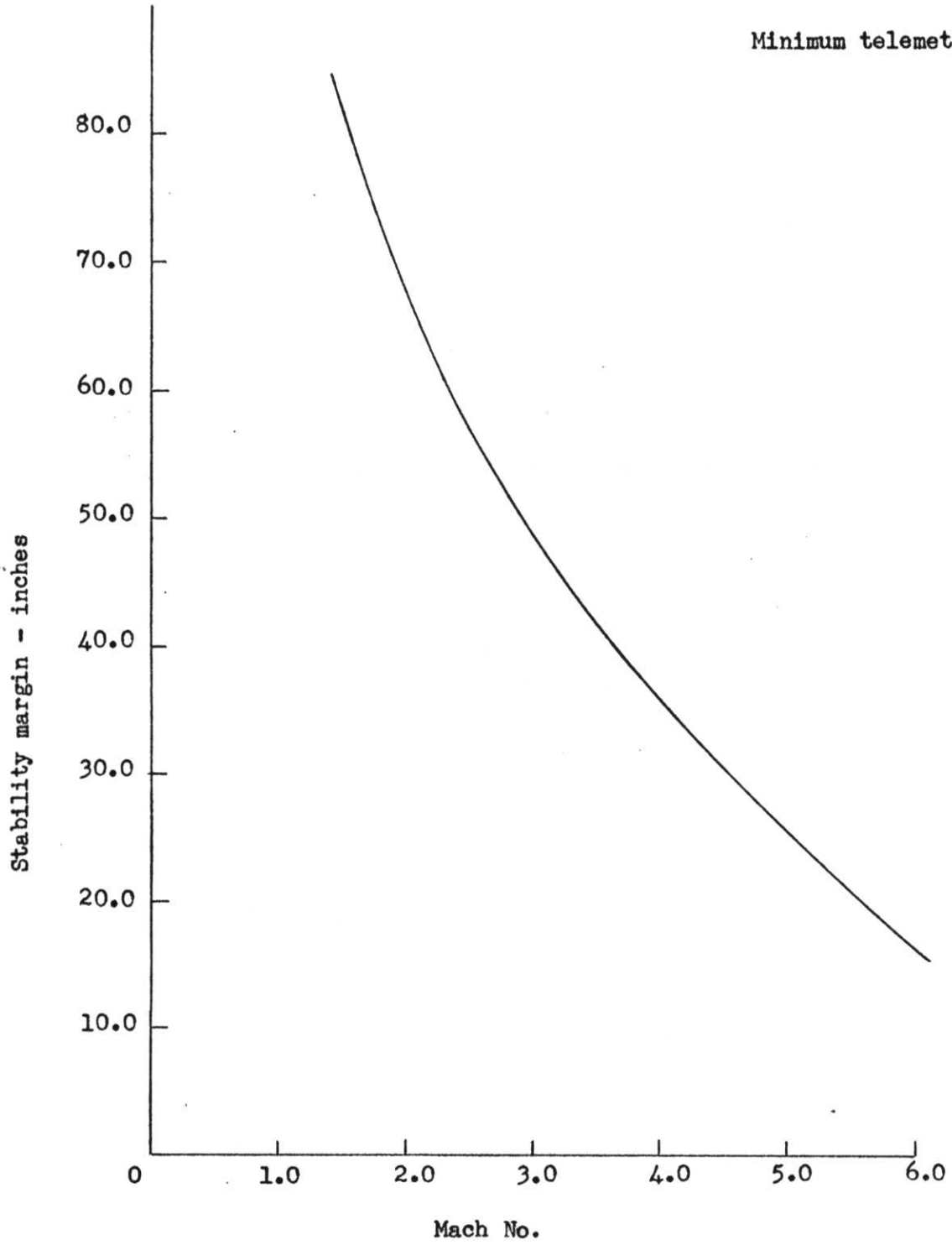
Variation of calculated static stability margin versus Mach No. for BB I - (01 and 02).

Figure 23A



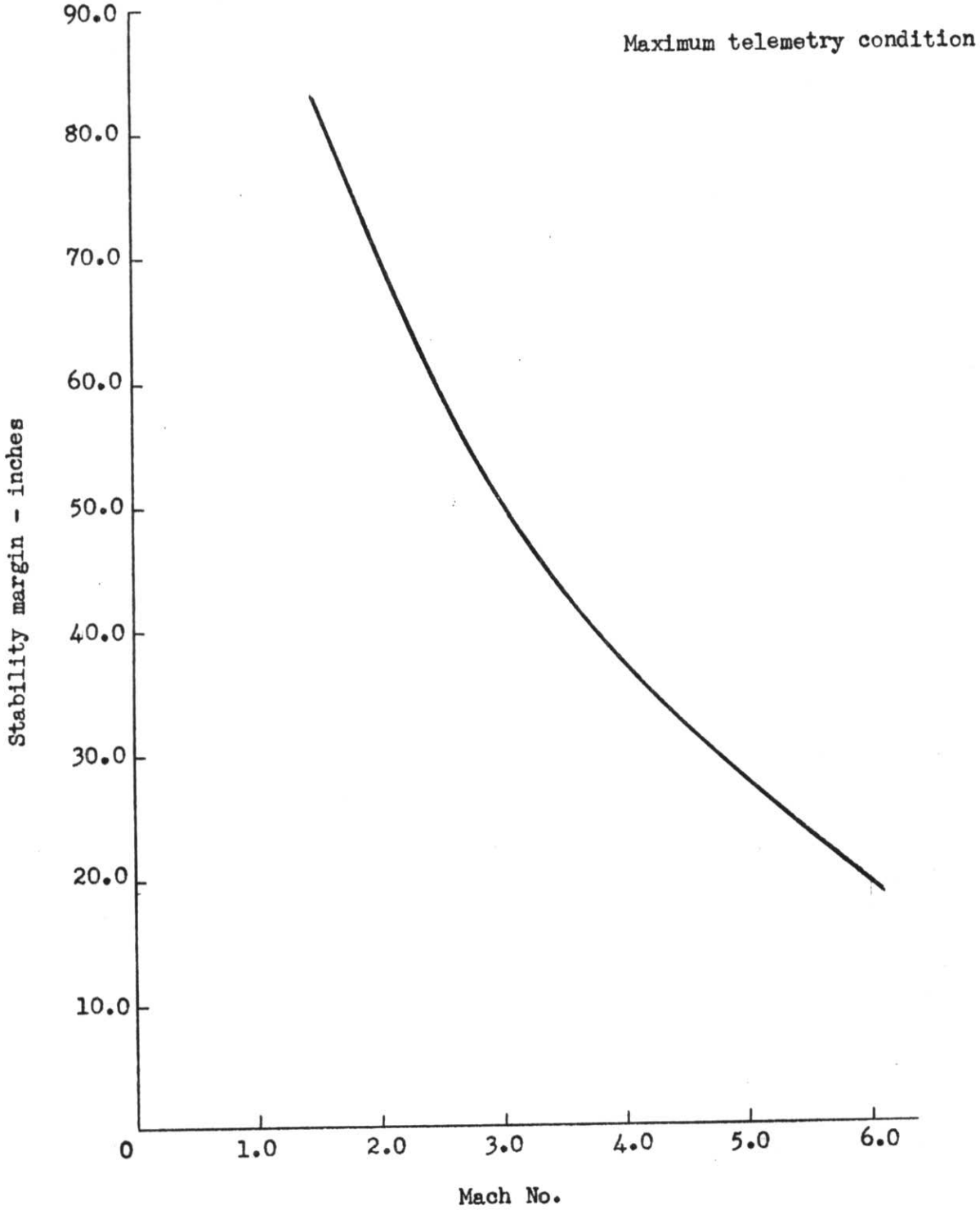
Variation of calculated static stability margin versus Mach No. for BB I - (03 and 04).

Figure 23B



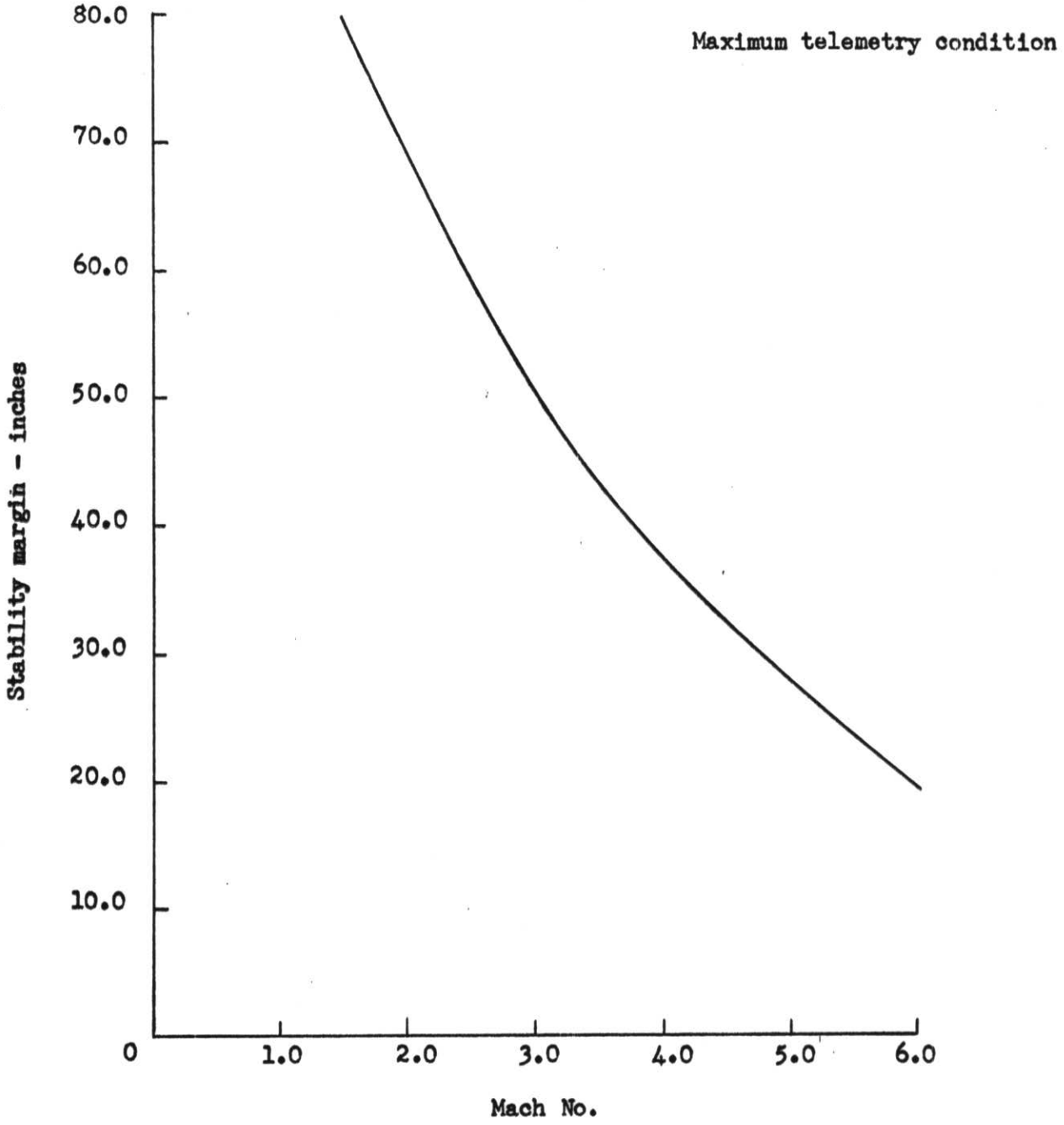
Variation of calculated static stability margin versus Mach No. for BB I - 05.

Figure 23C



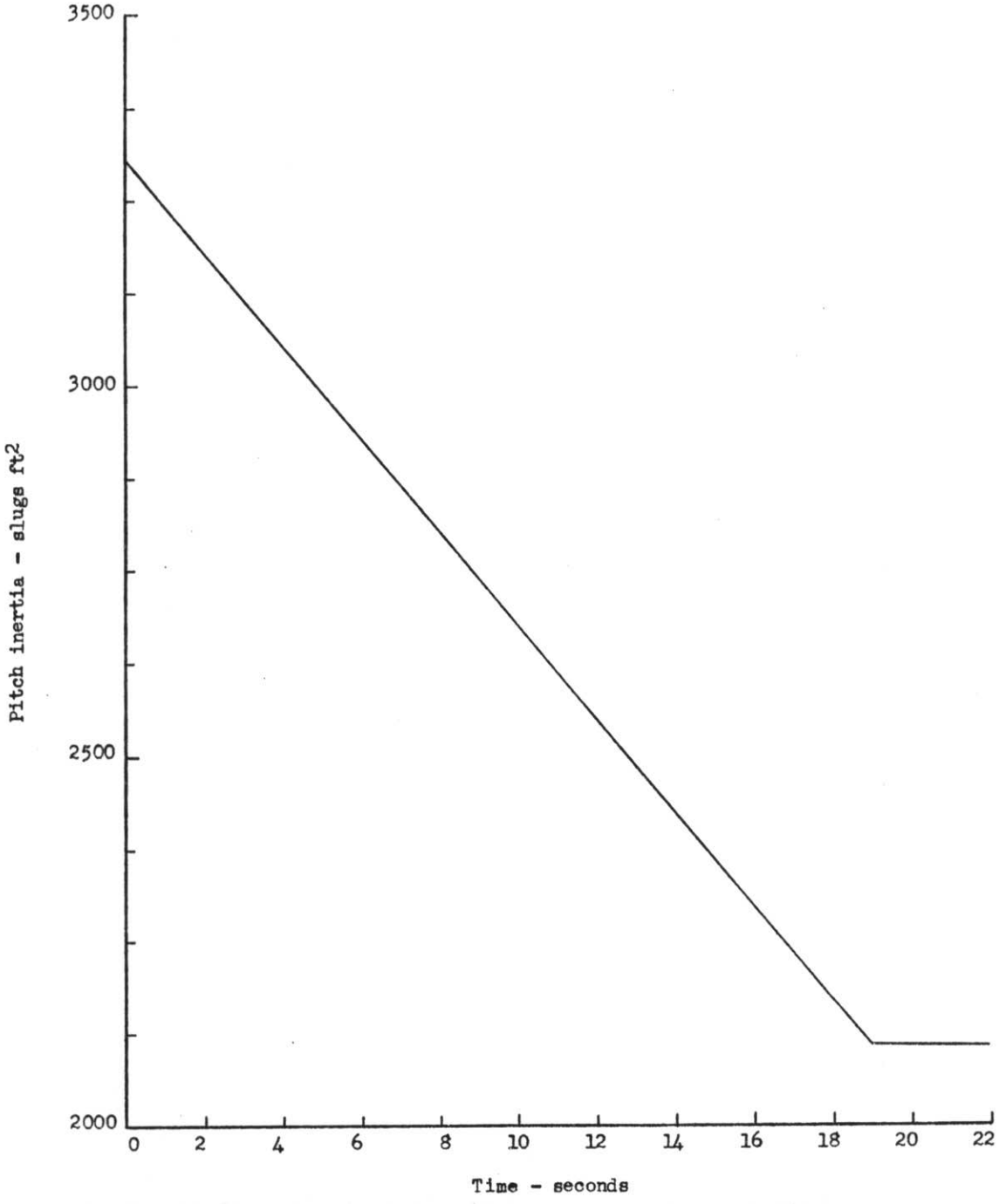
Variation of calculated static stability margin versus Mach No. for BB I - 06.

Figure 23D



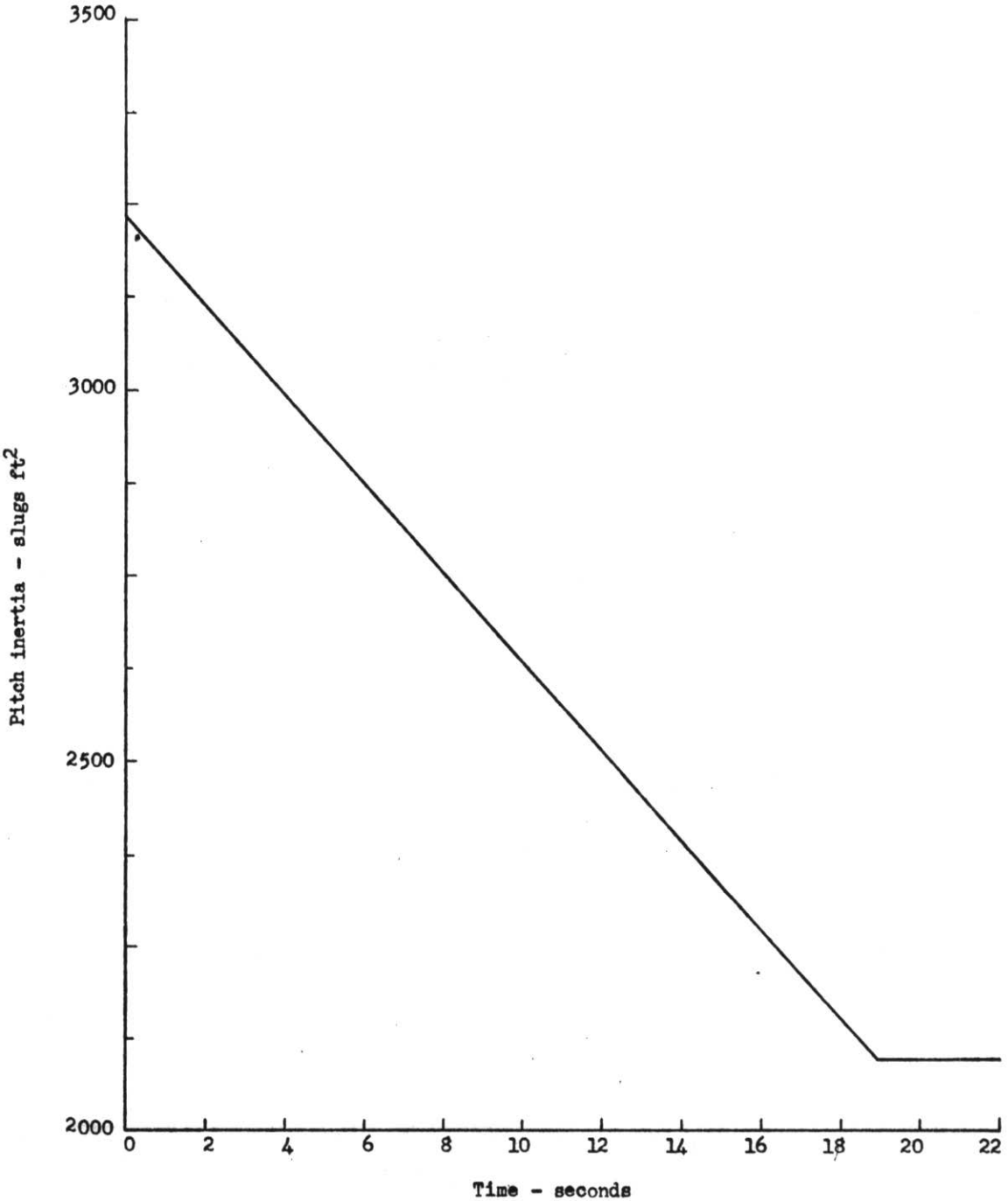
Variation of calculated static stability margin versus Mach No. for BB I - 07.

Figure 23E



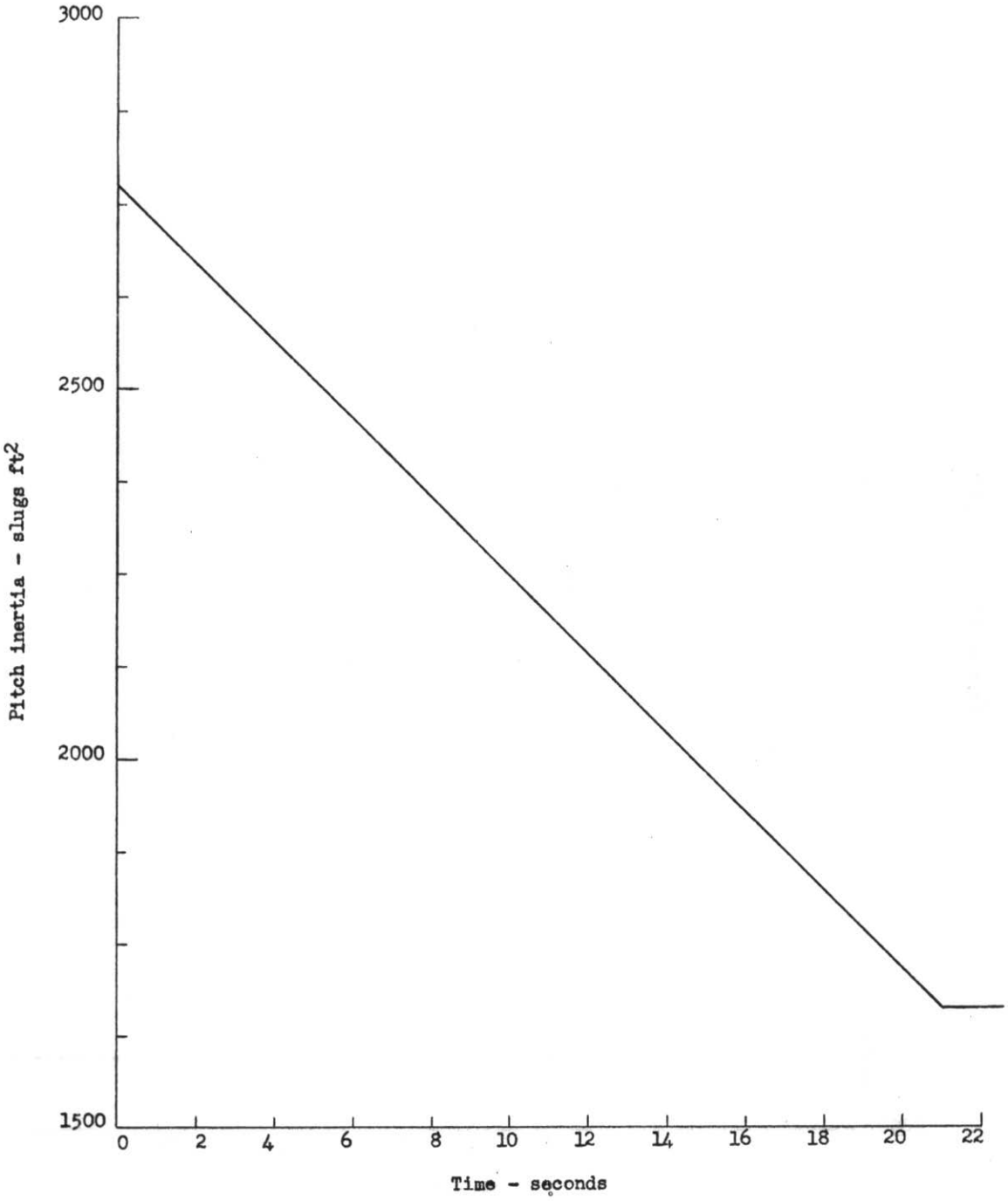
Calculated pitch inertia versus time for BB I - (01 and 02)

Figure 24A



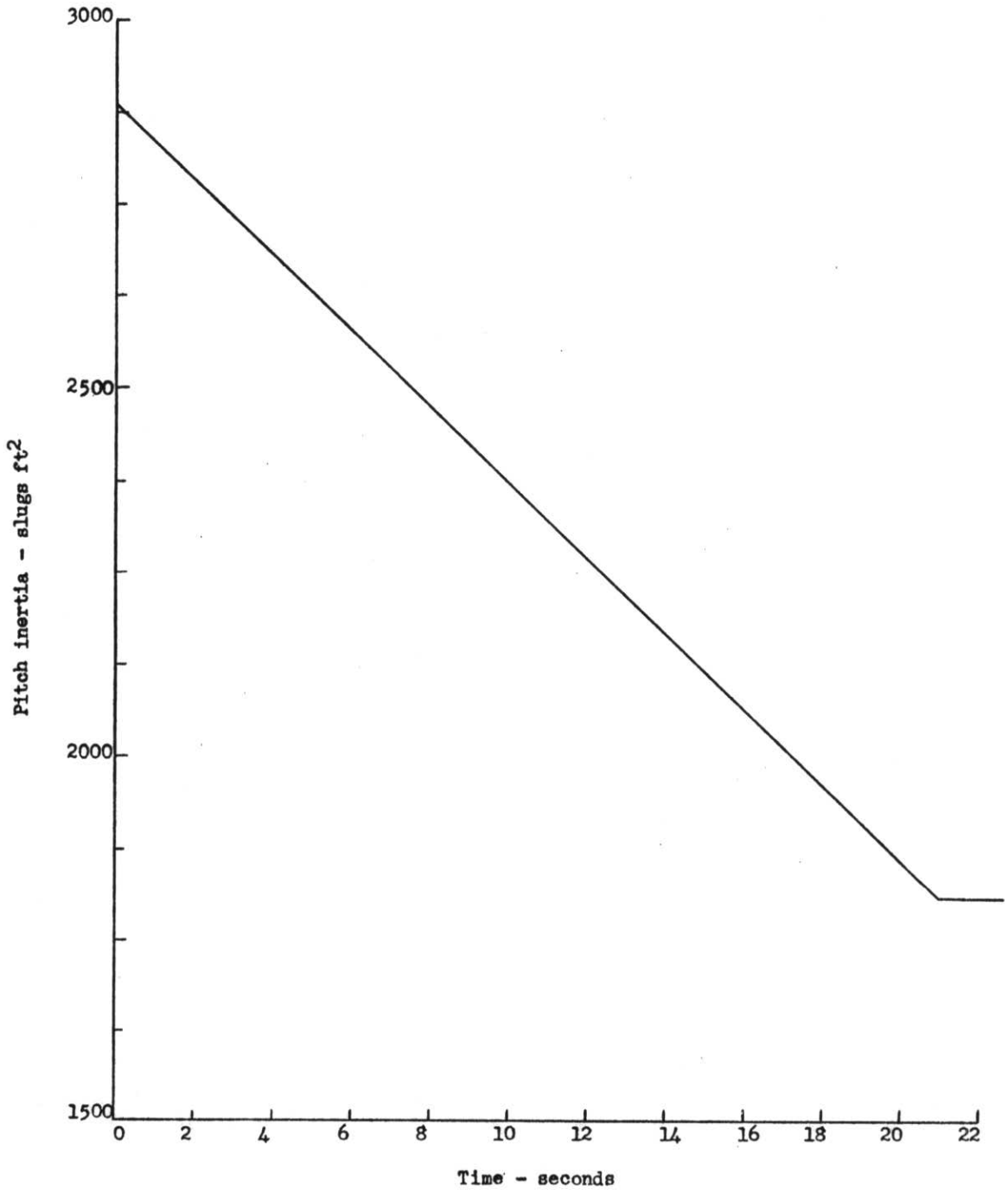
Calculated pitch inertia versus time for BB I - (03 and 04)

Figure 24B



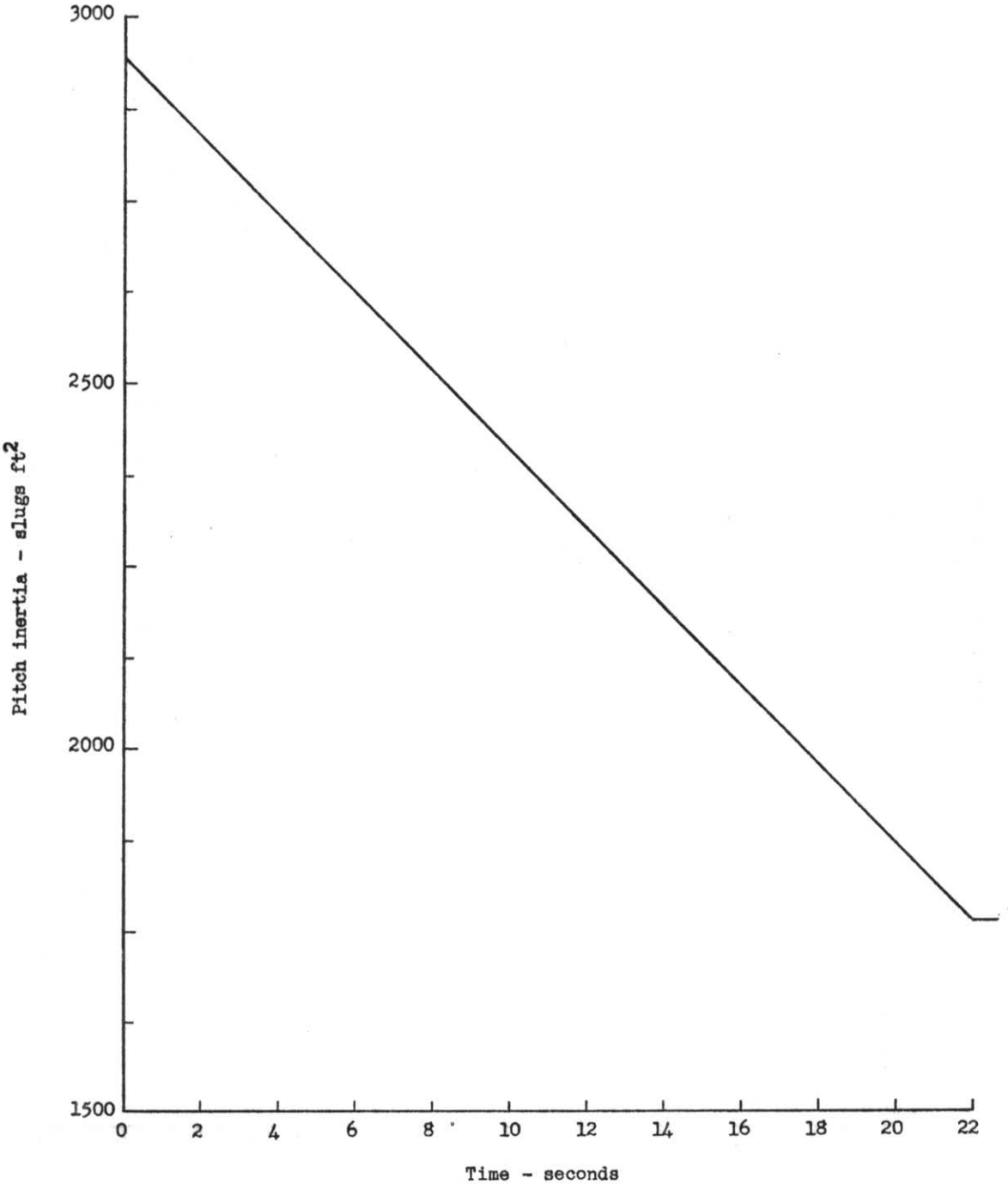
Calculated pitch inertia versus time for BB I - 05.

Figure 24C



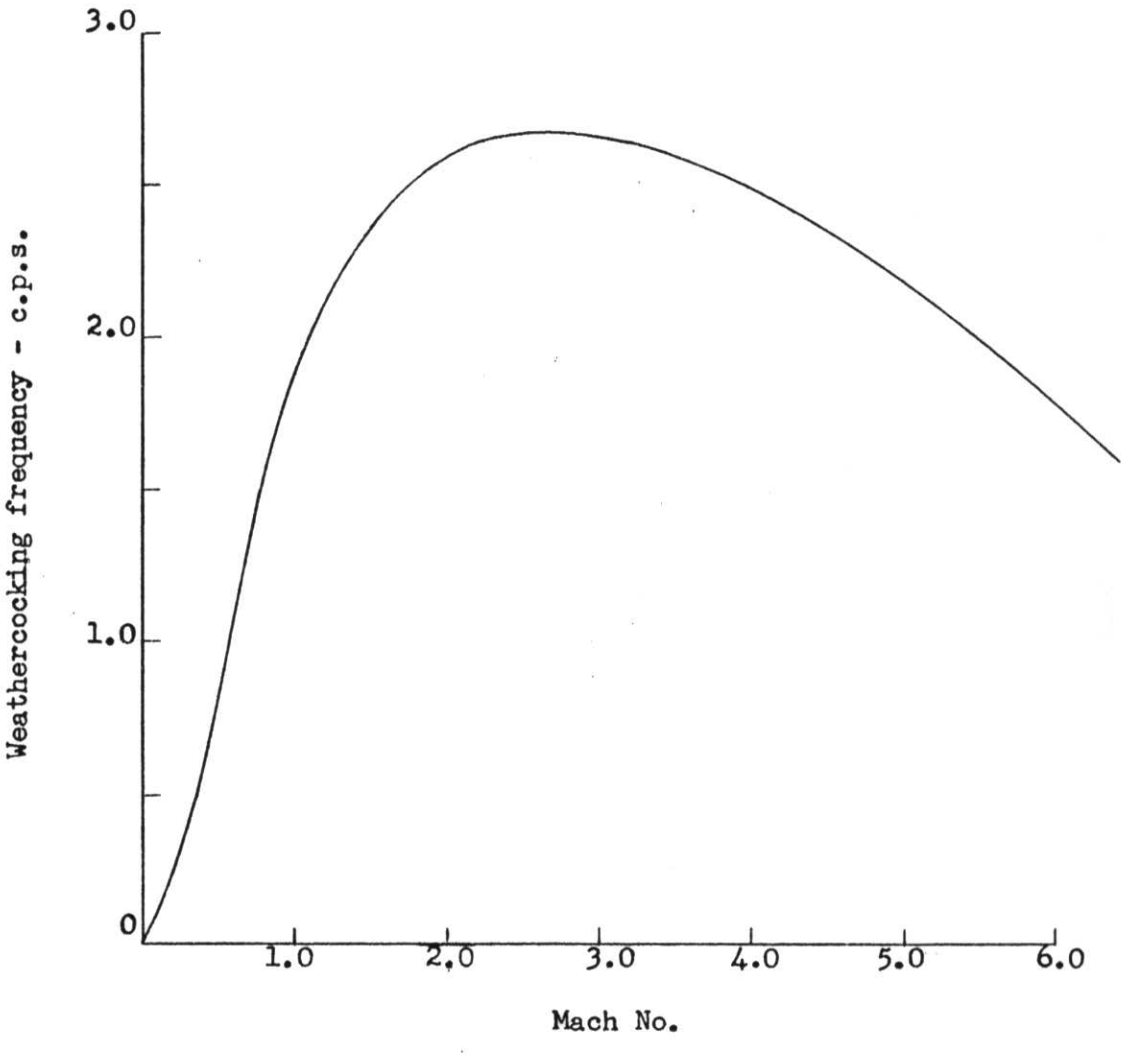
Calculated pitch inertia versus time for BB I - 06.

Figure 24D



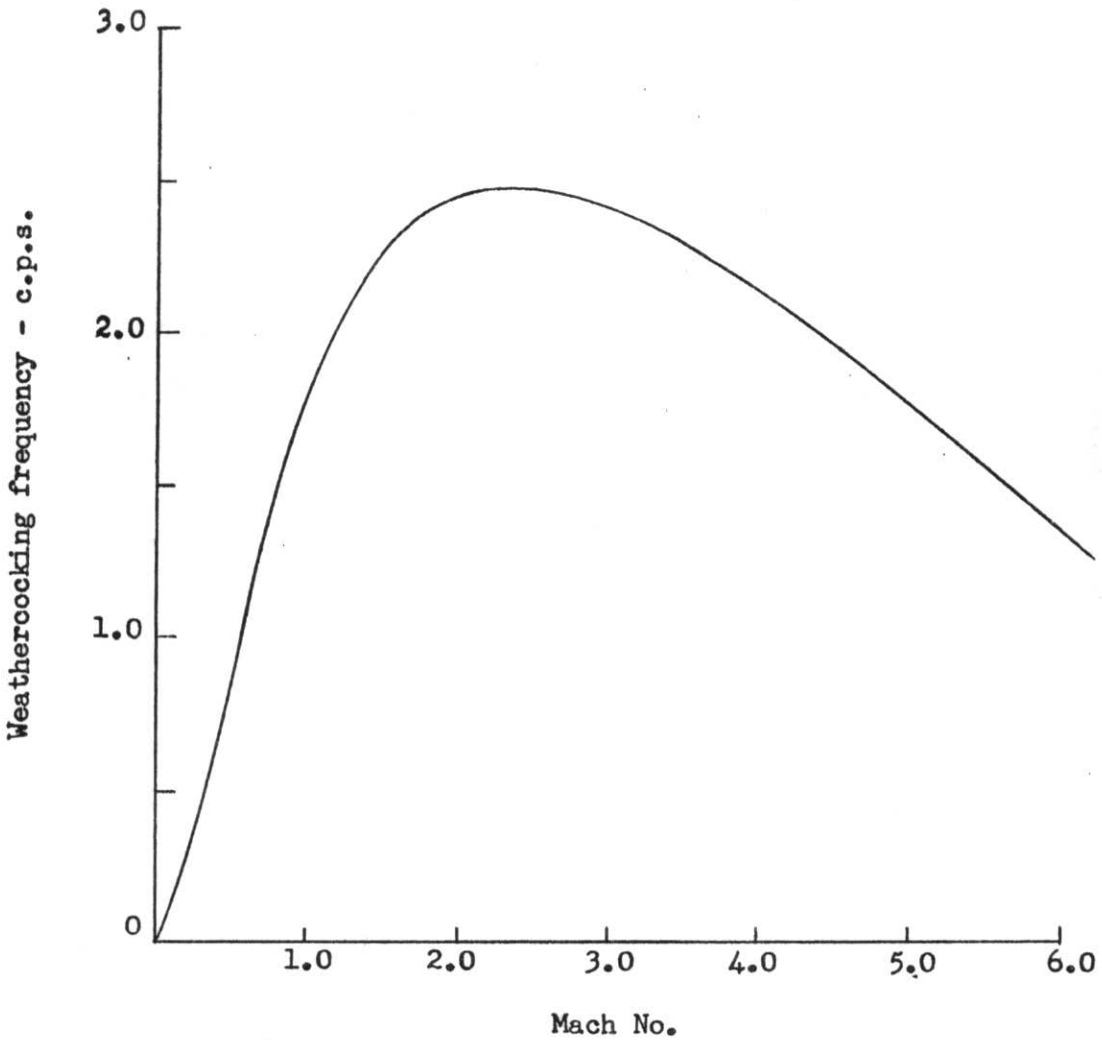
Calculated pitch inertia versus time for BB I - 07.

Figure 24E



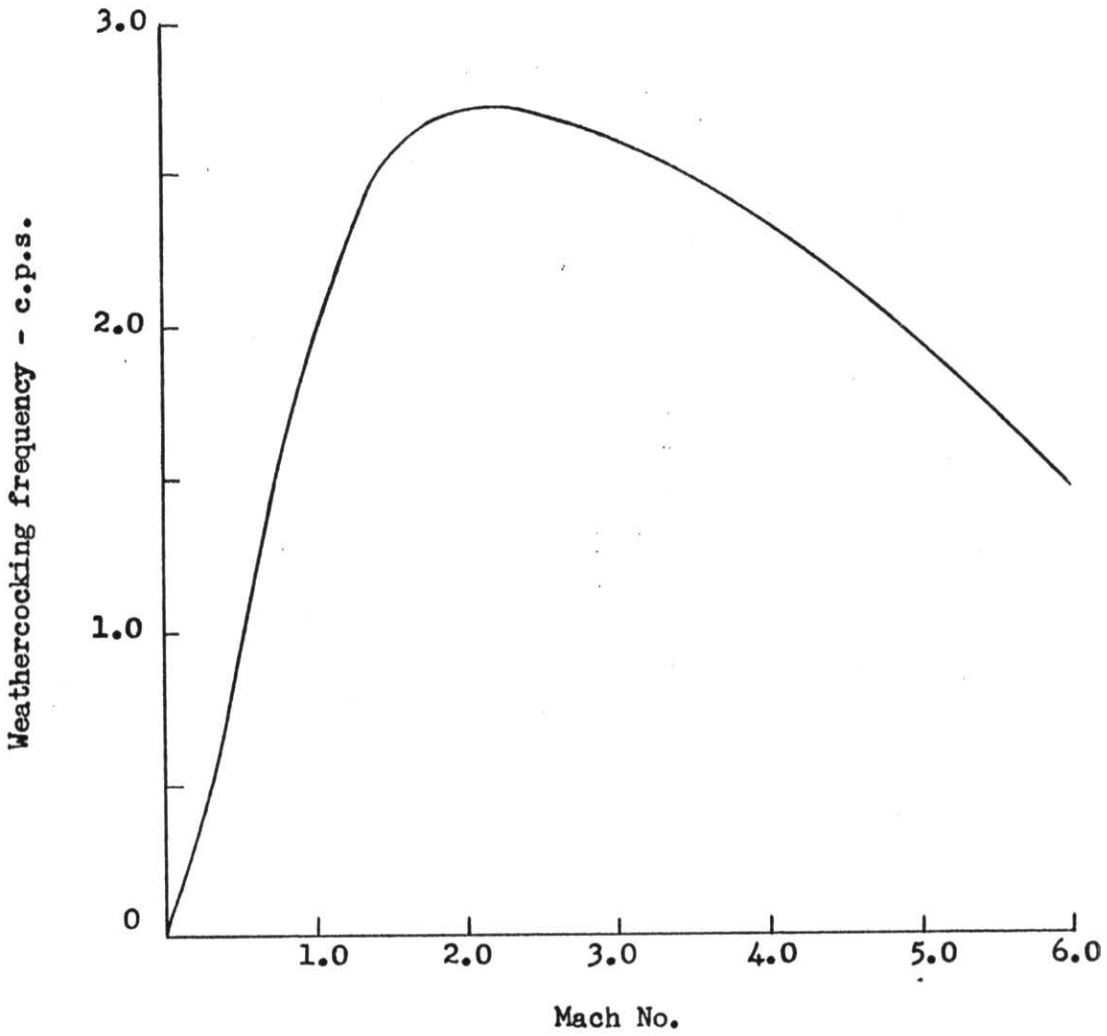
Variation of calculated weathercocking frequency versus Mach No. for BB I - (01 and 02).

Figure 25A



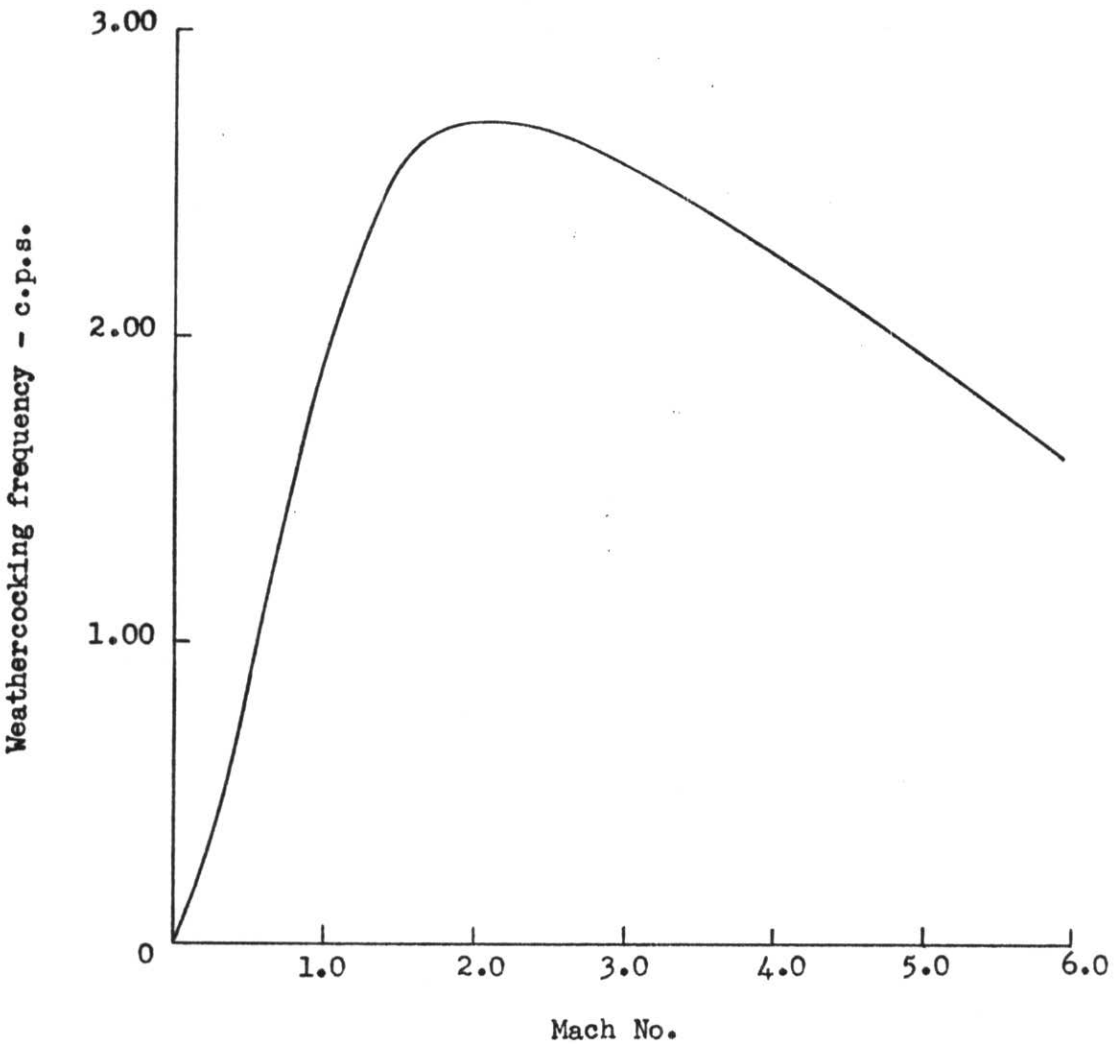
Variation of calculated weathercocking frequency versus Mach No. for BB I - (03 and 04).

Figure 25B



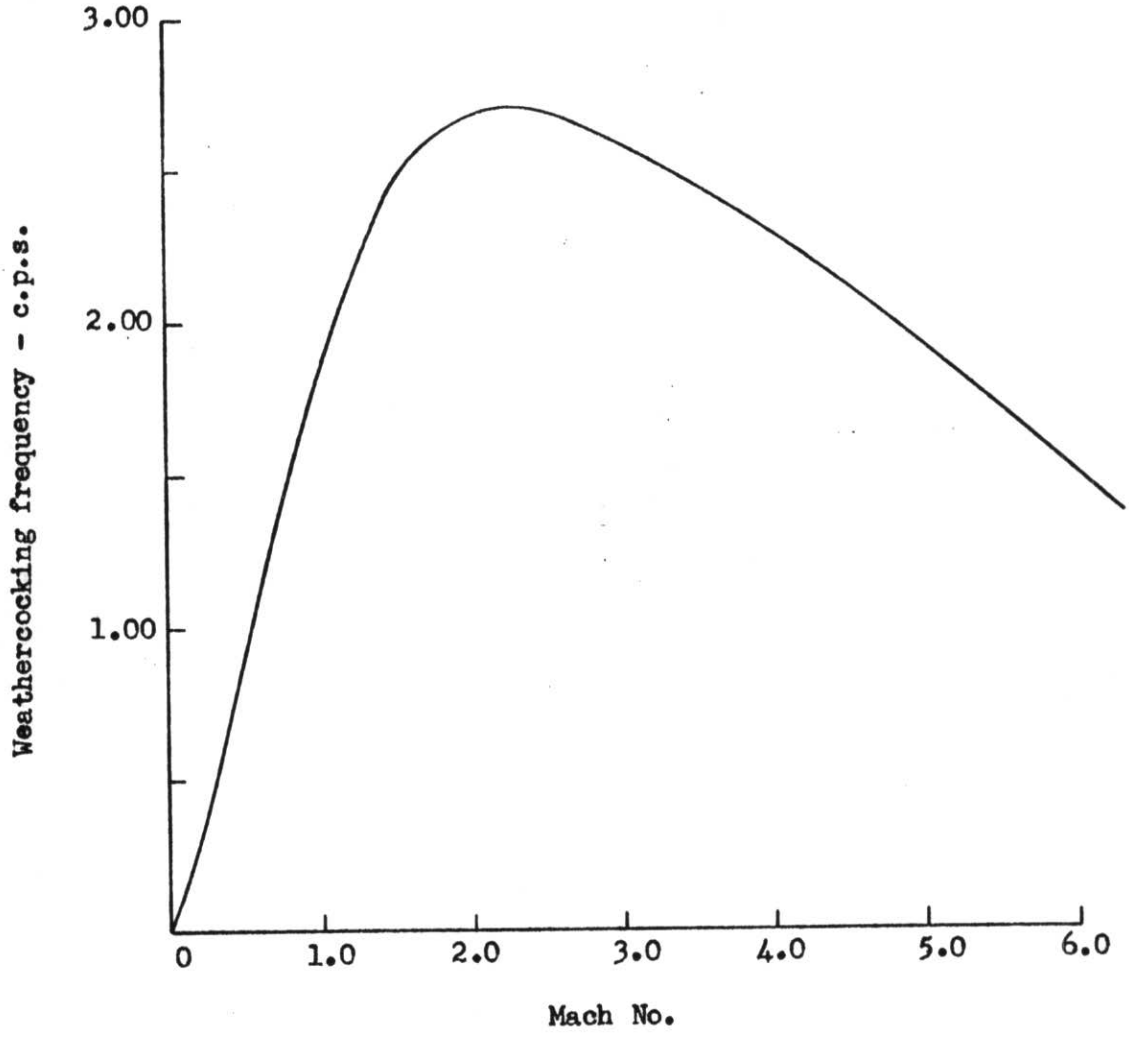
Variation of calculated weathercocking frequency versus Mach No. for BB I - 05..

Figure 25C



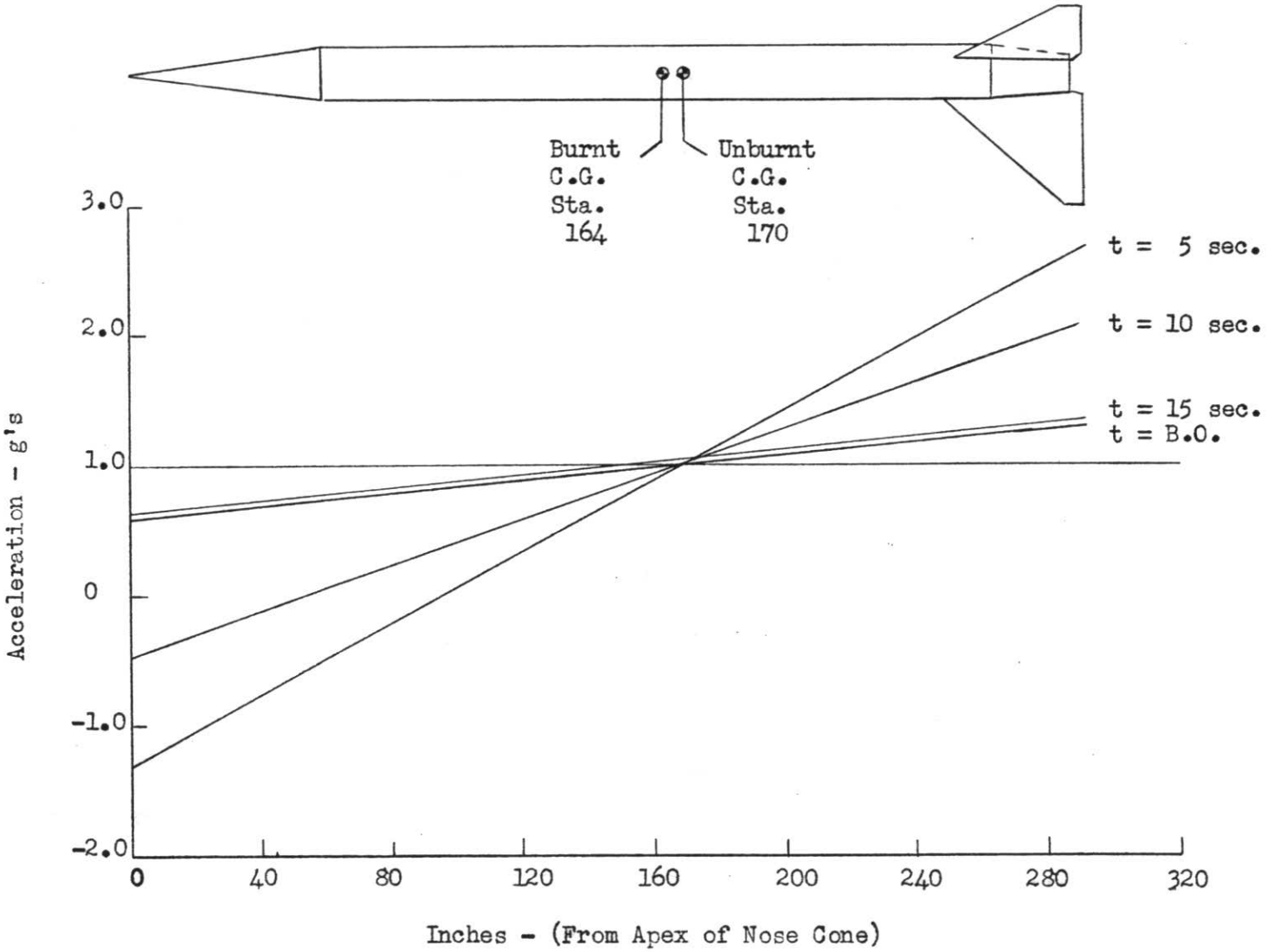
Variation of calculated weathercocking frequency versus Mach No. for BB I - 06.

Figure 25D



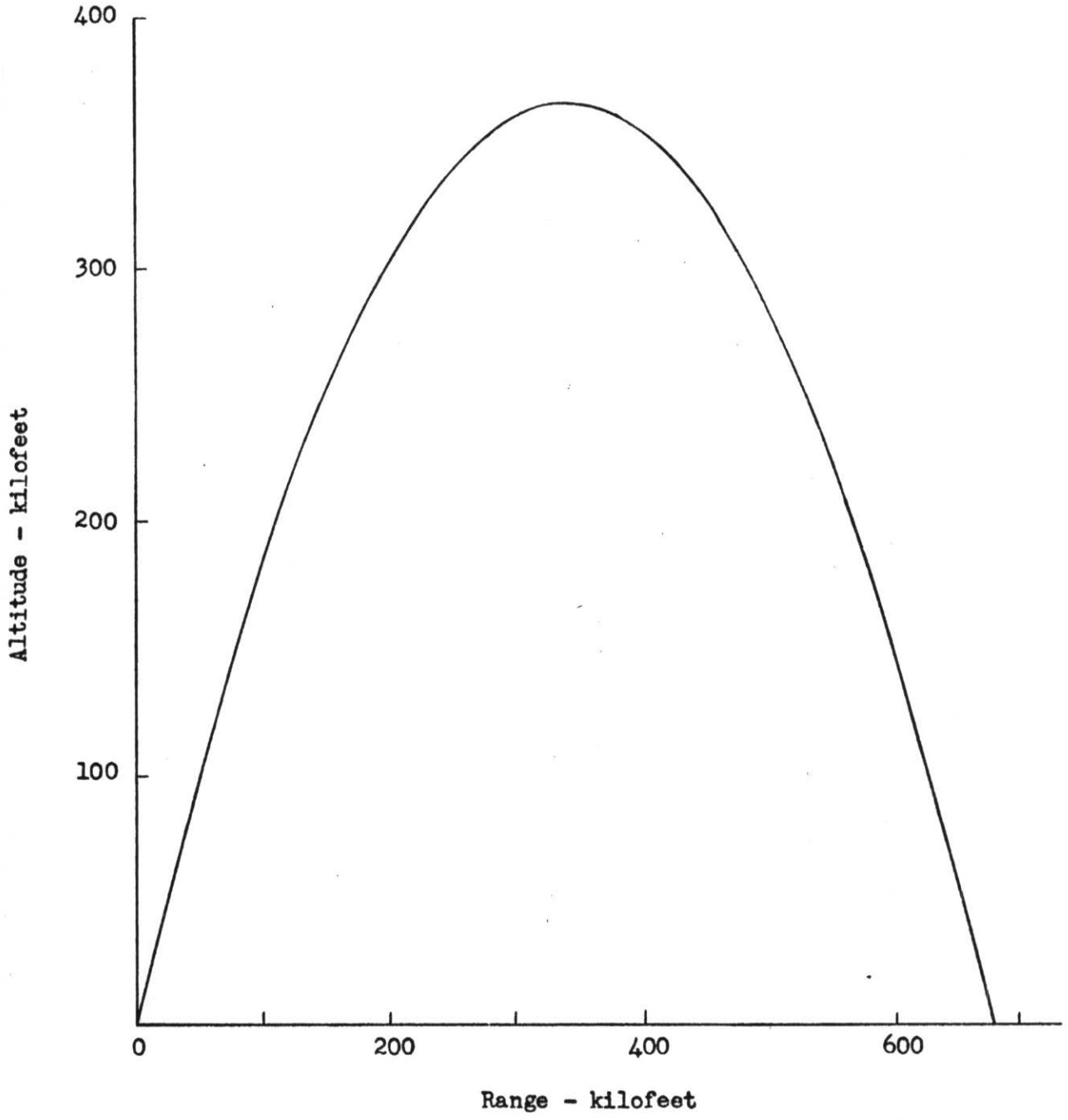
Variation of calculated weathercocking frequency versus Mach No. for BB I - 07.

Figure 25E



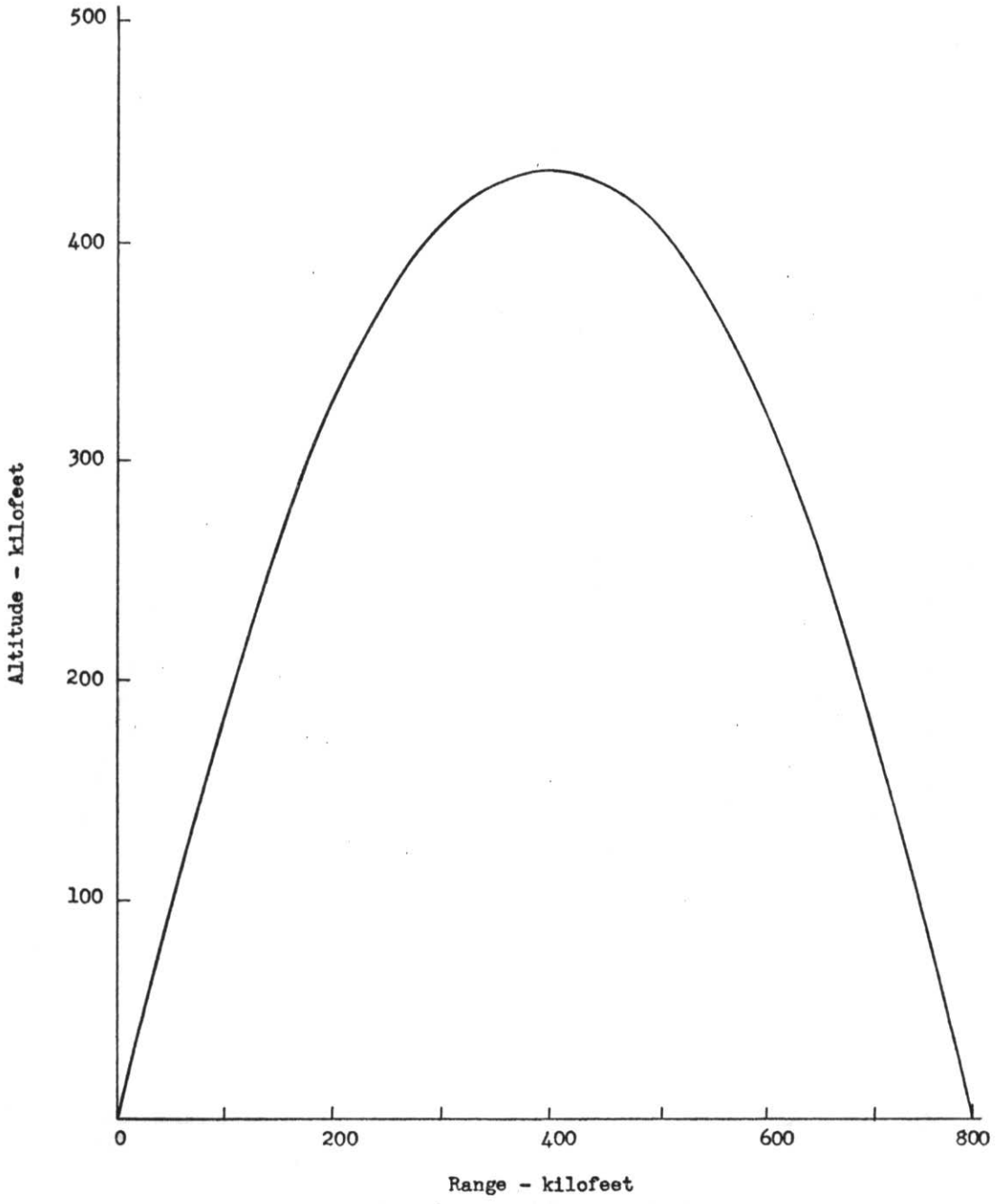
Distribution of lateral accelerations along the rocket vehicle (BB I - 06) for a unit "g" lateral acceleration at C.G. for various time intervals during boost phase.

Figure 25F



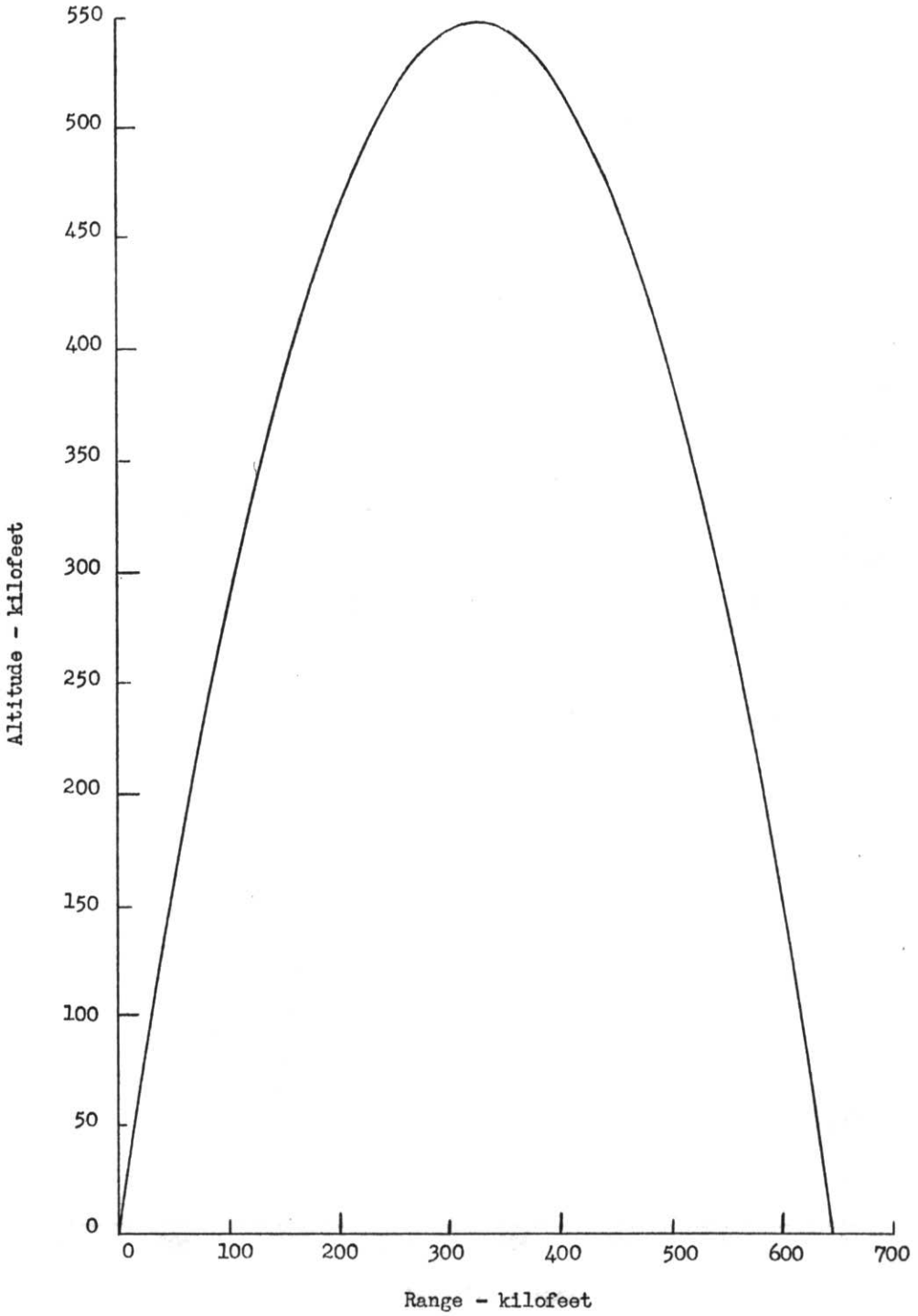
Calculated trajectory for BB I - (01 and 02).

Figure 26A



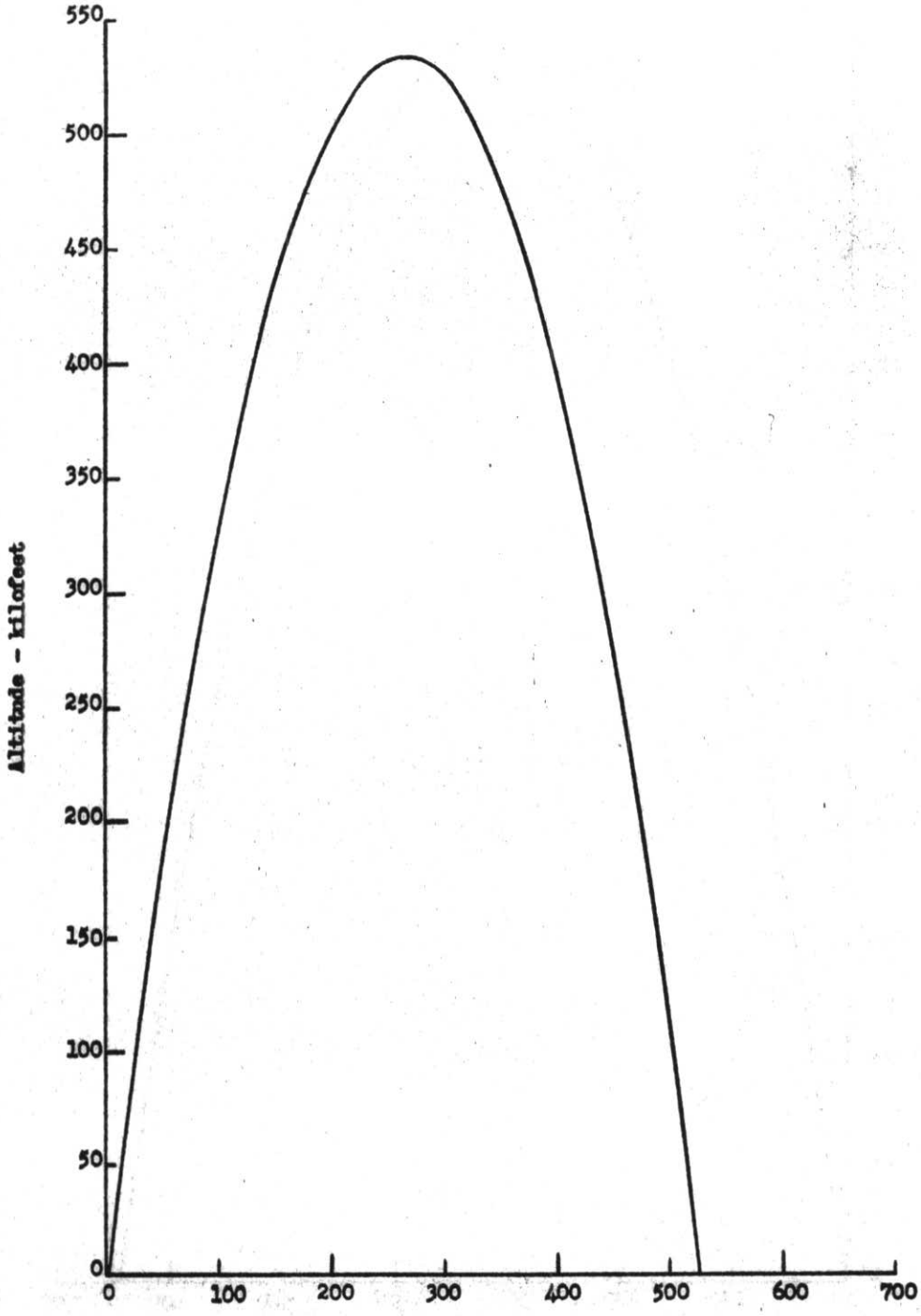
Calculated trajectory for BB I - (03 and 04).

Figure 26B



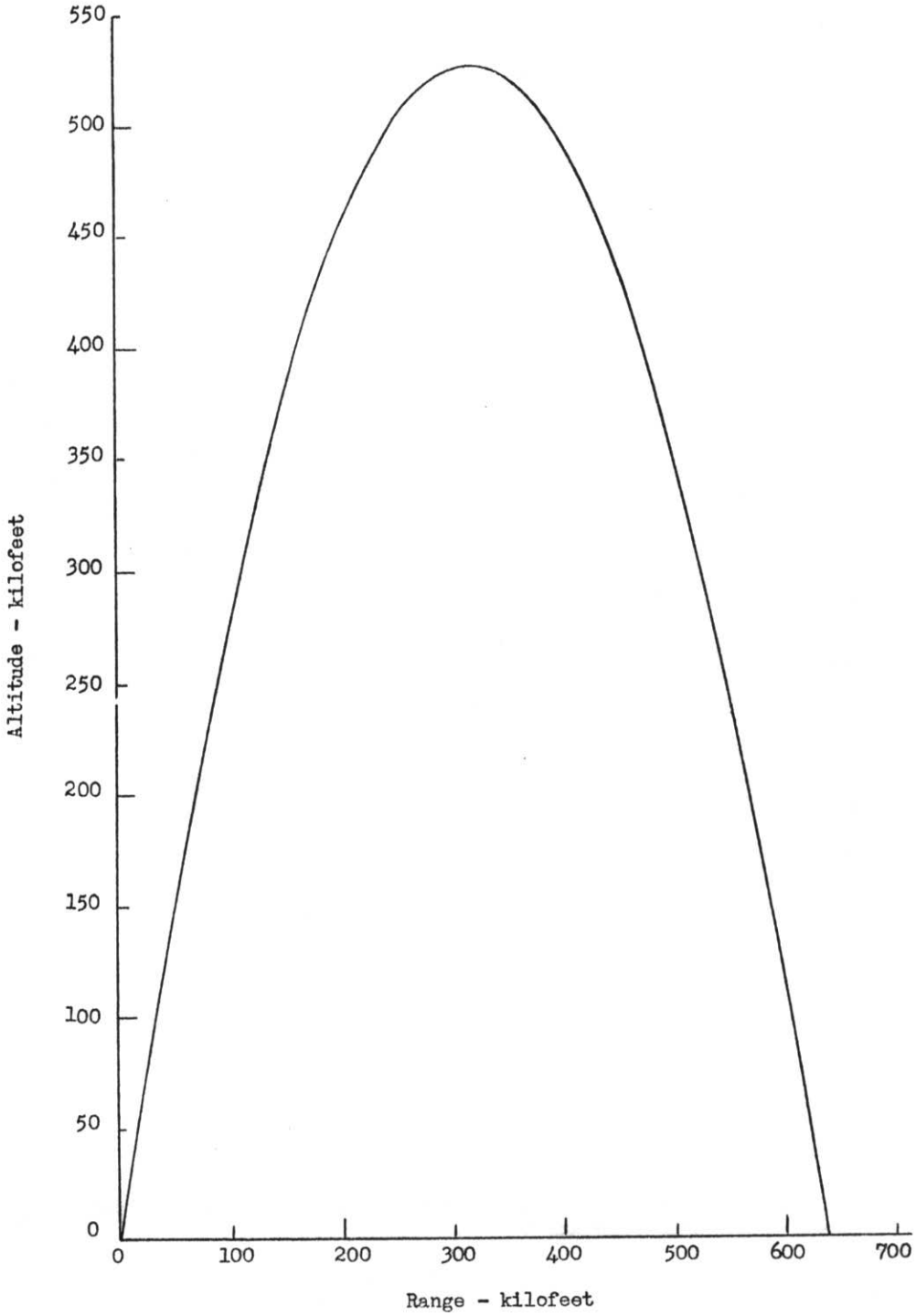
Calculated trajectory for BB I - 05.

Figure 26C



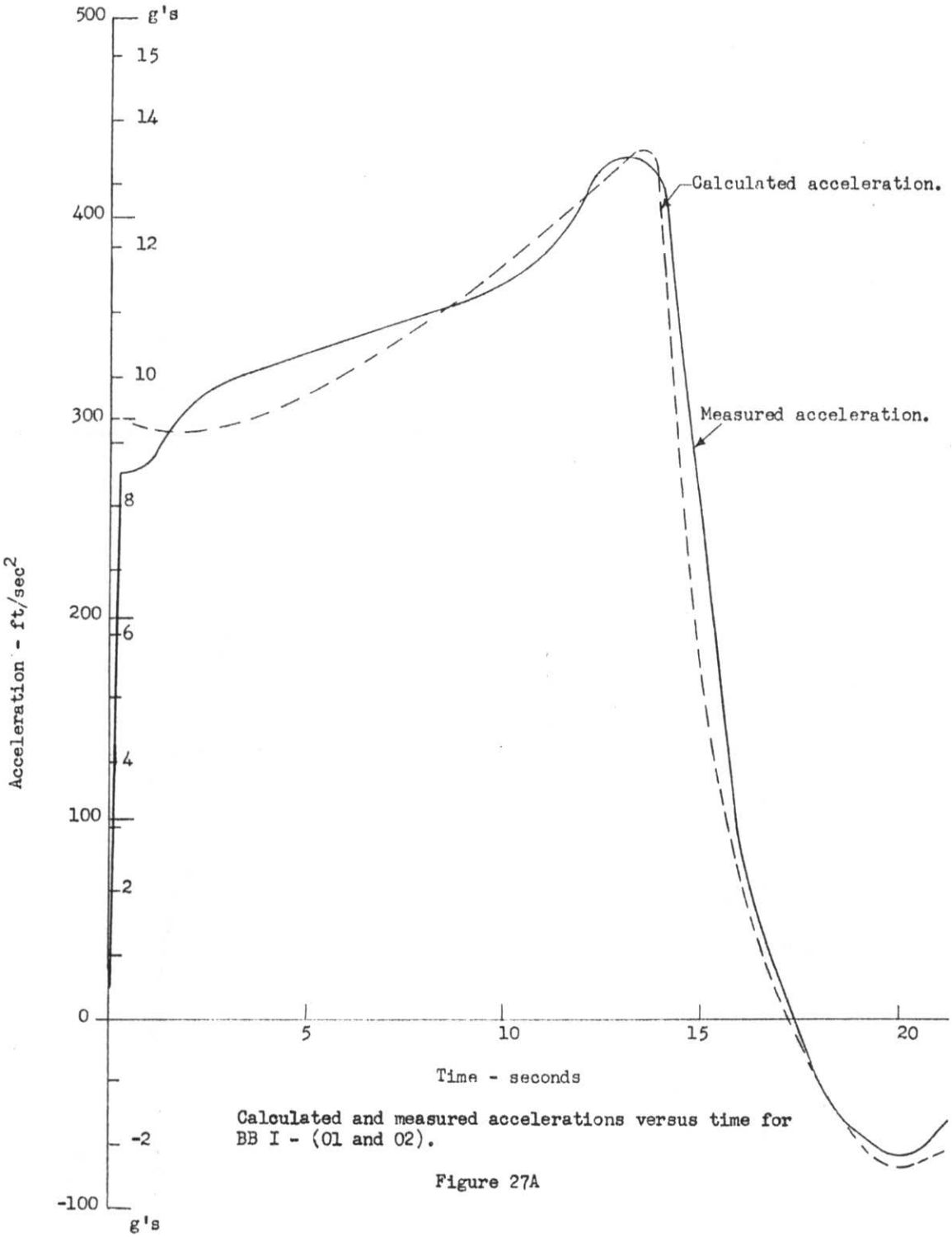
Calculated trajectory for BB I - 06.

Figure 26D



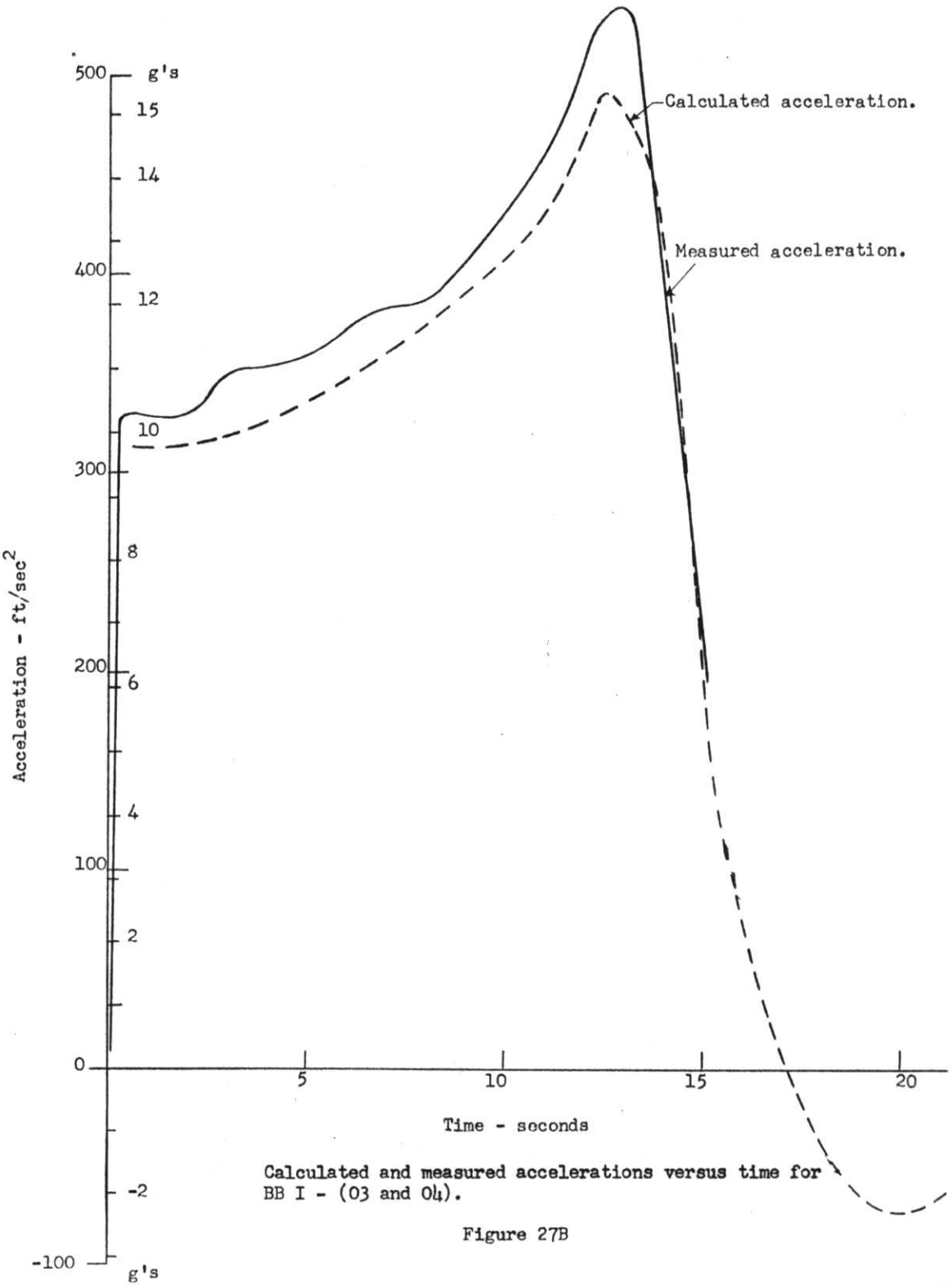
Calculated trajectory for BB I - 07.

Figure 26E



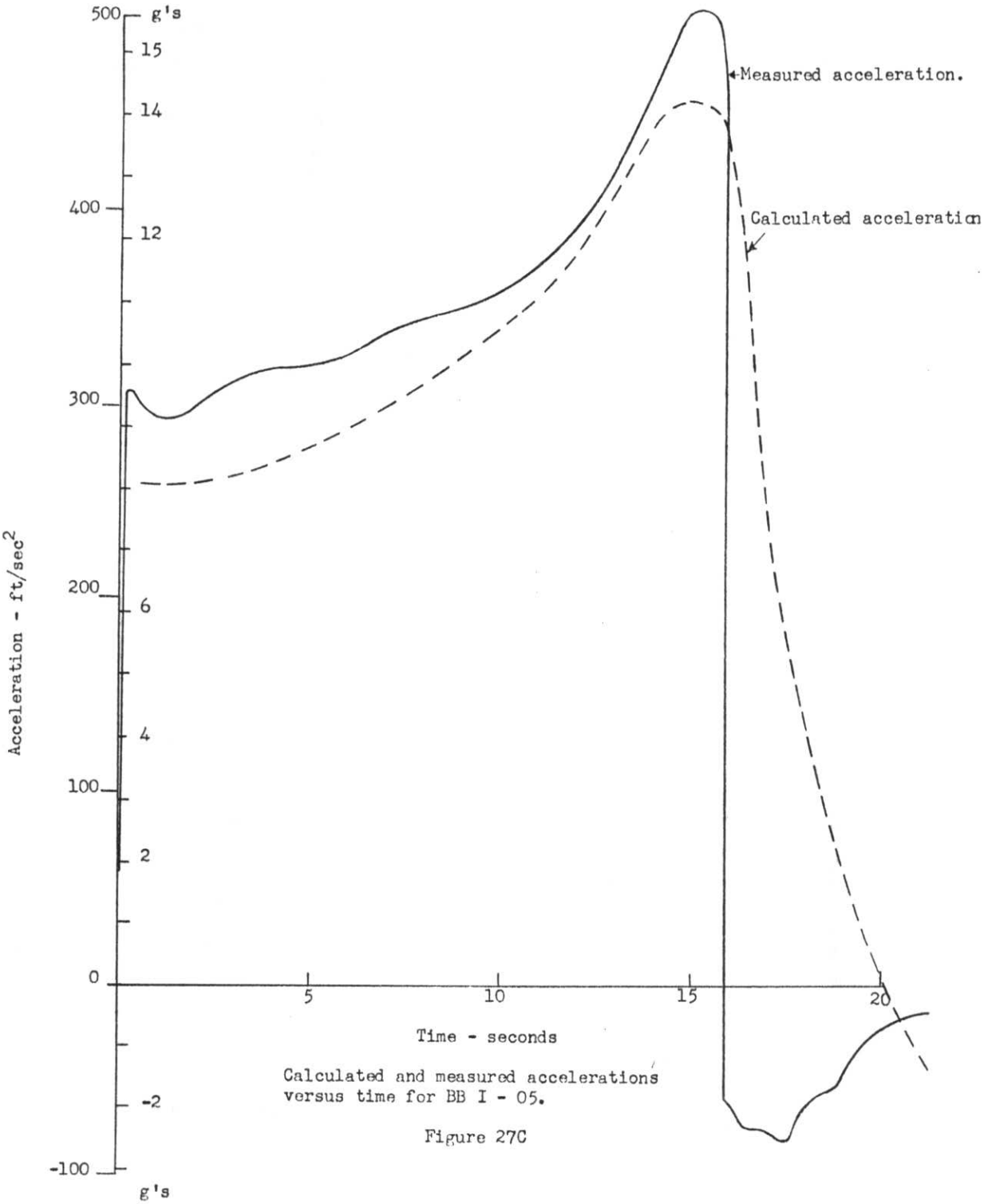
Calculated and measured accelerations versus time for BB I - (01 and 02).

Figure 27A



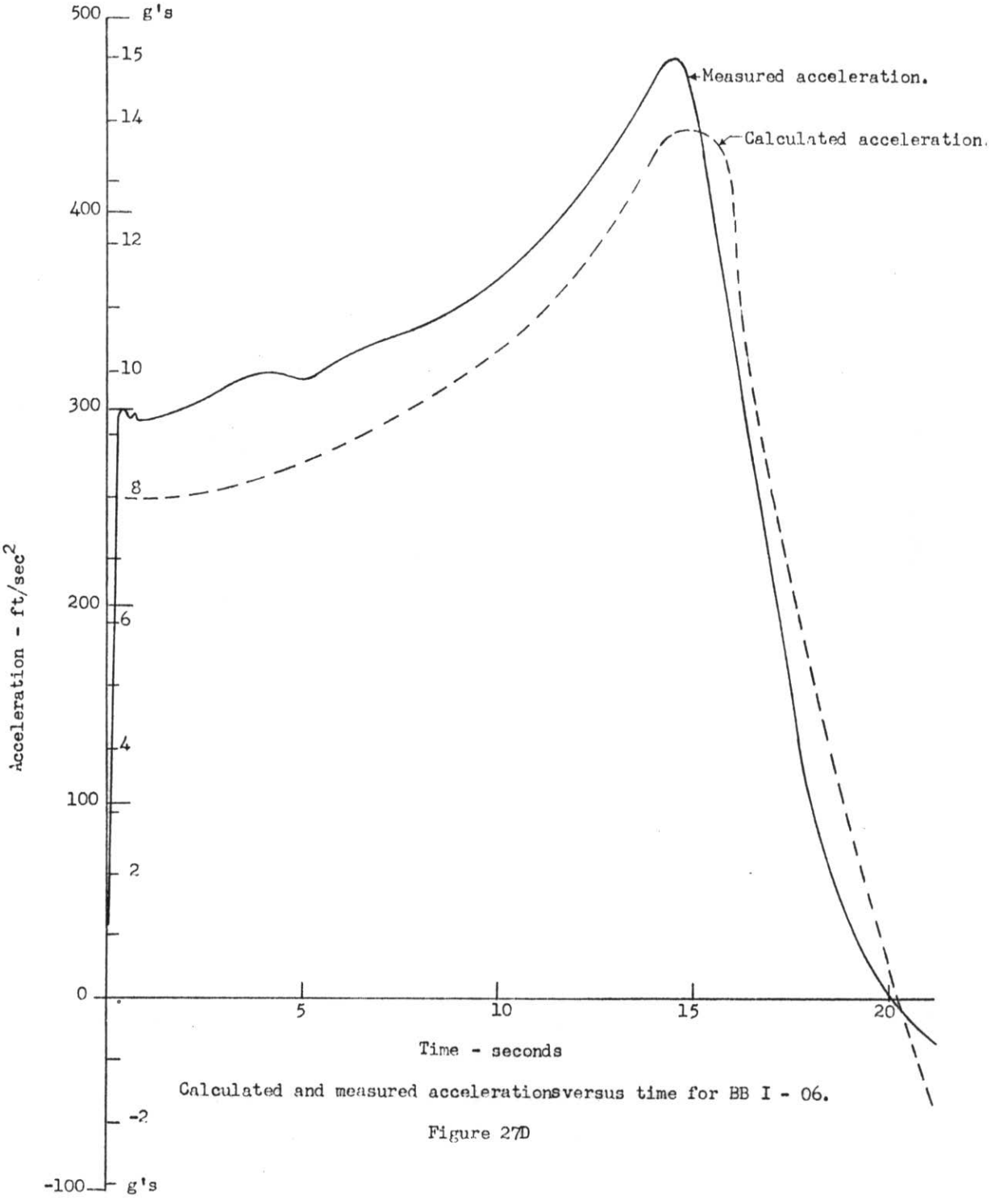
Calculated and measured accelerations versus time for BB I - (03 and 04).

Figure 27B



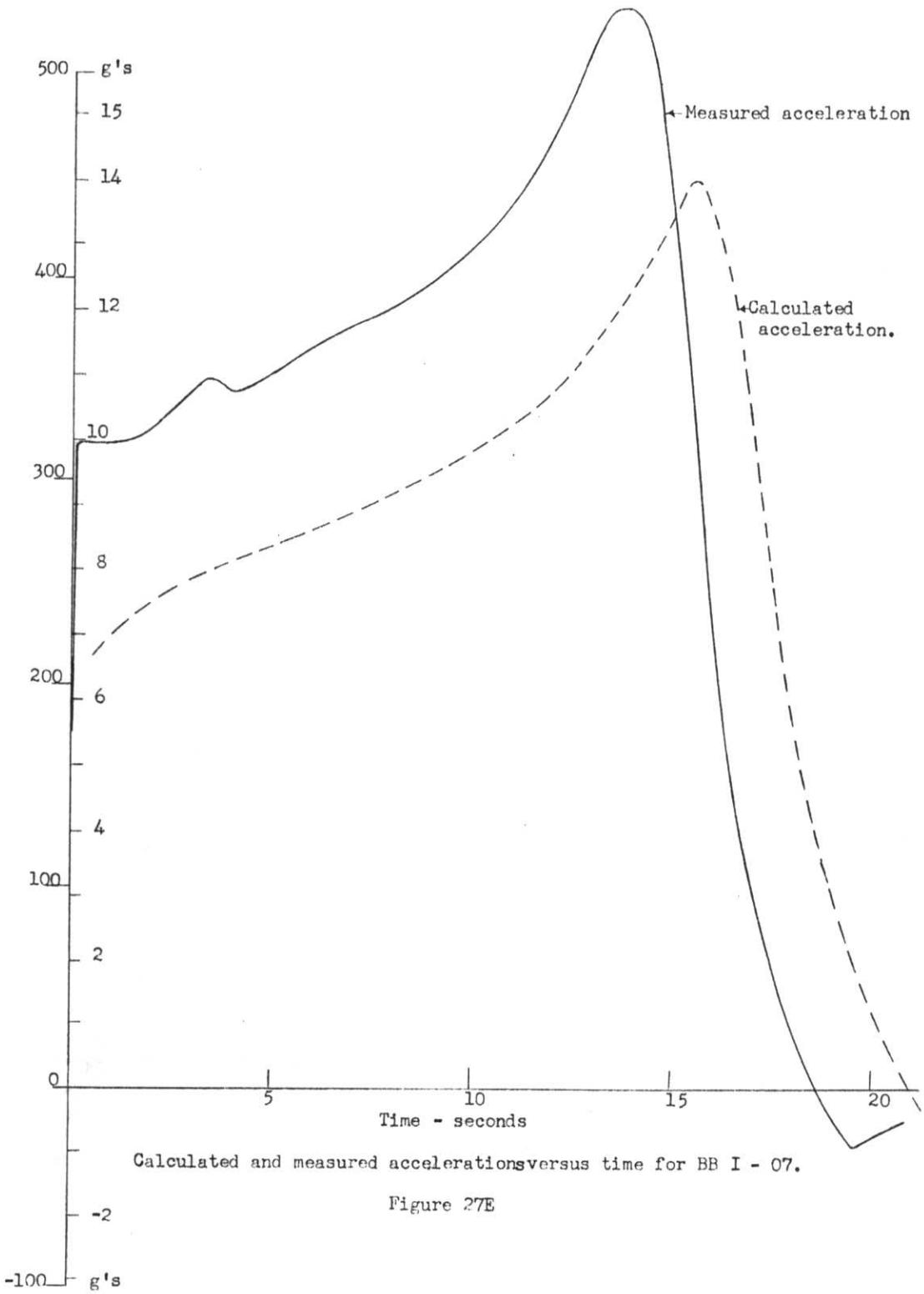
Calculated and measured accelerations versus time for BB I - 05.

Figure 27C



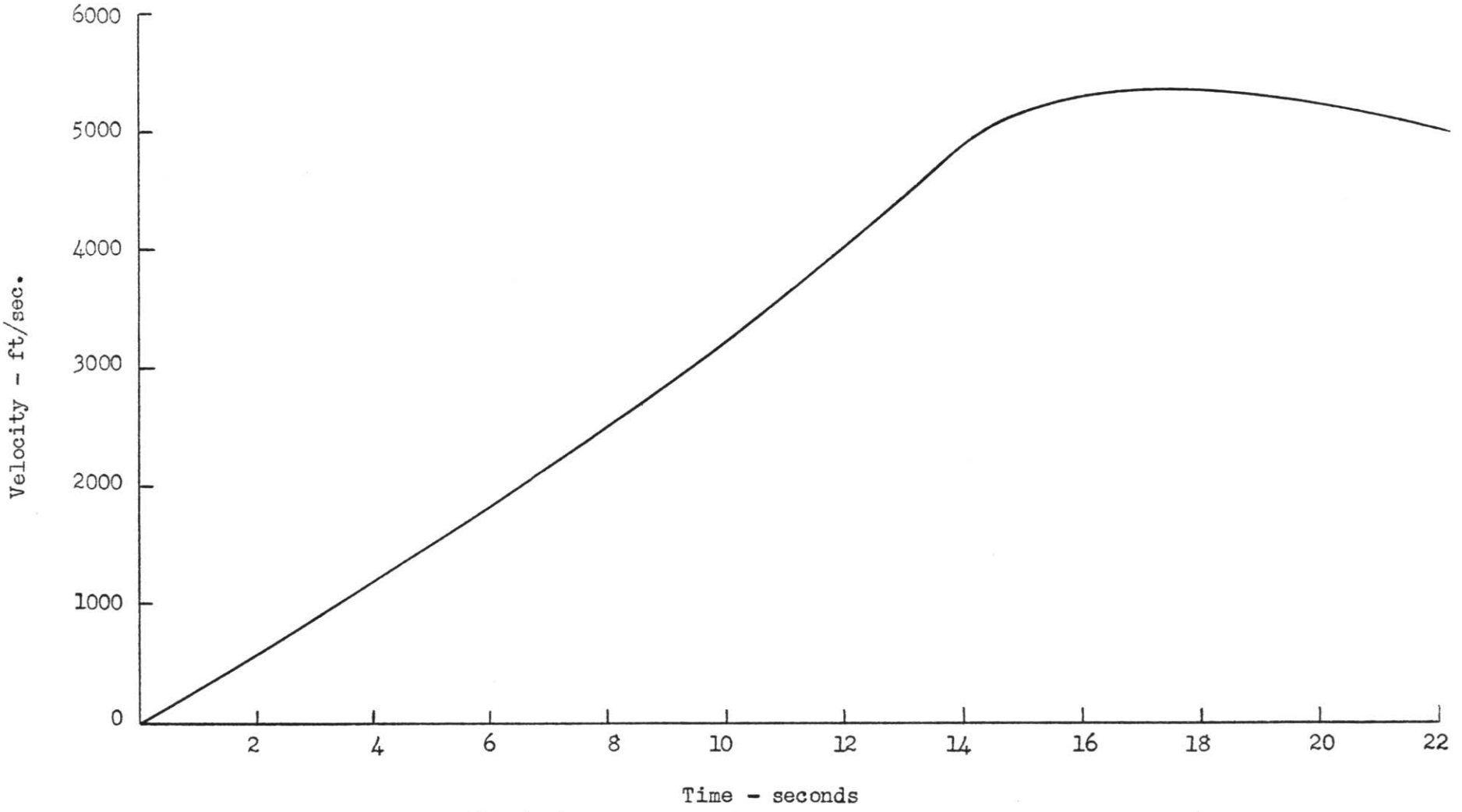
Calculated and measured accelerationsversus time for BB I - 06.

Figure 27D



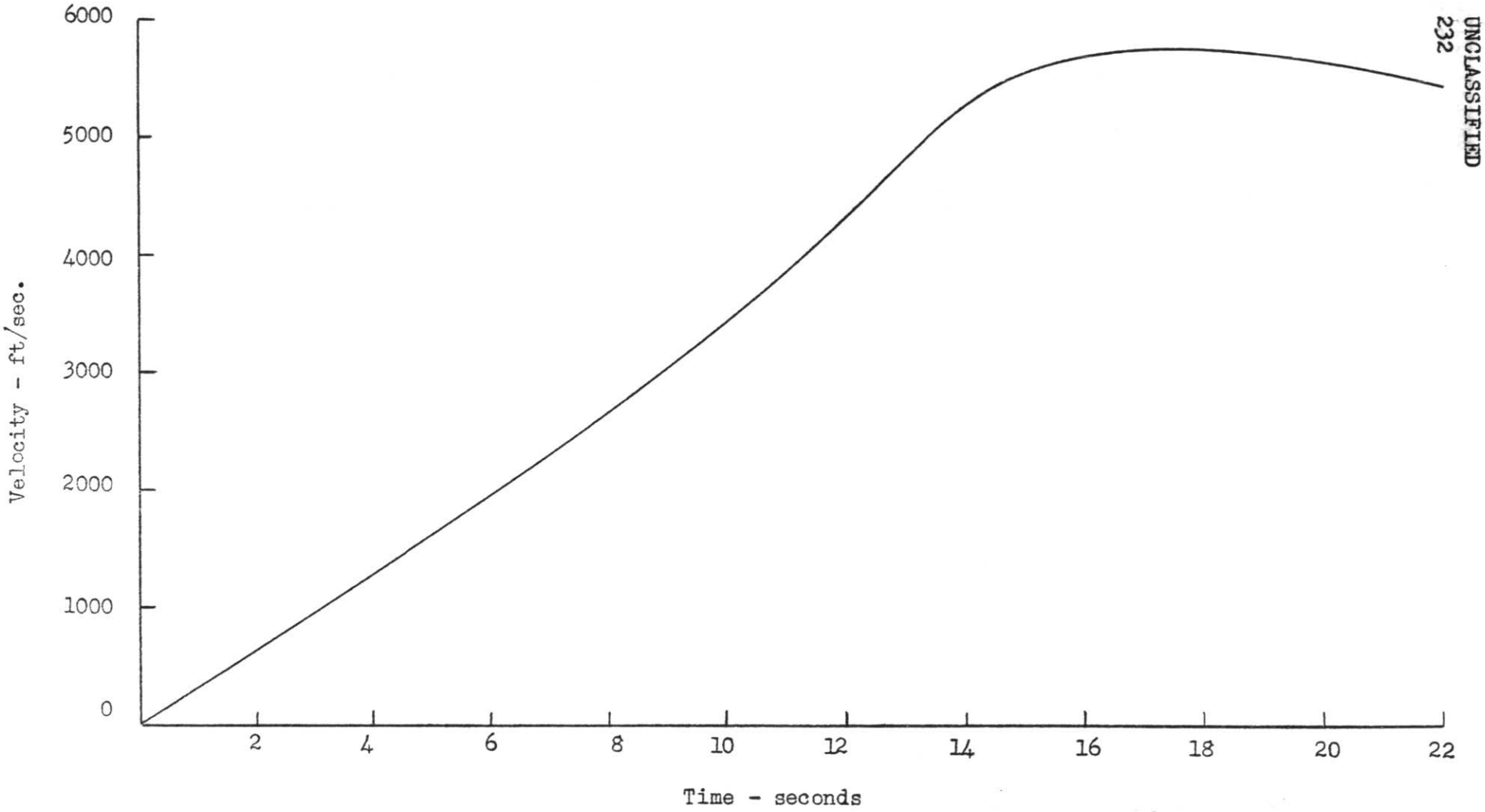
Calculated and measured accelerationsversus time for BB I - 07.

Figure 27E



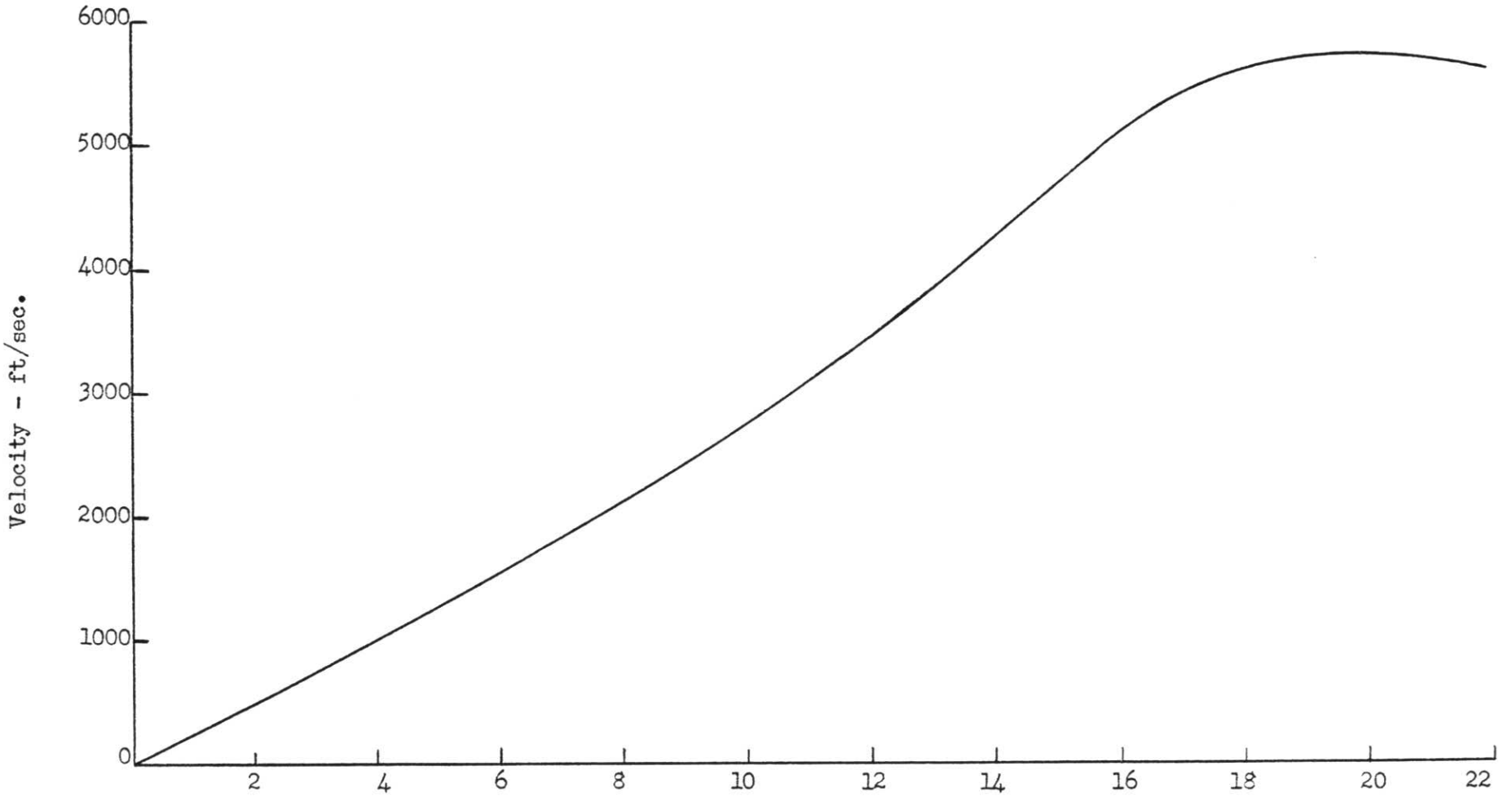
Variation of calculated velocity versus time for BB I - (01 and 02).

Figure 28A



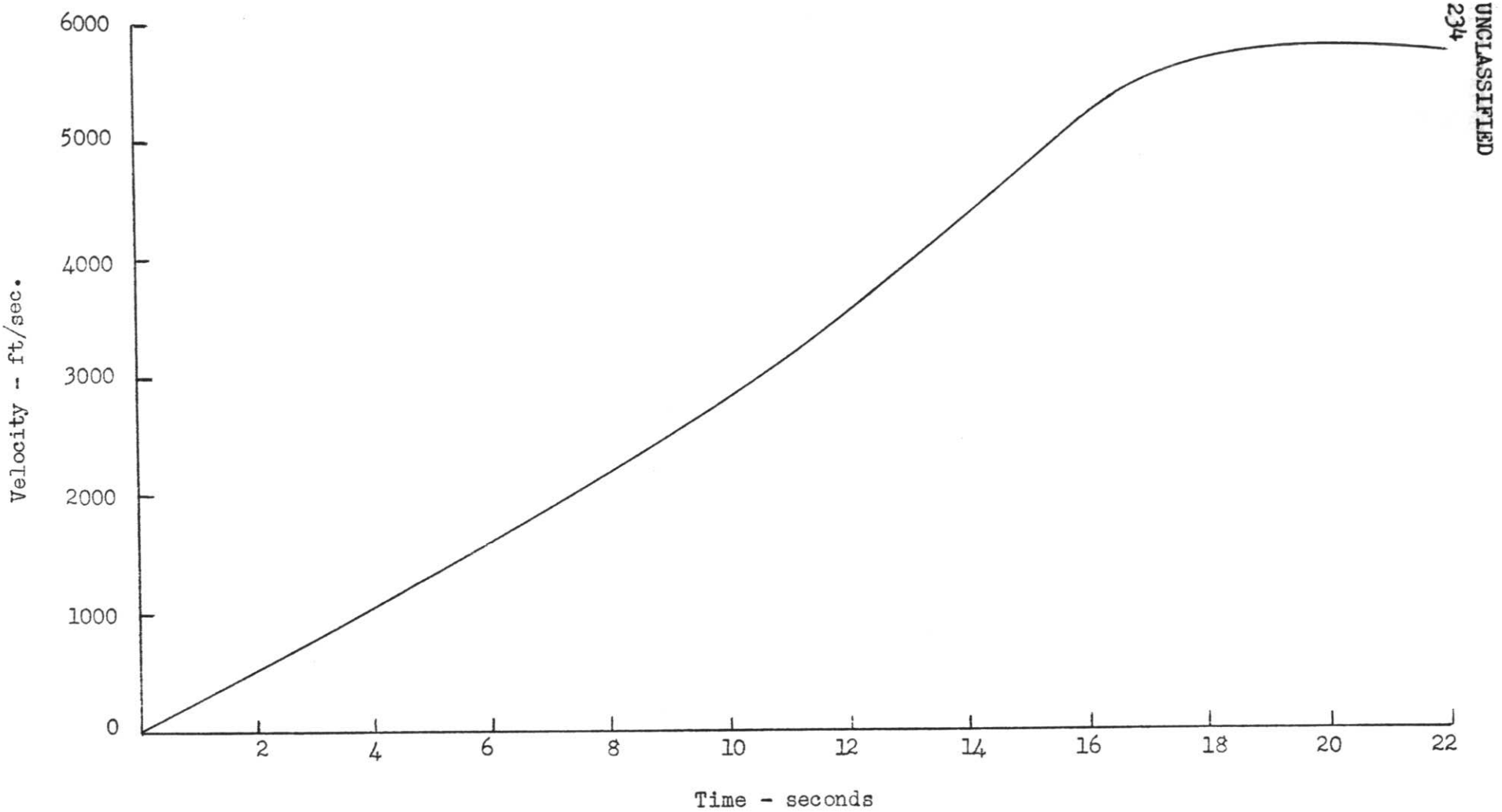
Variation of calculated velocity versus time for BB I - (03 and 04).

Figure 28B



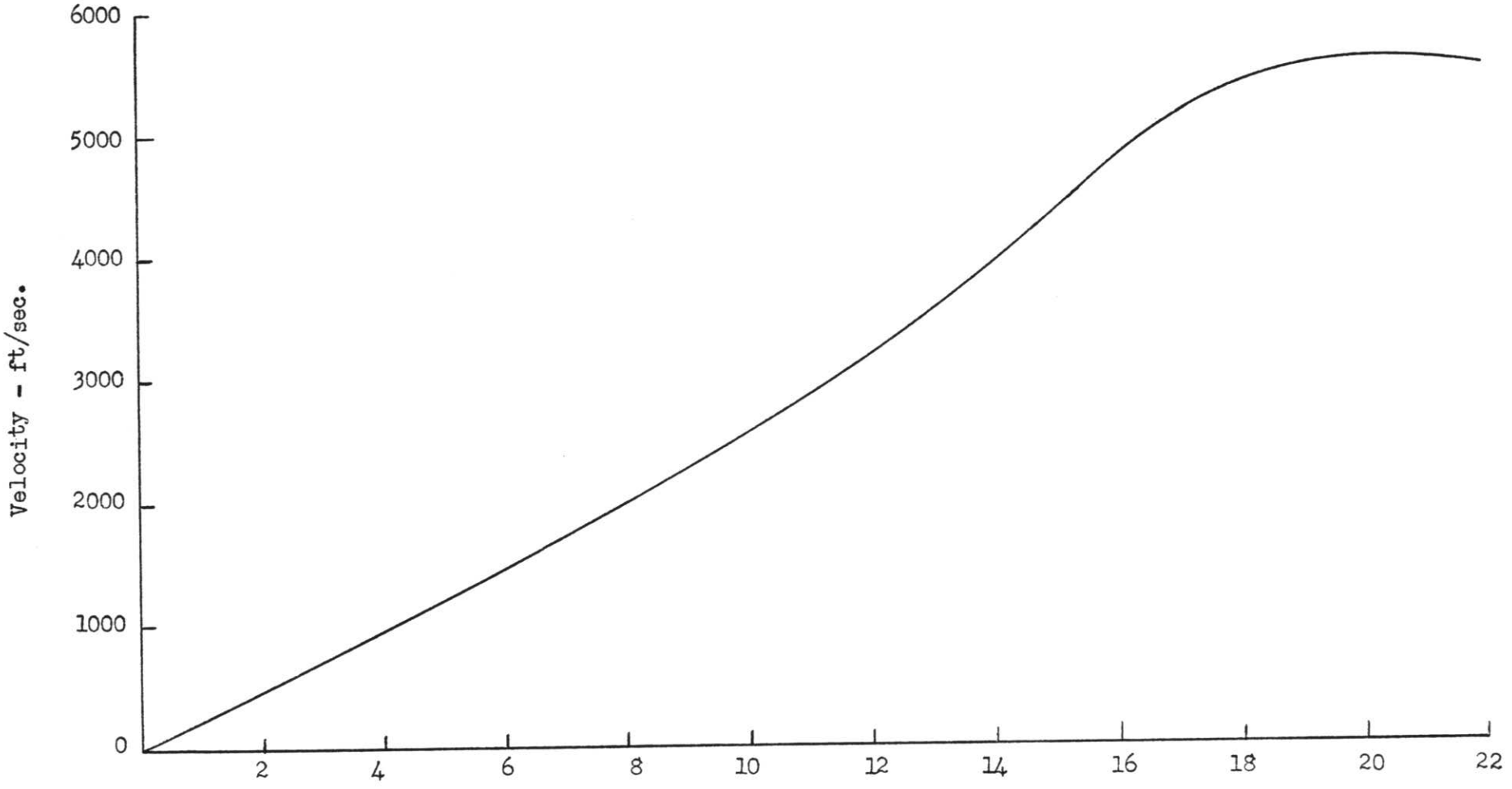
Variation of calculated velocity versus time for BB I - 05.

Figure 28C



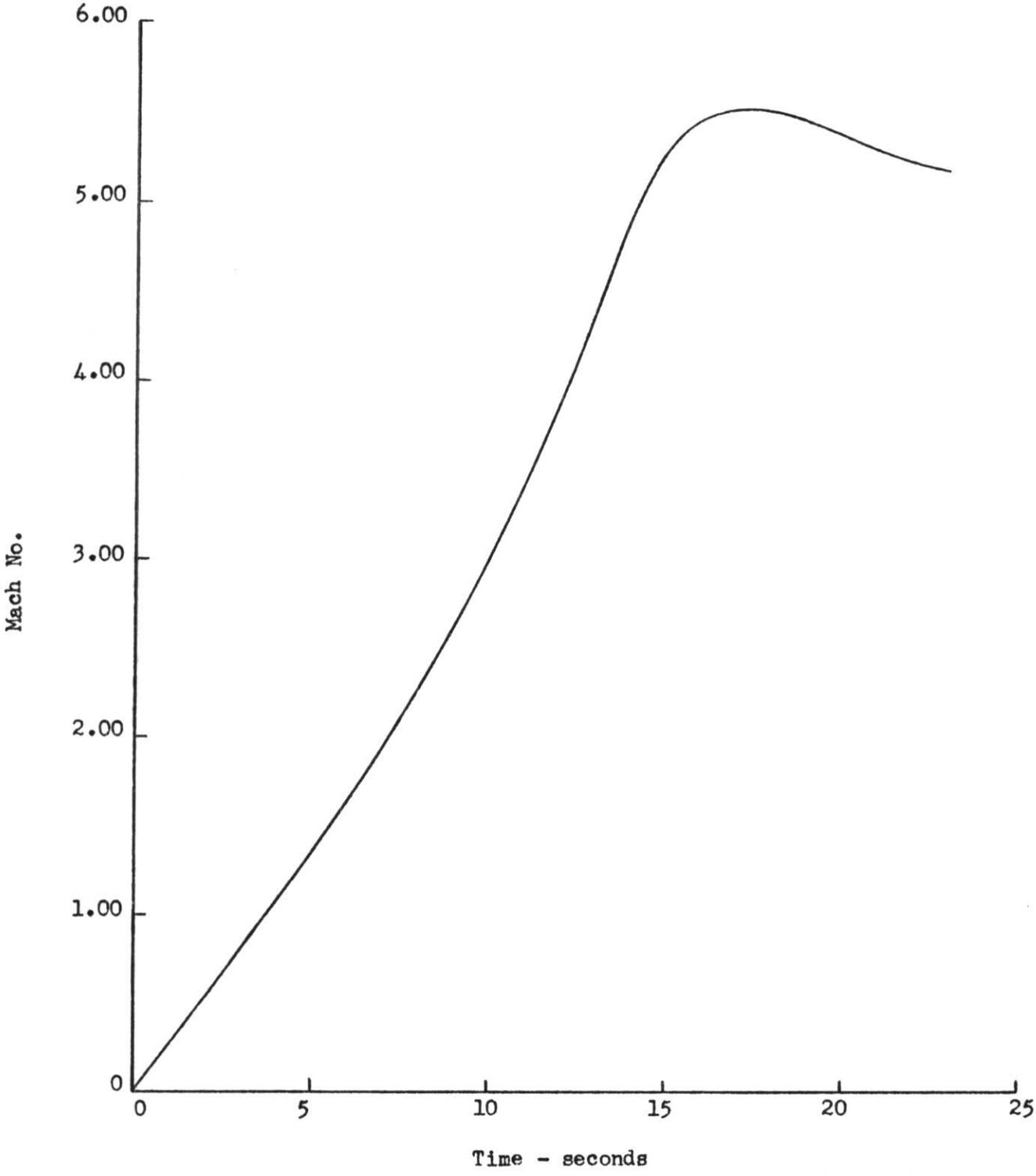
Variation of calculated velocity versus time for BB I - 06.

Figure 28D



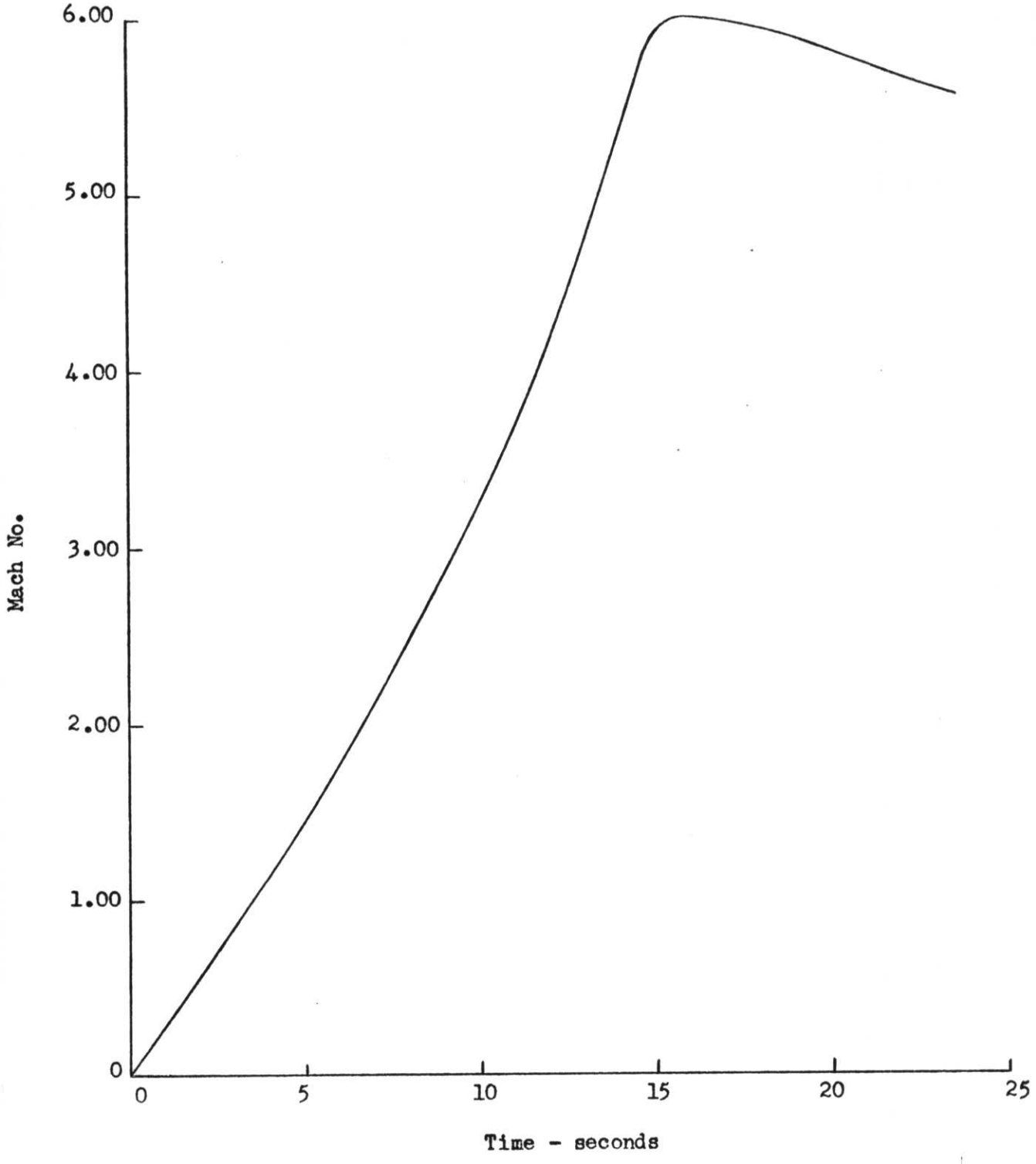
Variation of calculated velocity versus time for BB I - 07.

Figure 28E



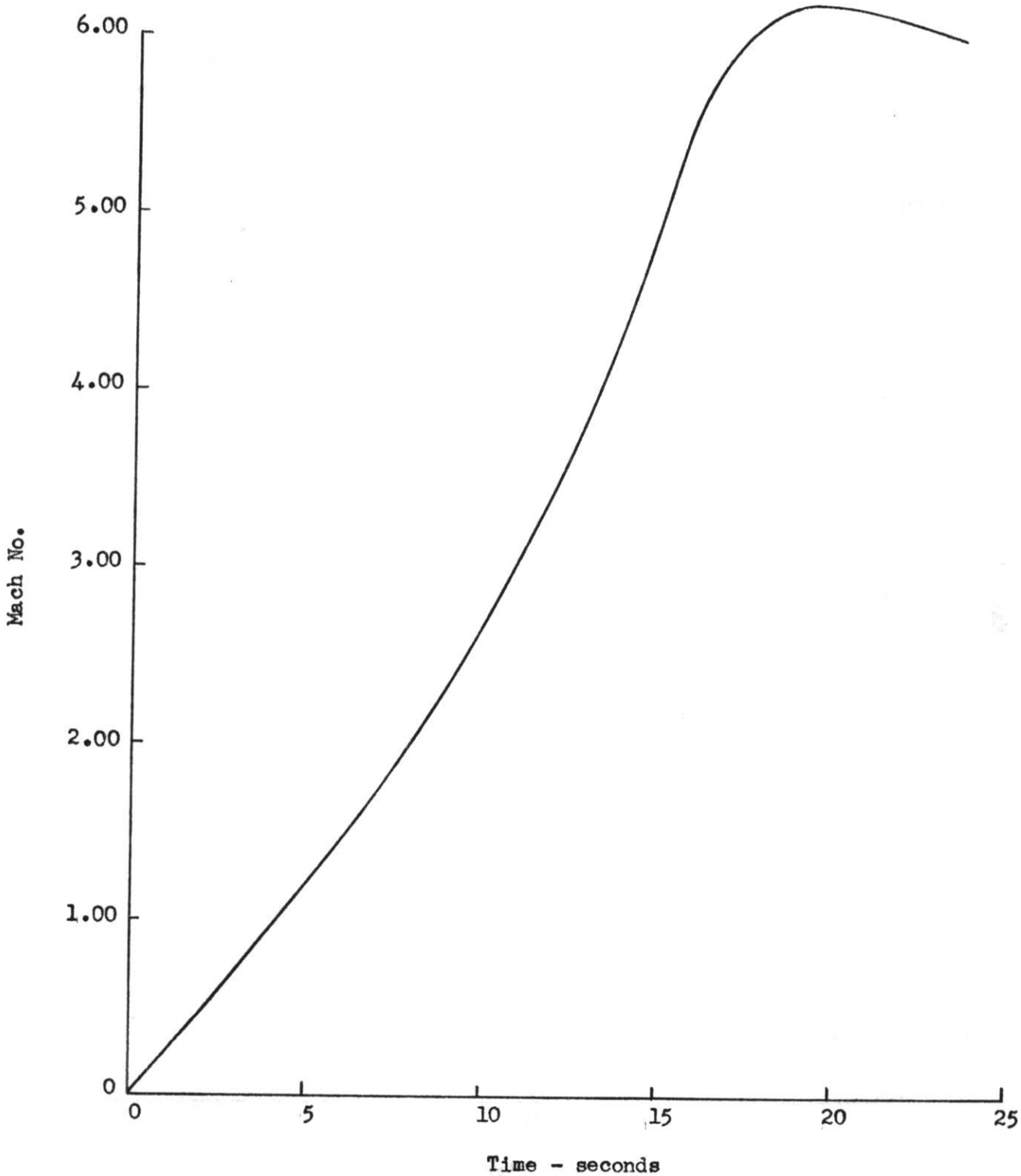
Calculated Mach No. versus time for BB I - (01 and 02).

Figure 29A



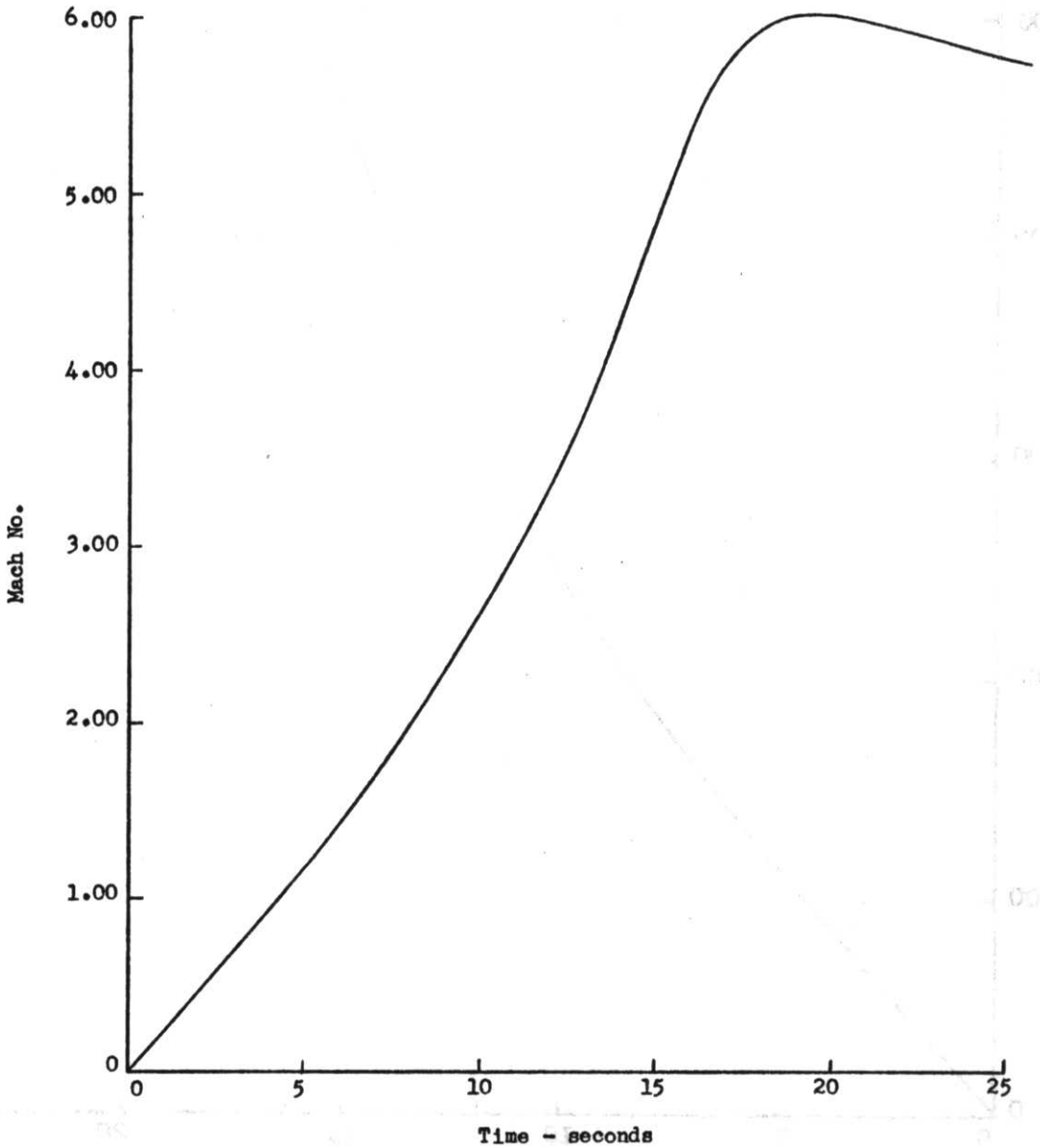
Calculated Mach No. versus time for BB I - (03 and 04).

Figure 29B



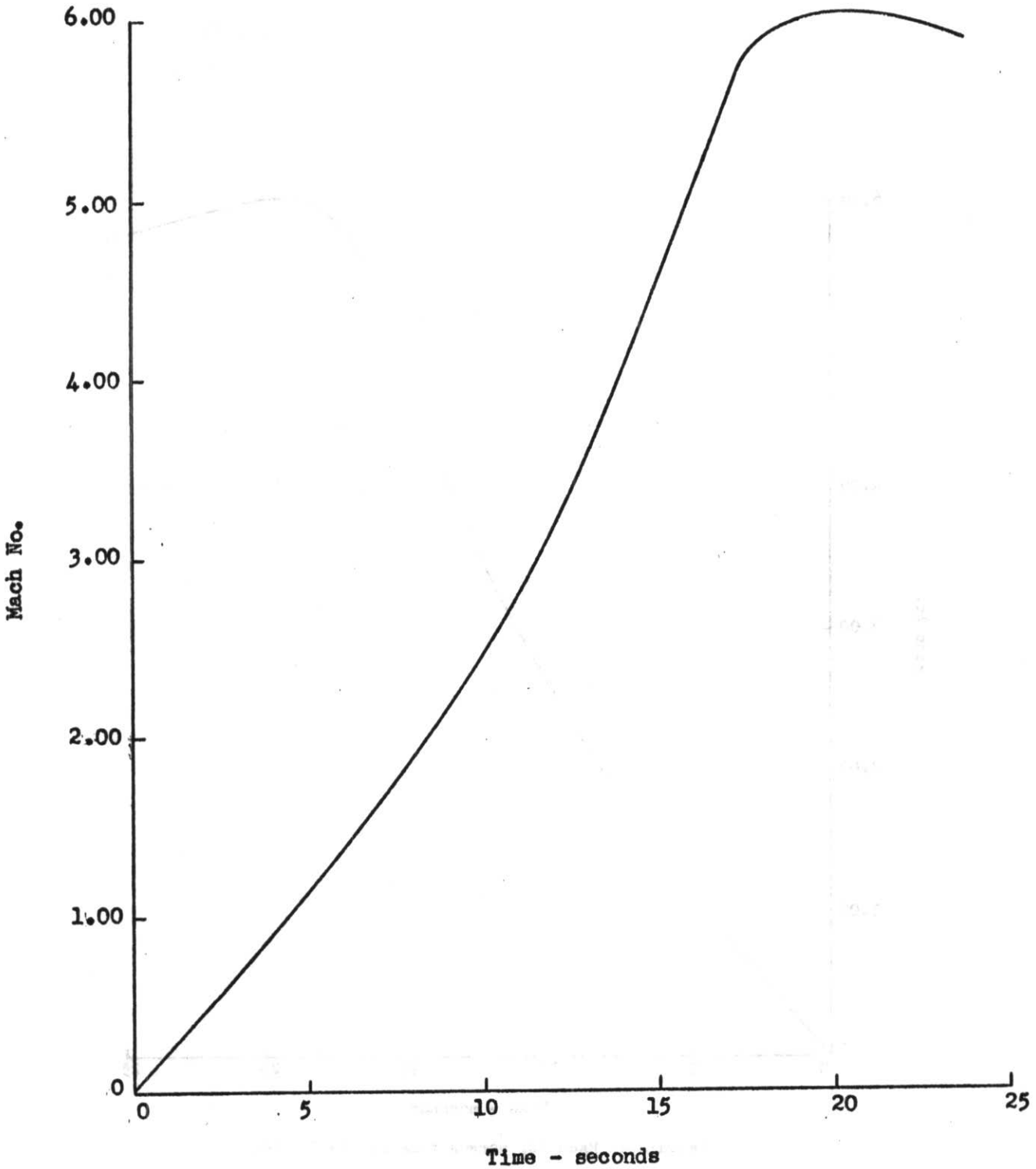
Calculated Mach No. versus time for BB I - 05.

Figure 29C



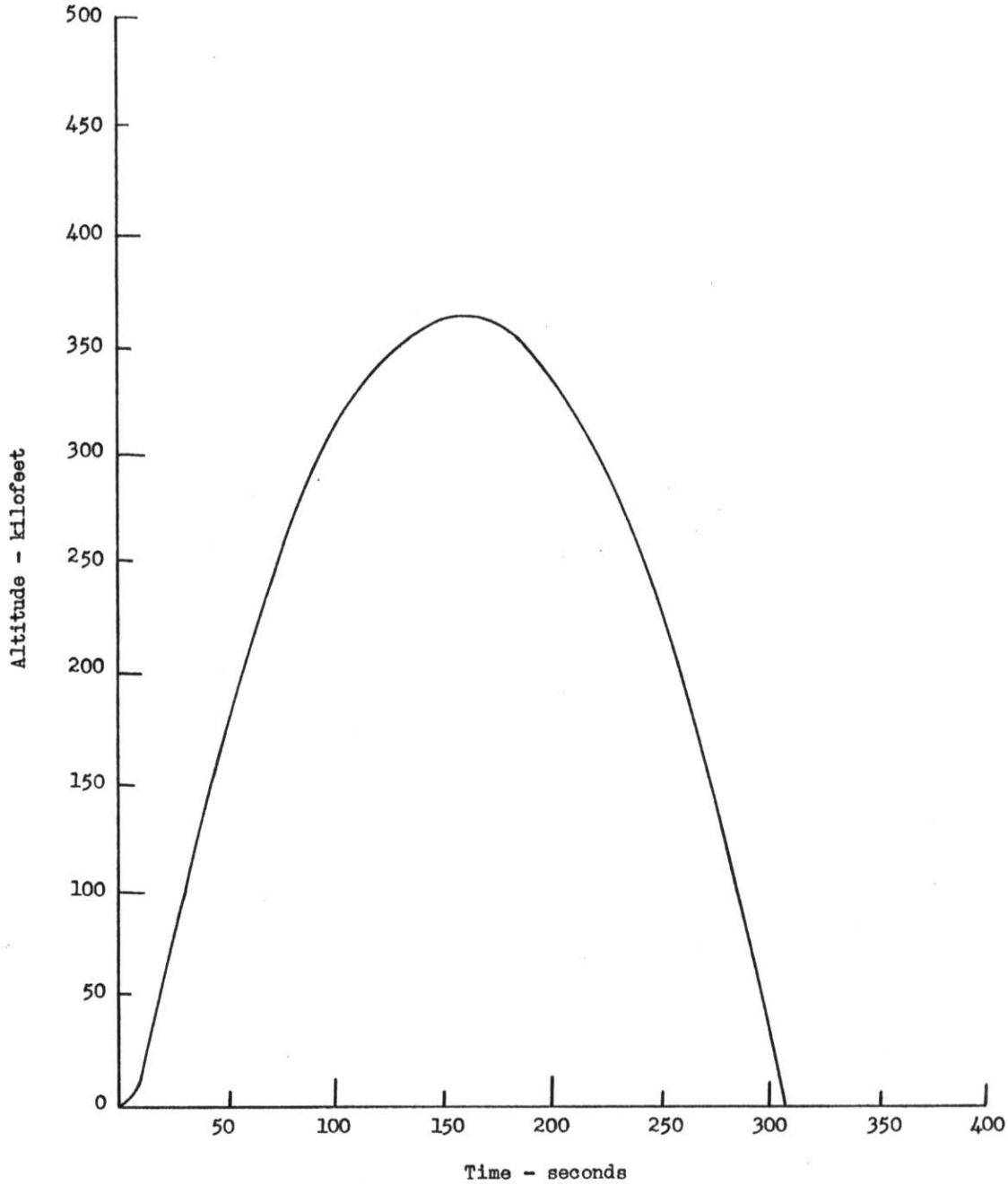
Calculated Mach No. versus time for BB I - 06.

Figure 29D



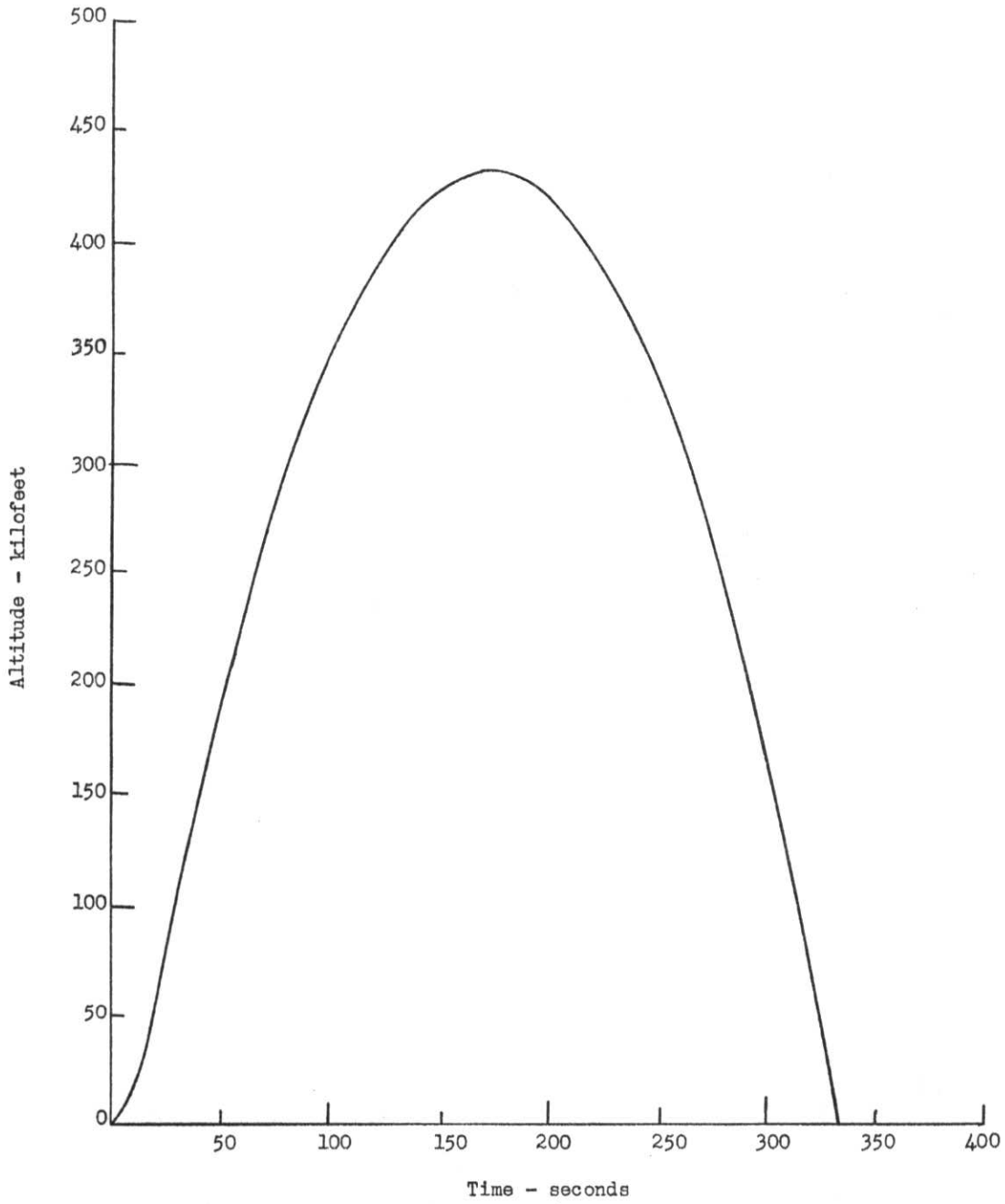
Calculated Mach No. versus time for BB I - 07.

Figure 29E



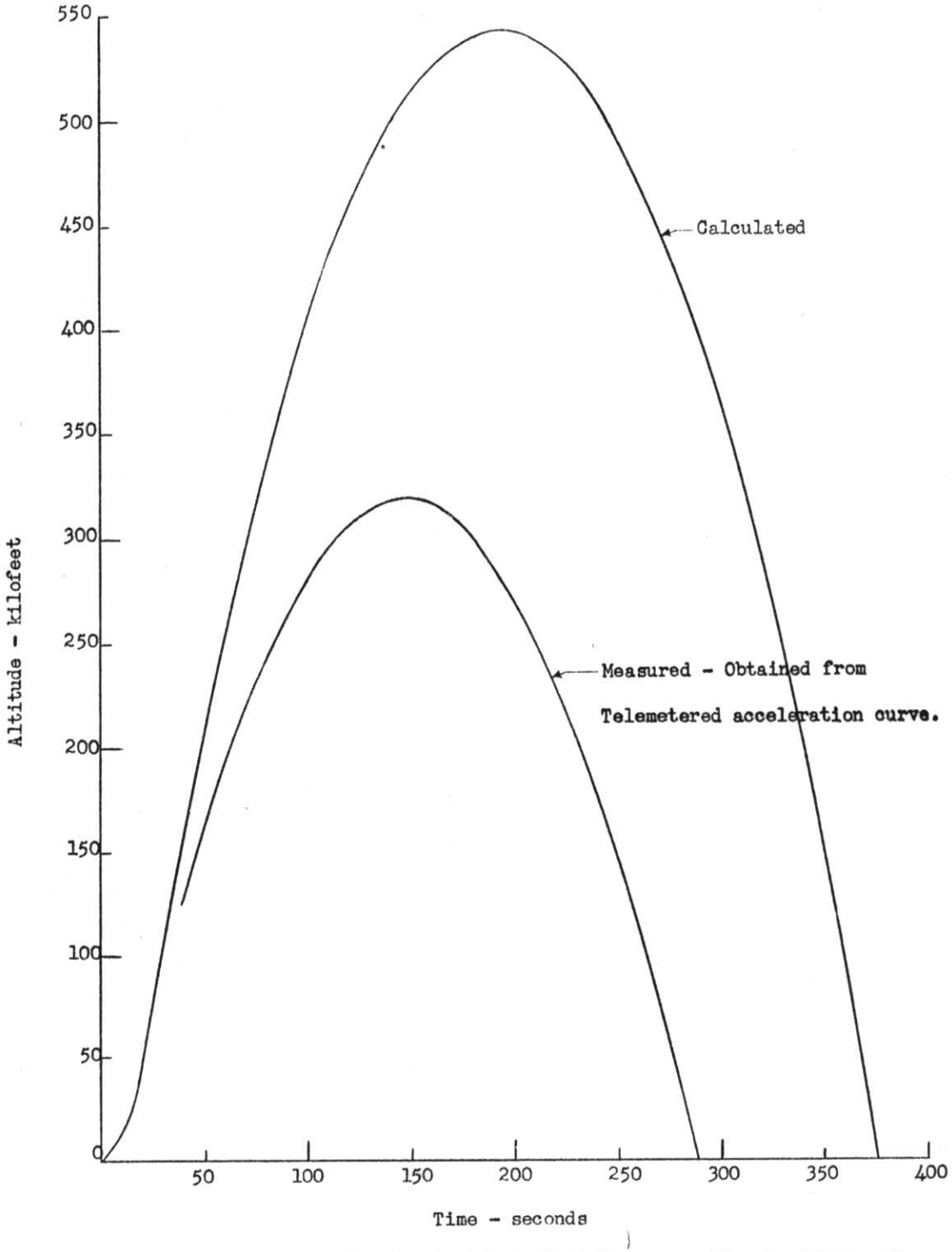
Variation of calculated altitude versus time for BB I - (01 and 02).

Figure 30A



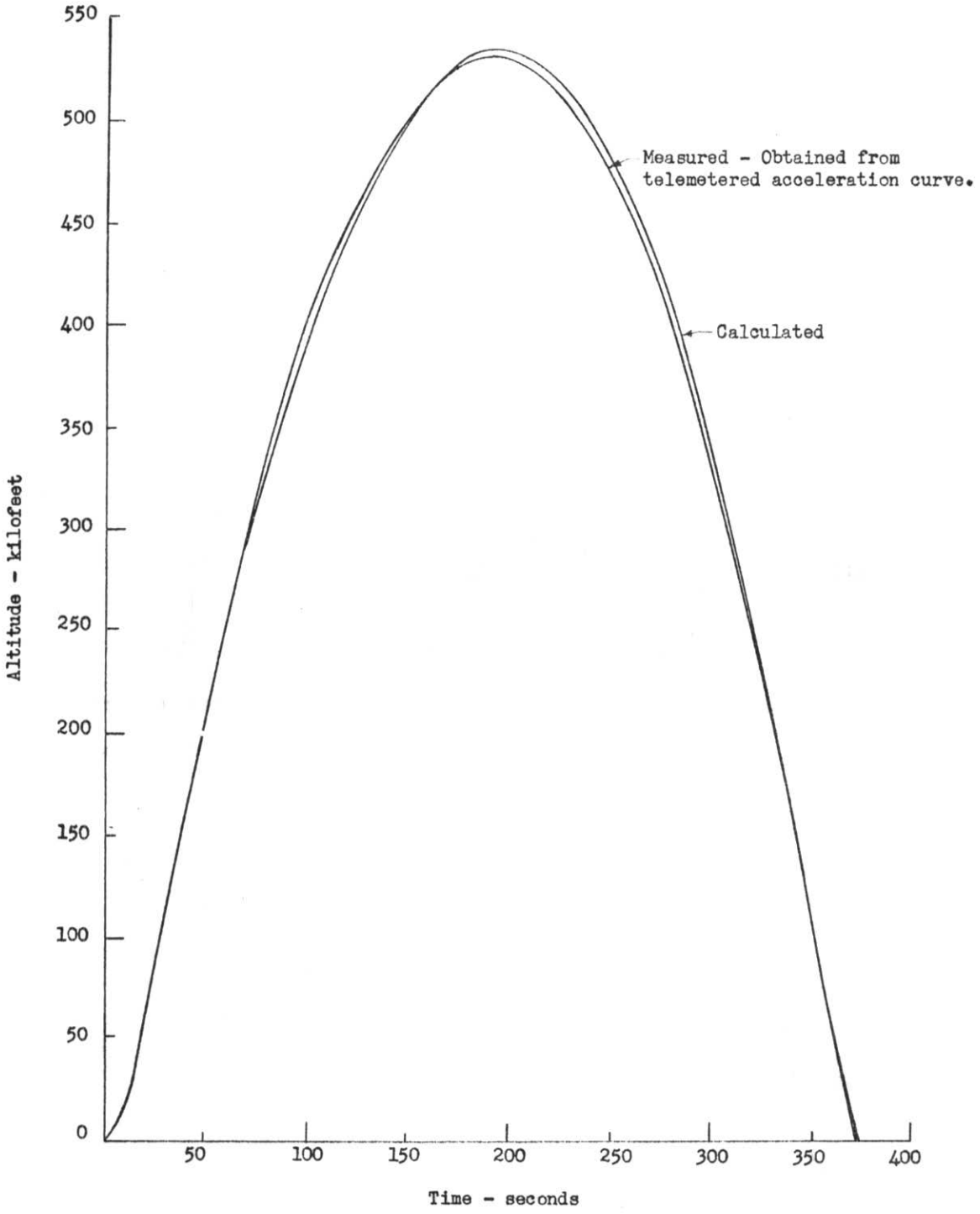
Variation of calculated altitude versus time for BB I - (03 and 04).

Figure 30B



Variation of measured and calculated altitudes versus time for BB I - 05.

Figure 30C



Variation of measured and calculated altitudesversus time for BB I - 06.

Figure 30D

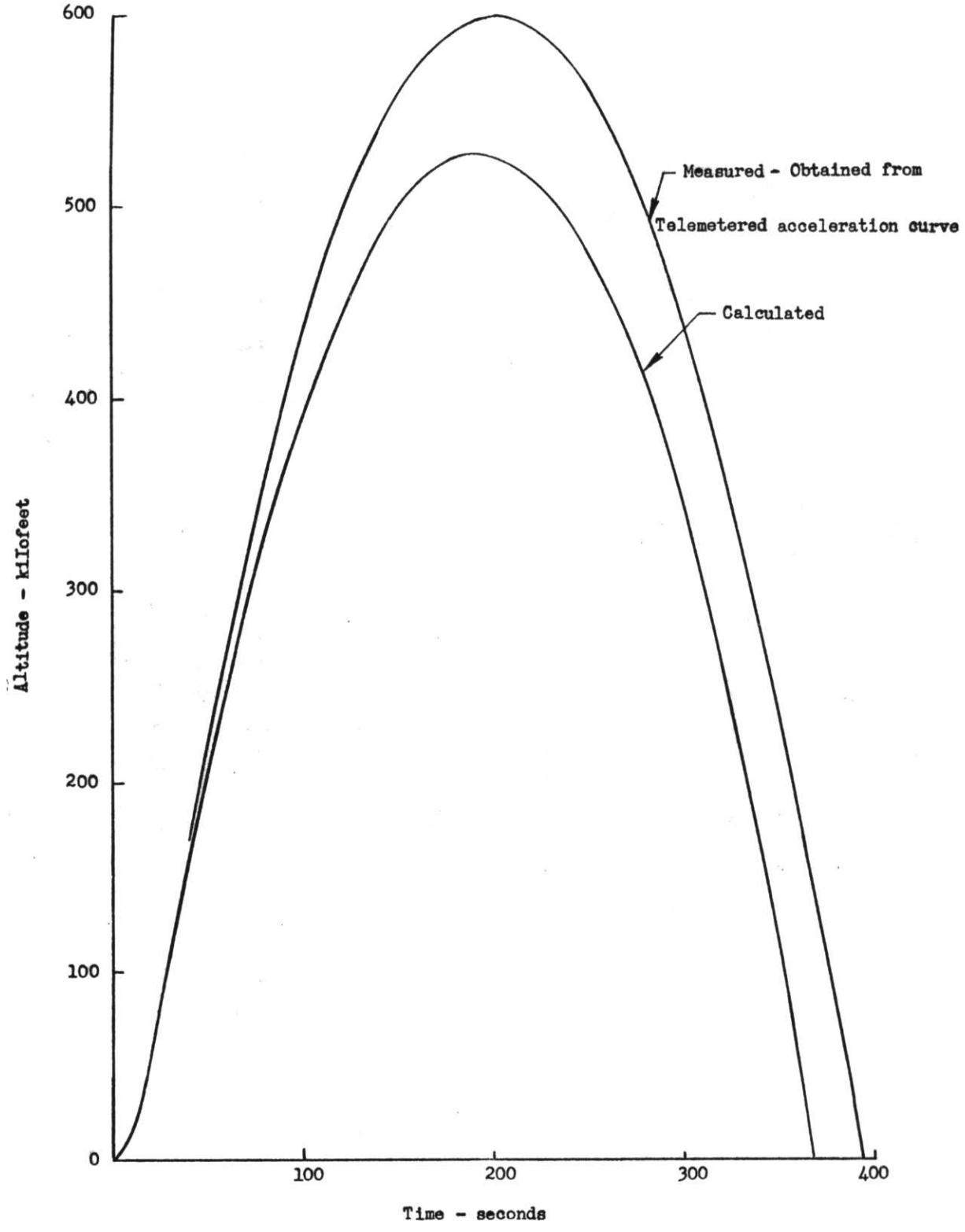
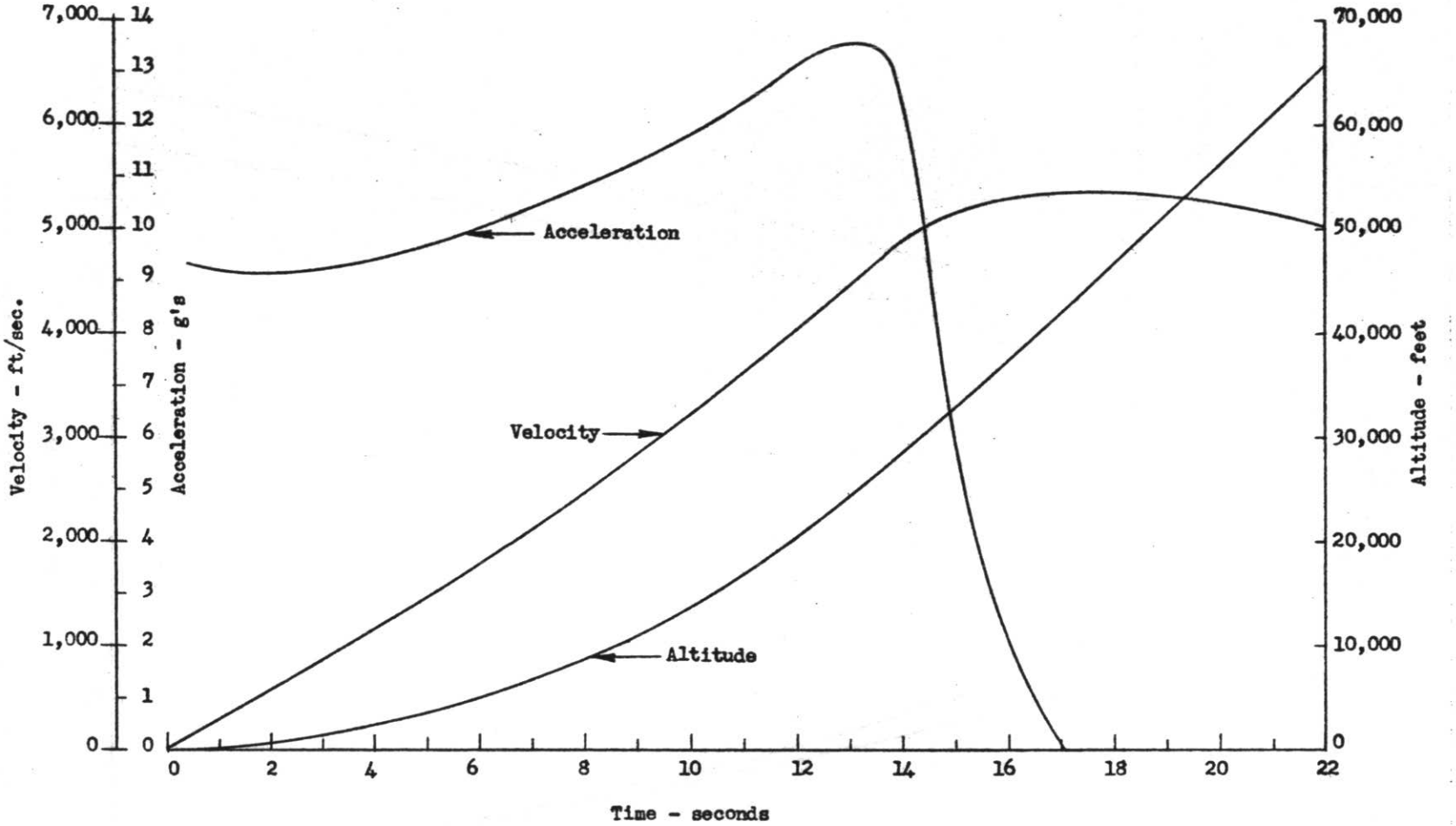
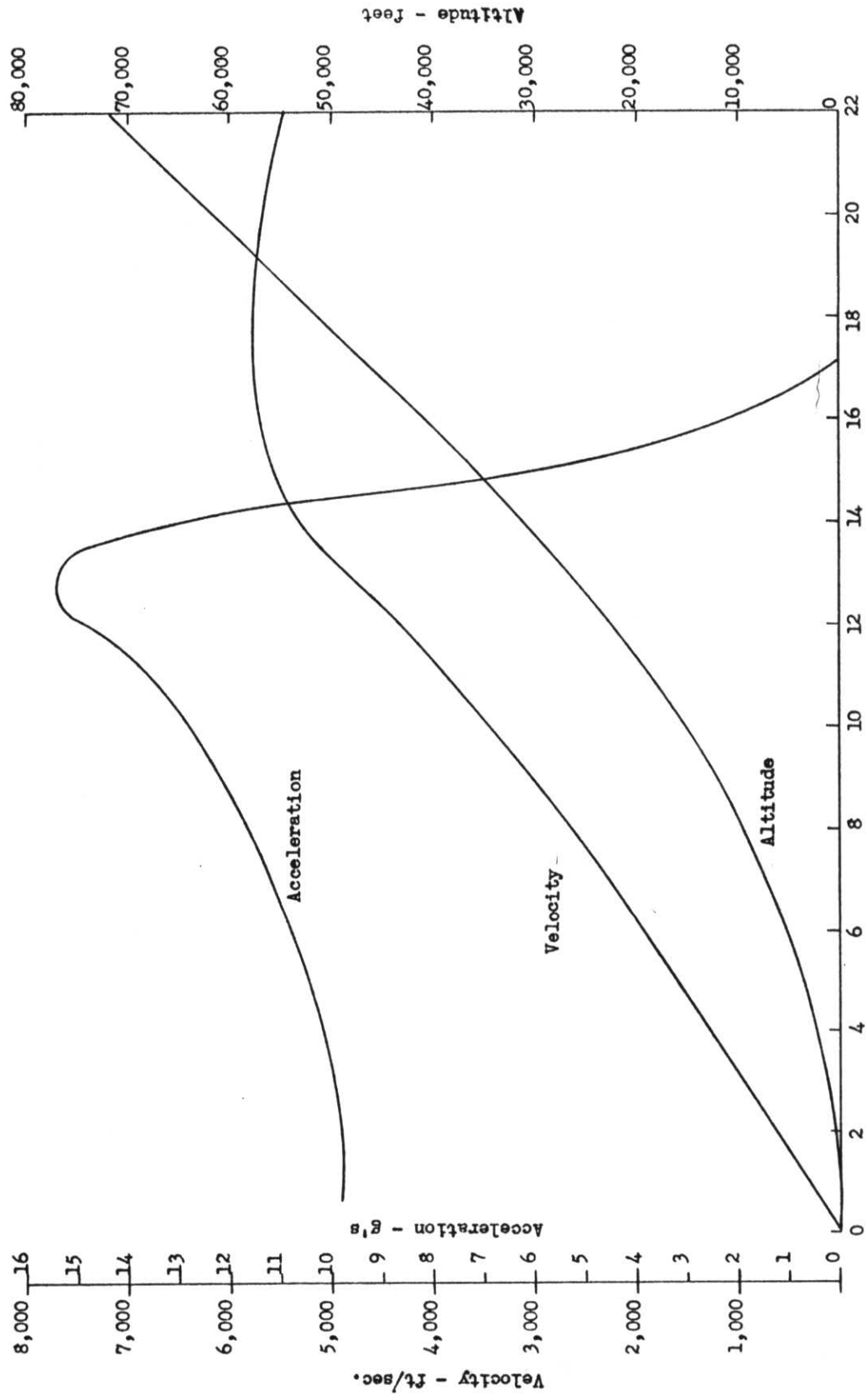


Figure 30E - Variation of measured and calculated altitudes with time for BB I - 07.



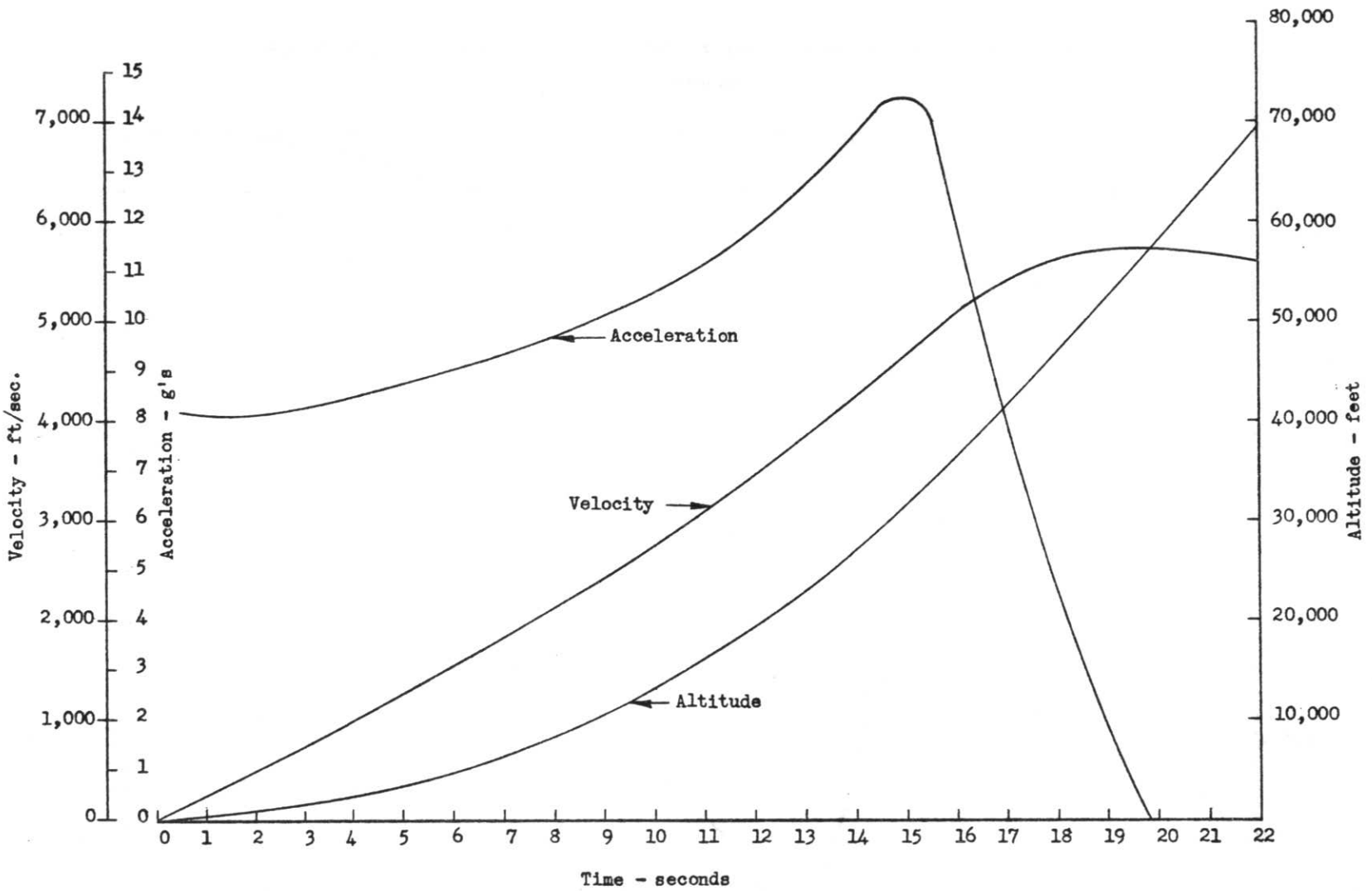
Calculated altitude, velocity and acceleration versus time for BB I - (01 and 02).

Figure 31A



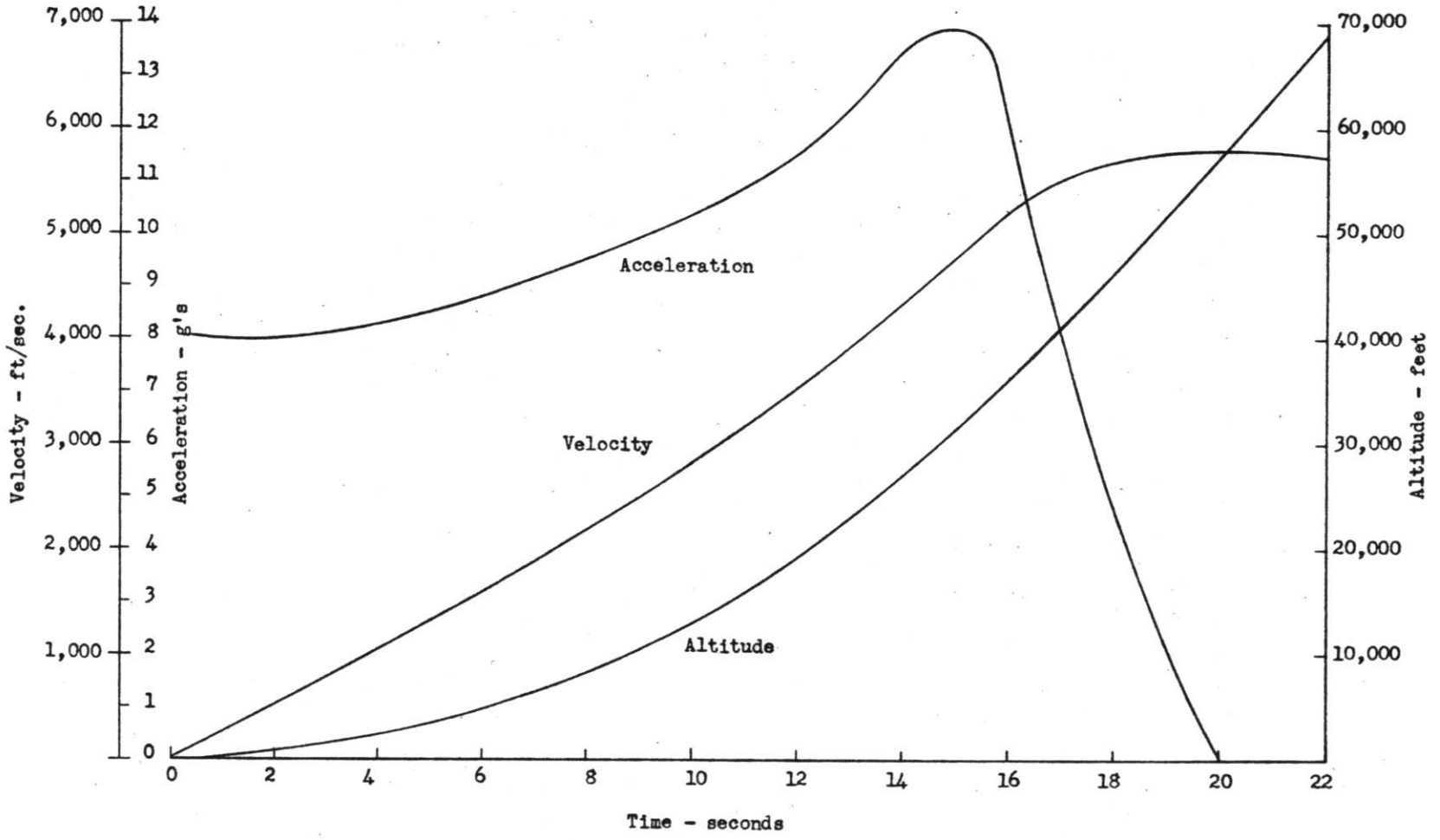
Calculated altitude, velocity and acceleration versus time for BB I - (03 and 04).

Figure 31B



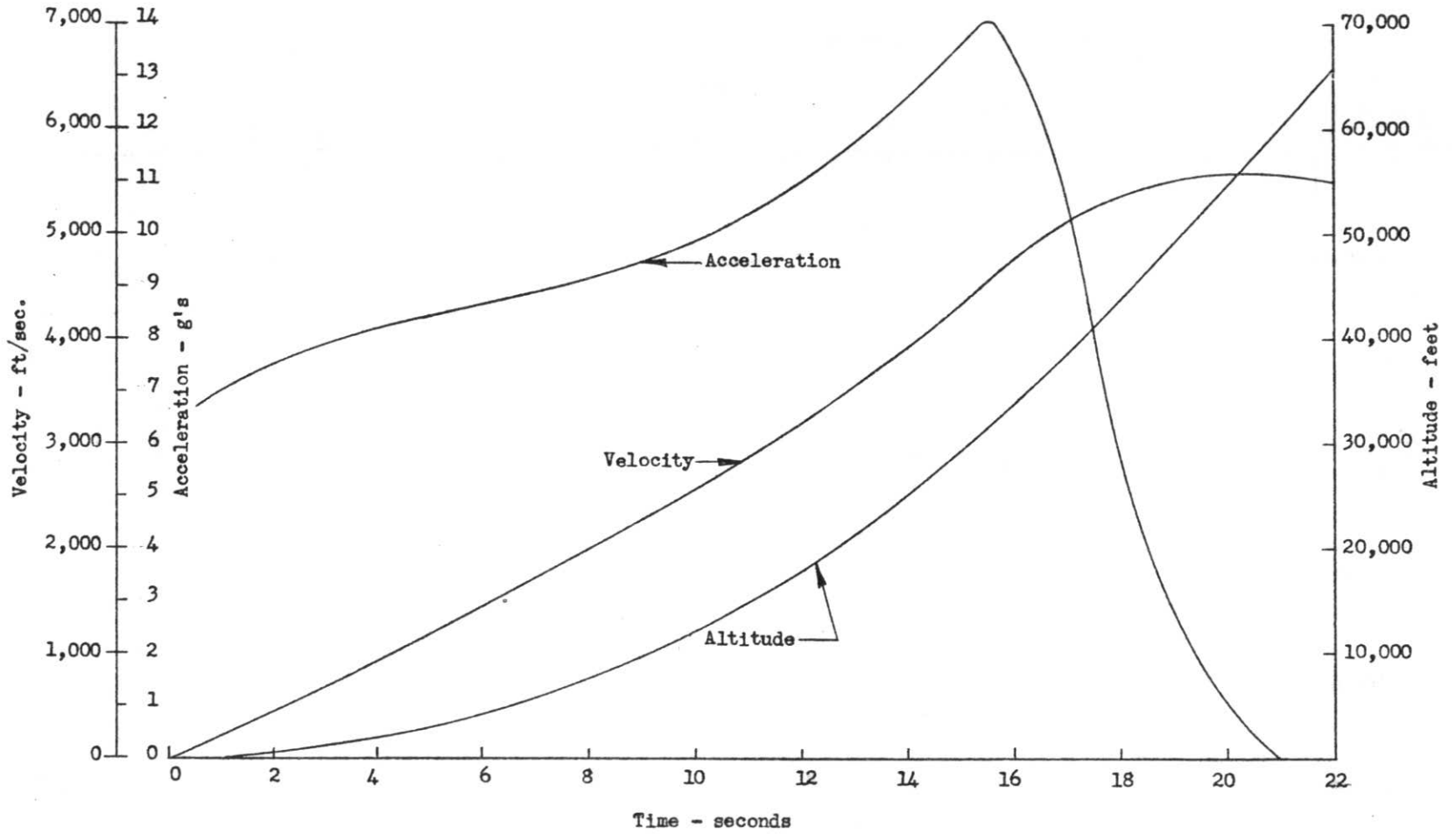
Calculated altitude, velocity and acceleration versus time for BB I - 05.

Figure 31C



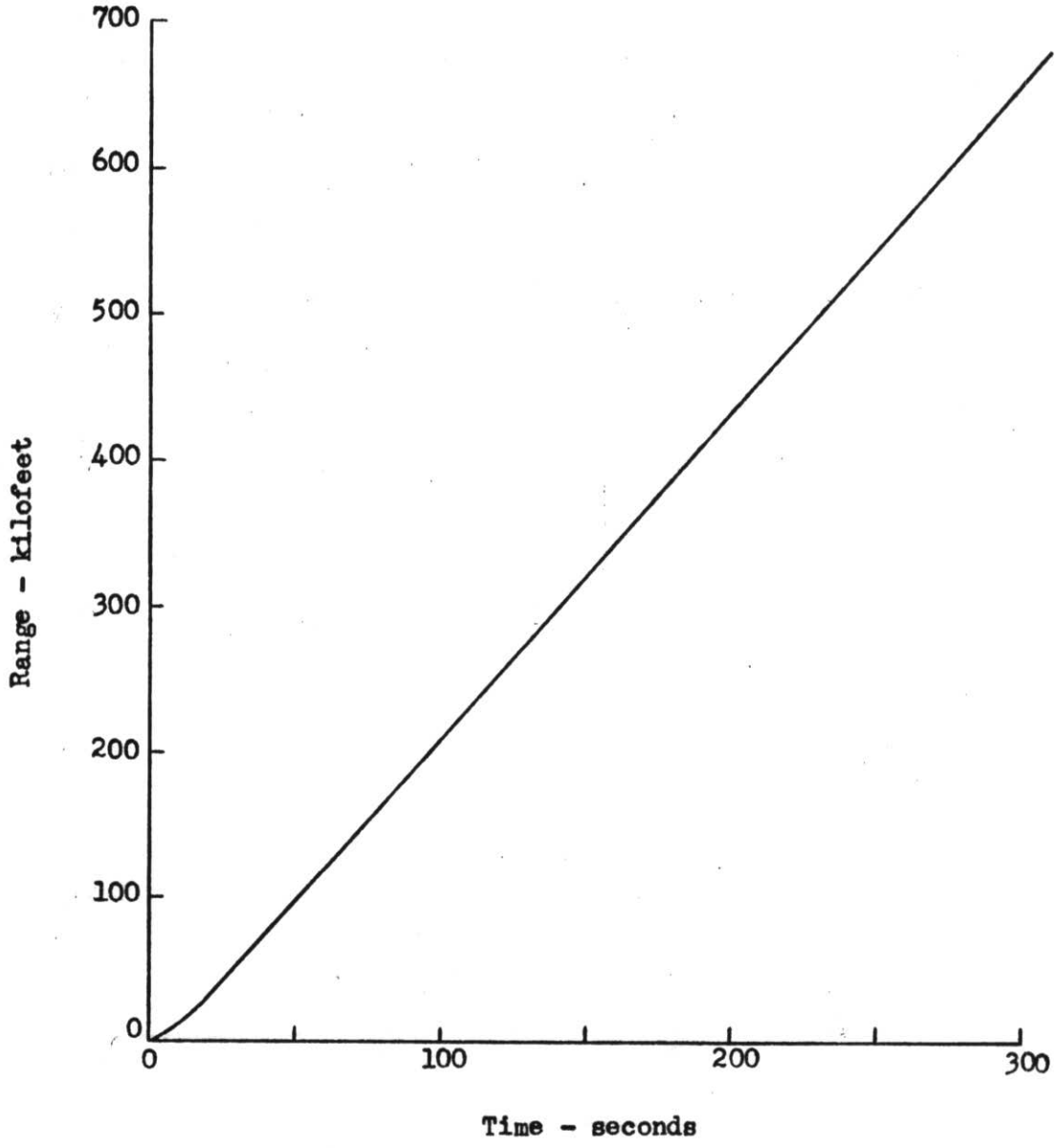
Calculated altitude, velocity and acceleration versus time for BB I - 06.

Figure 31D



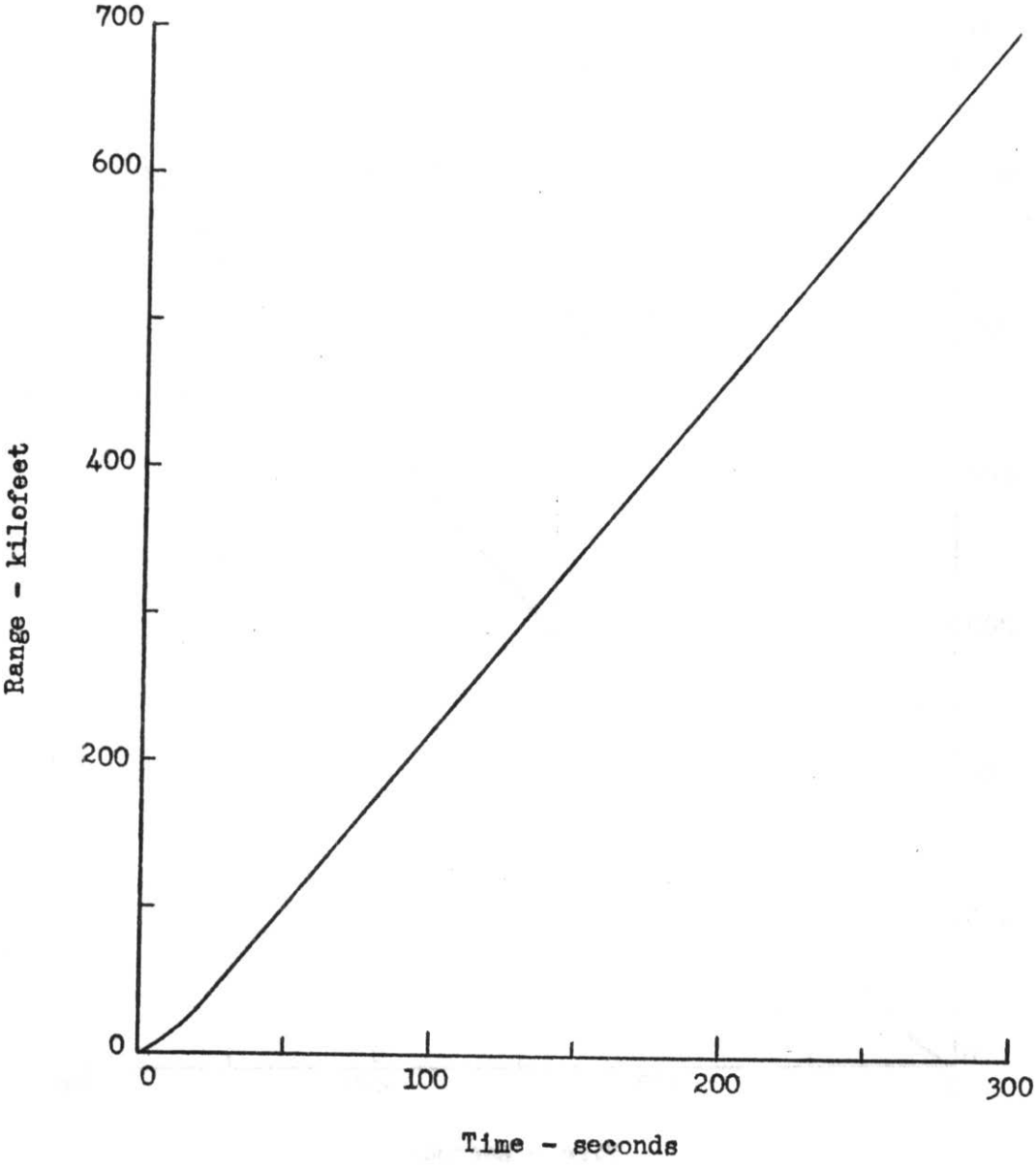
Calculated altitude, velocity and acceleration versus time for BB I - 07.

Figure 31E



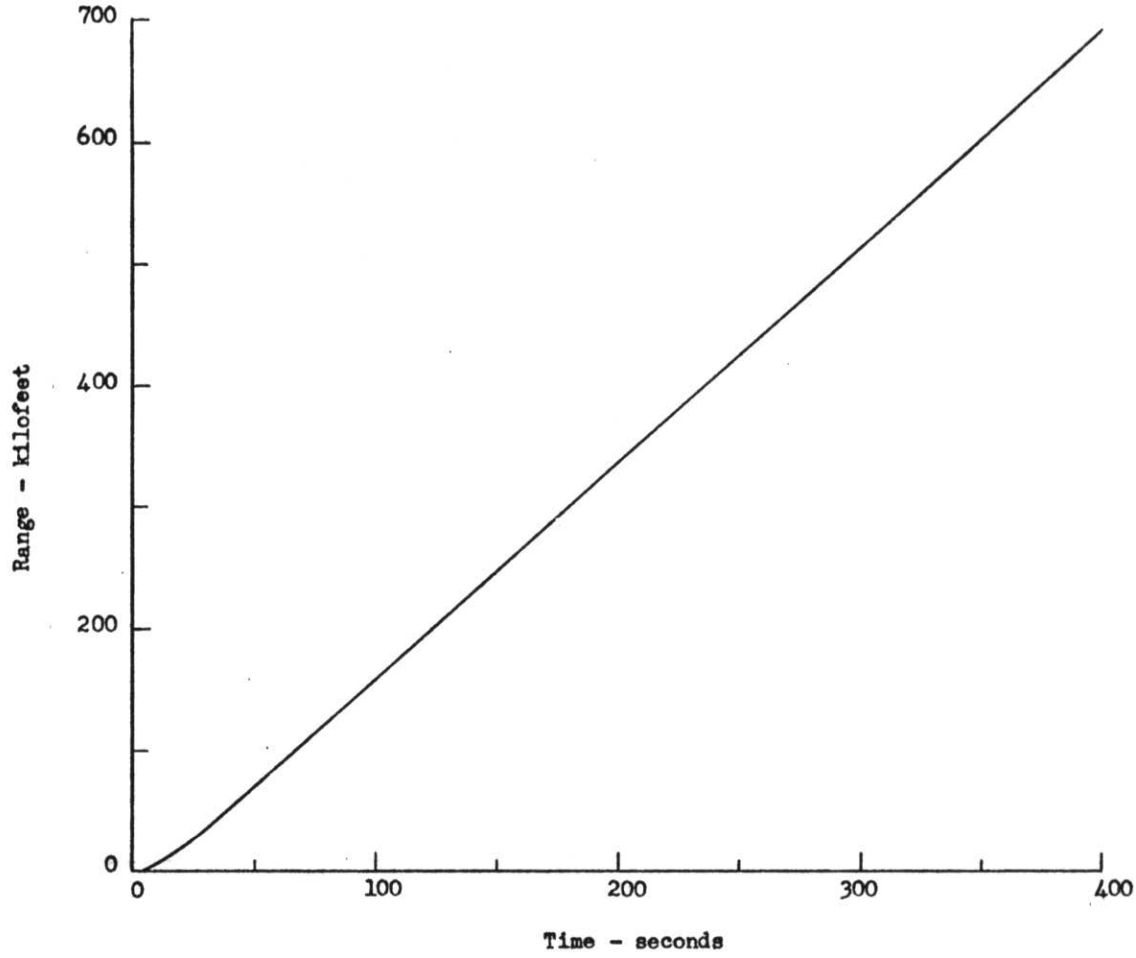
Calculated range versus time for BB I - (01 and 02).

Figure 32A



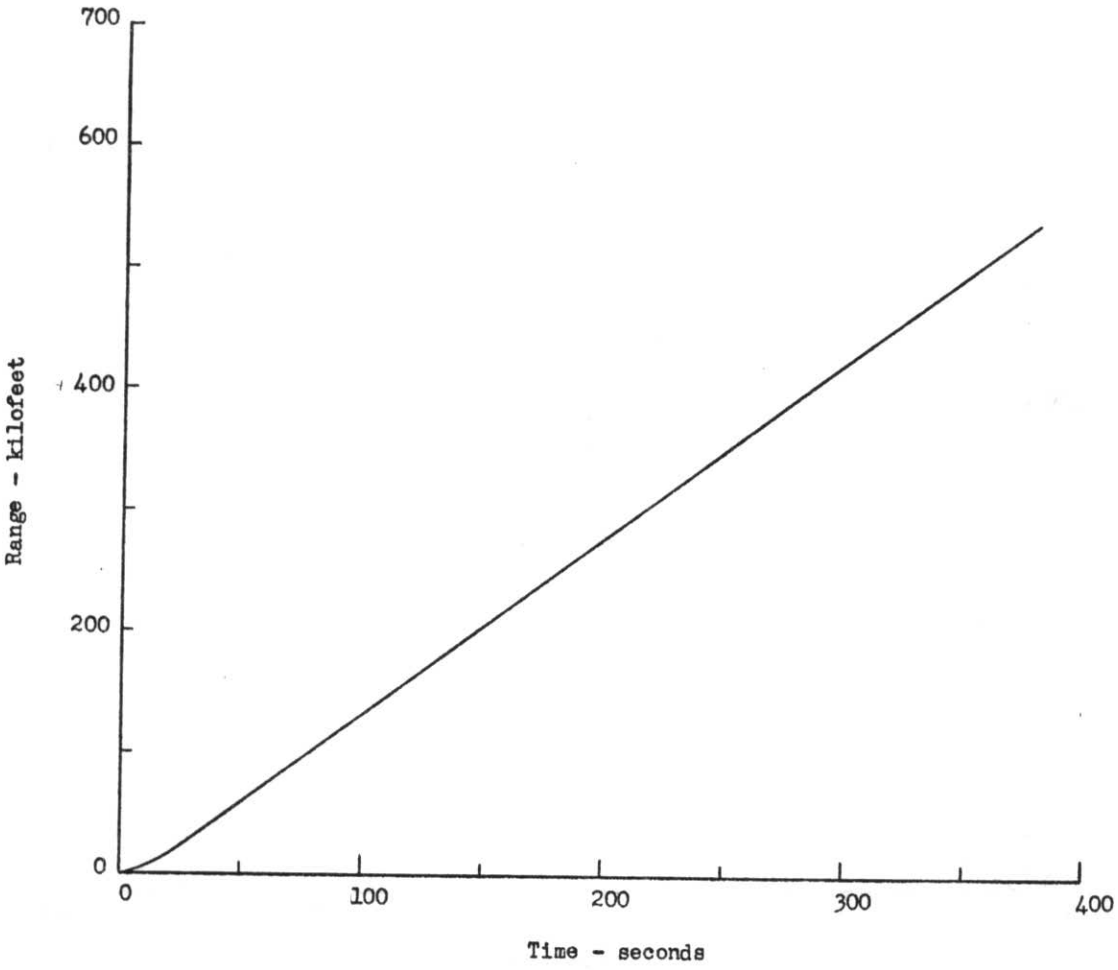
Calculated range versus time for BB I - (03 and 04).

Figure 32B



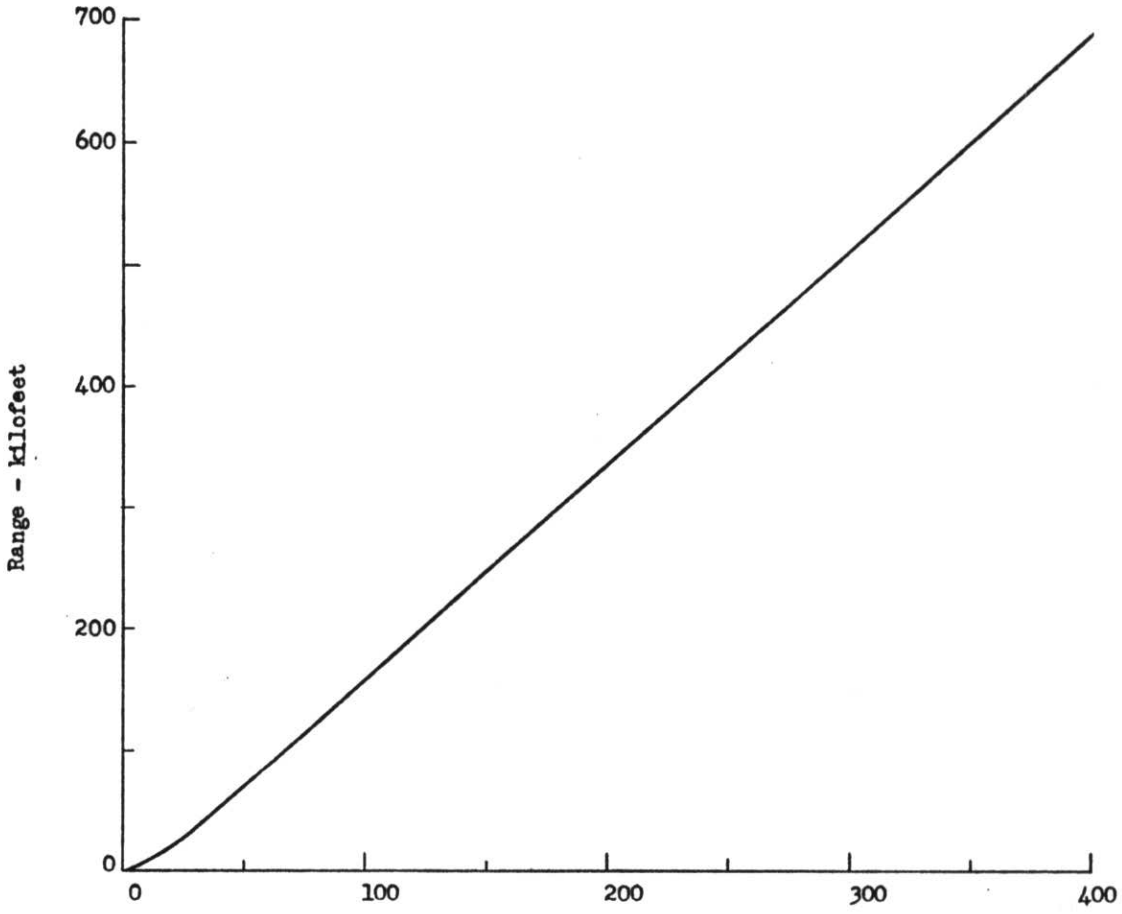
Calculated range versus time for BB I - 05.

Figure 32C



Calculated range versus time for BB I - 06.

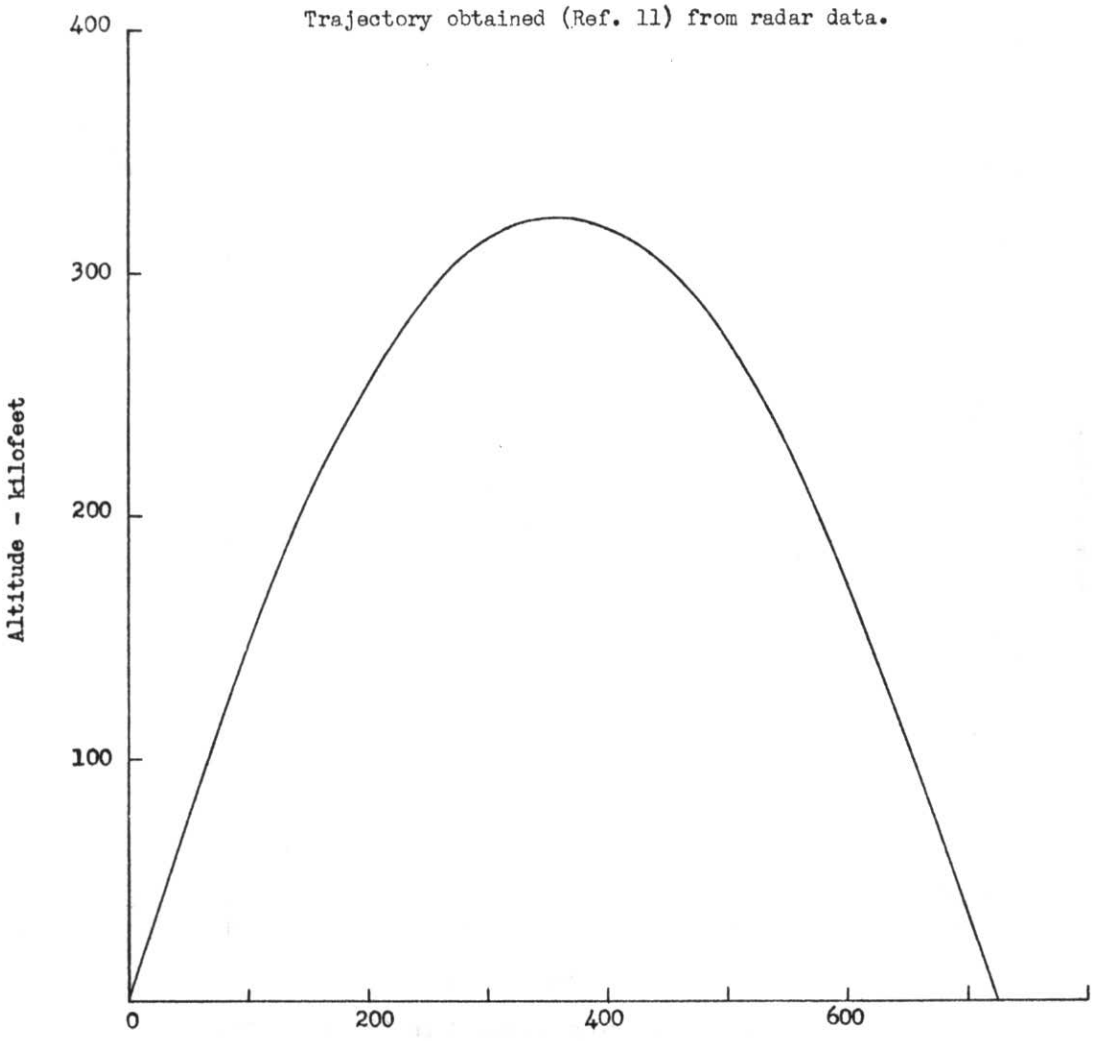
Figure 32D



Calculated range versus time for BB I - 07.

Figure 32E

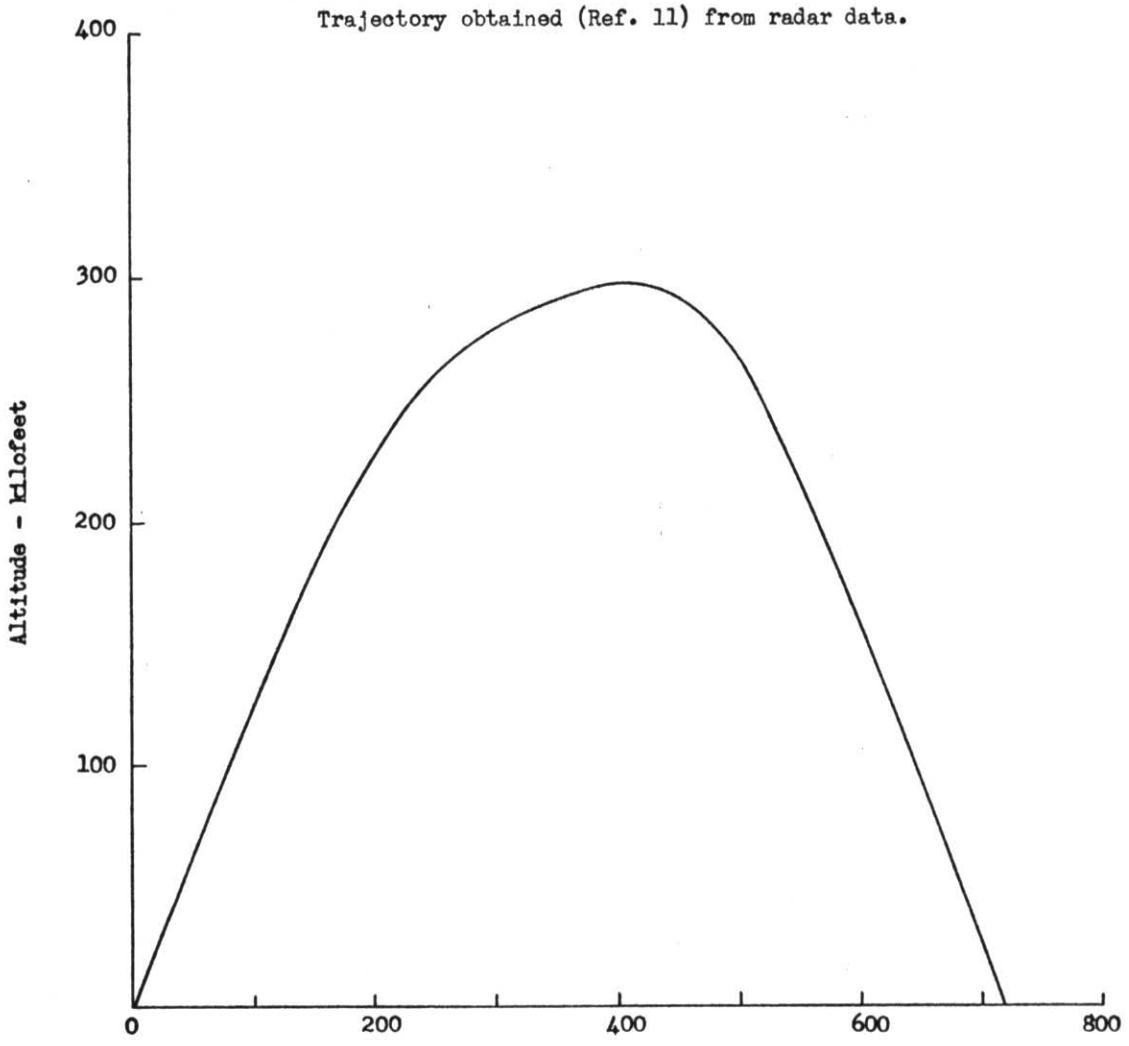
Trajectory obtained (Ref. 11) from radar data.



Measured trajectory for BB I - 01.

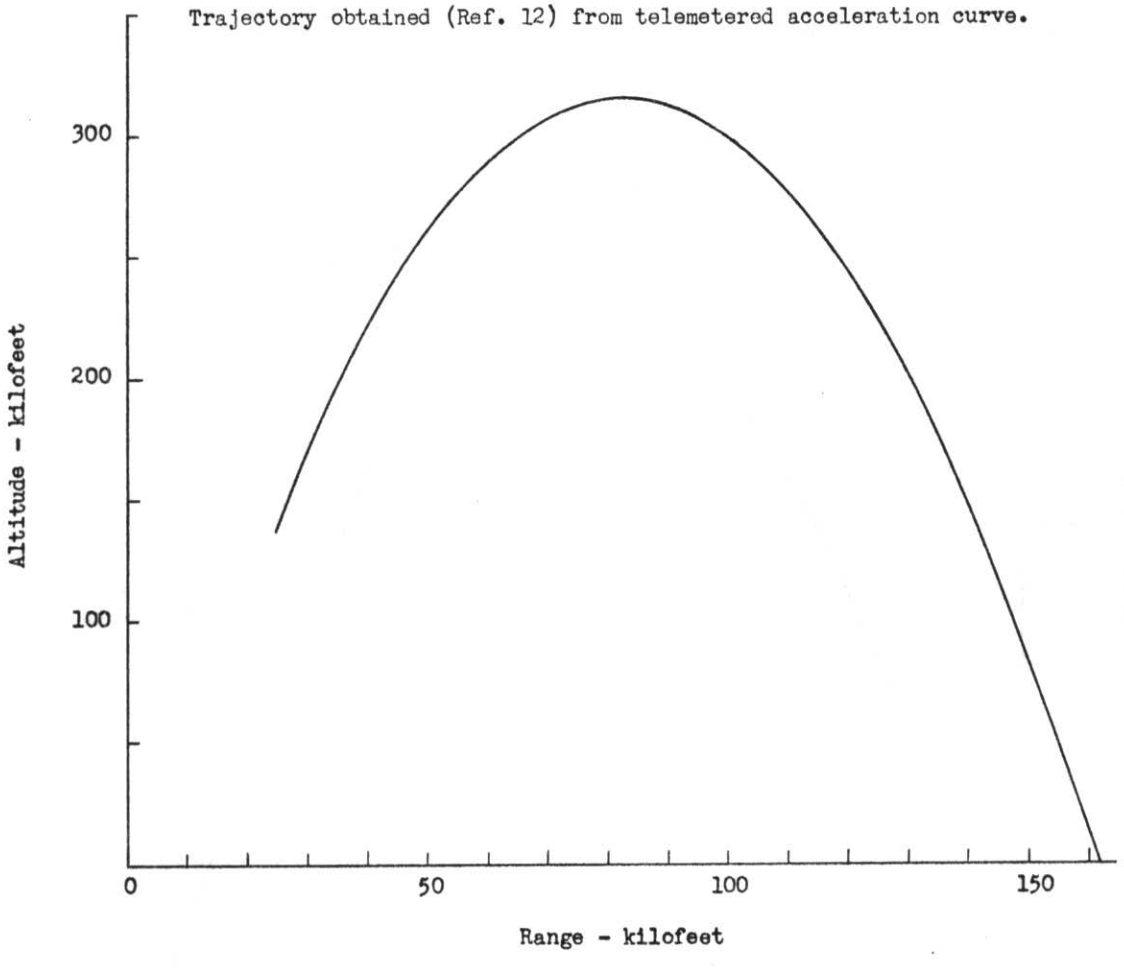
Figure 33A

Trajectory obtained (Ref. 11) from radar data.



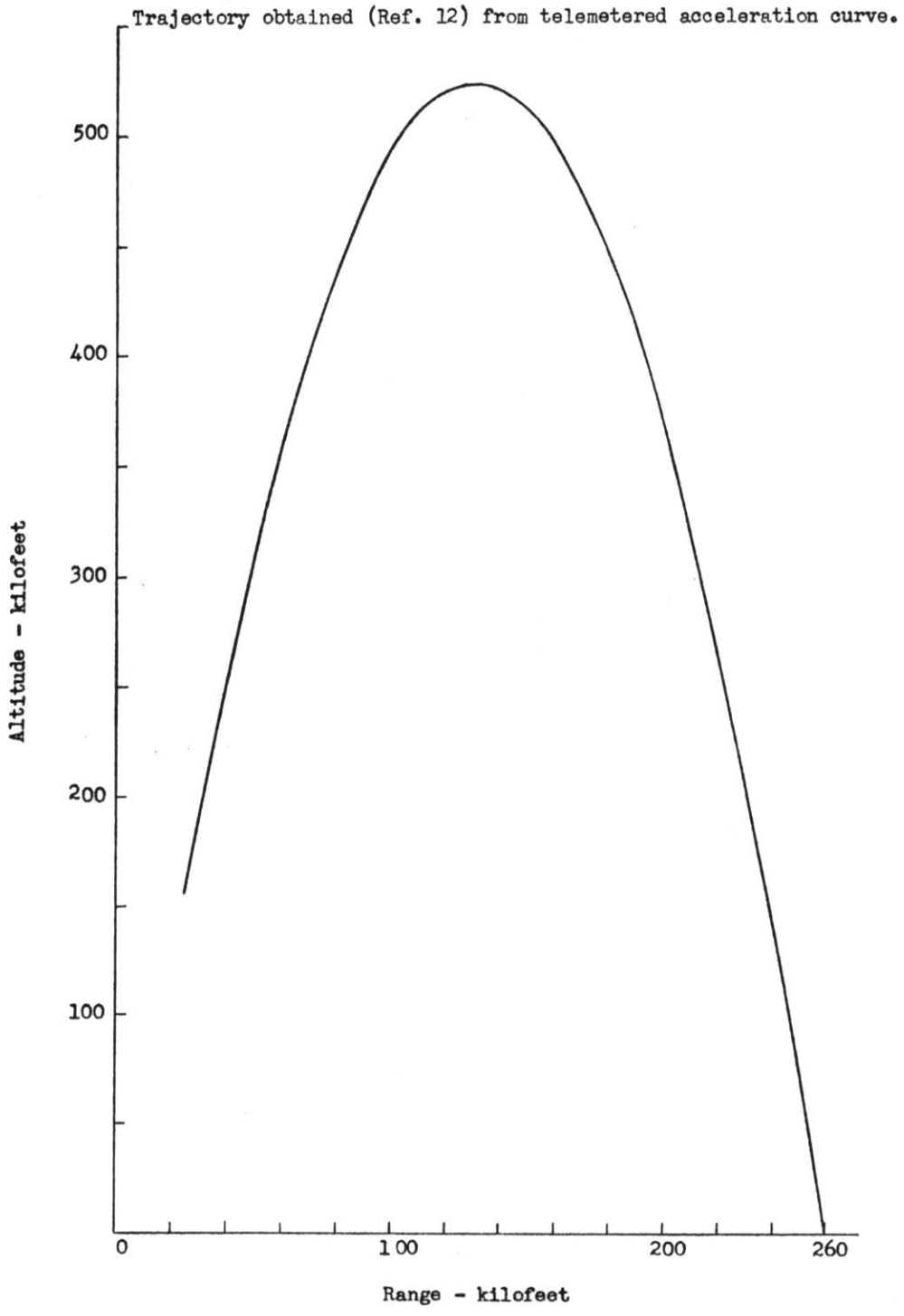
Measured trajectory for BB I - 02.

Figure 33B



Measured trajectory for BB I - 05.

Figure 33C



Measured trajectory for BB I - 06.

Figure 33D

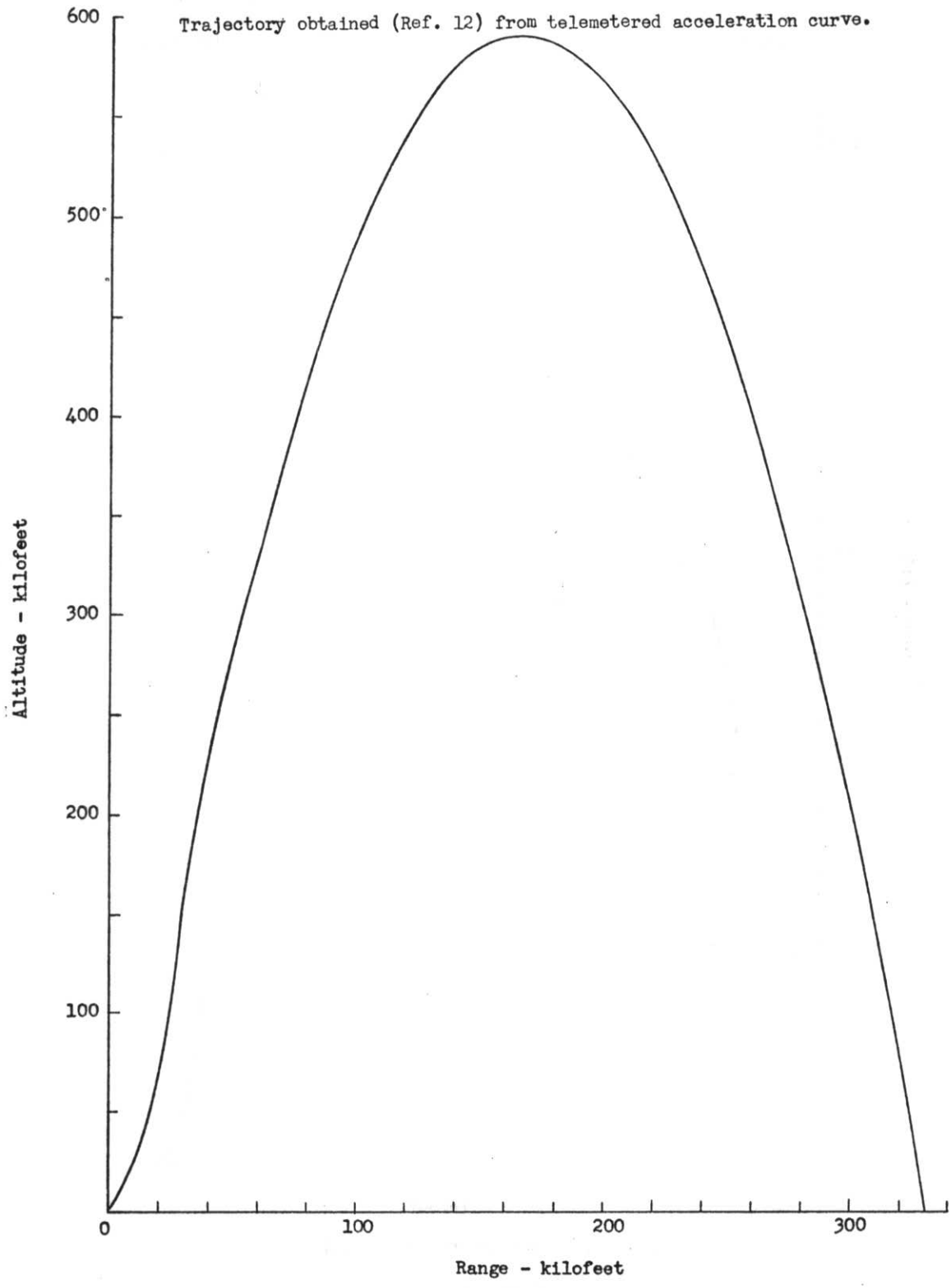
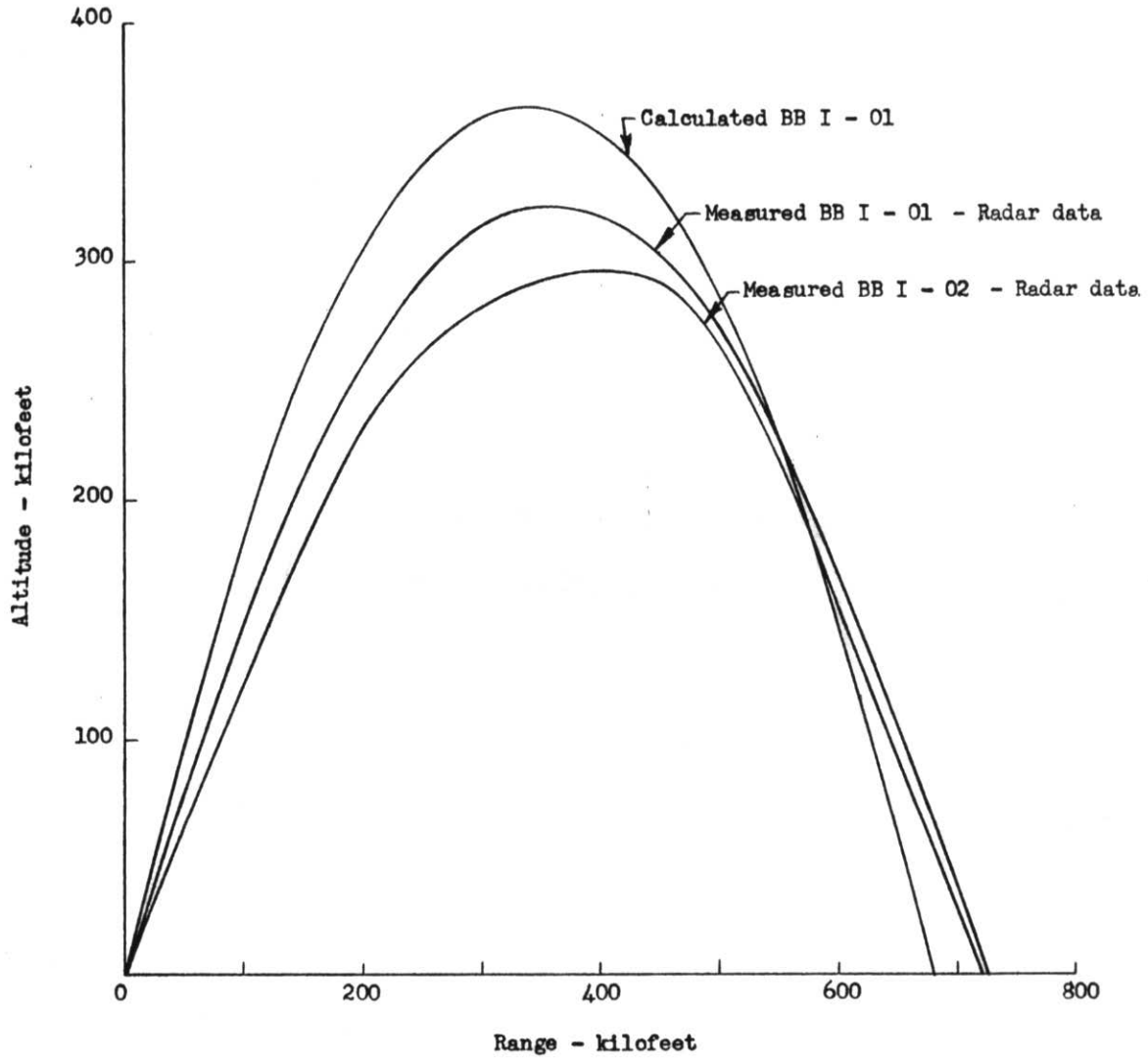


Figure 33E - Measured trajectory for BB I - 07.



Plots of measured and calculated trajectories for BB I - (01 and 02).

Figure 34A

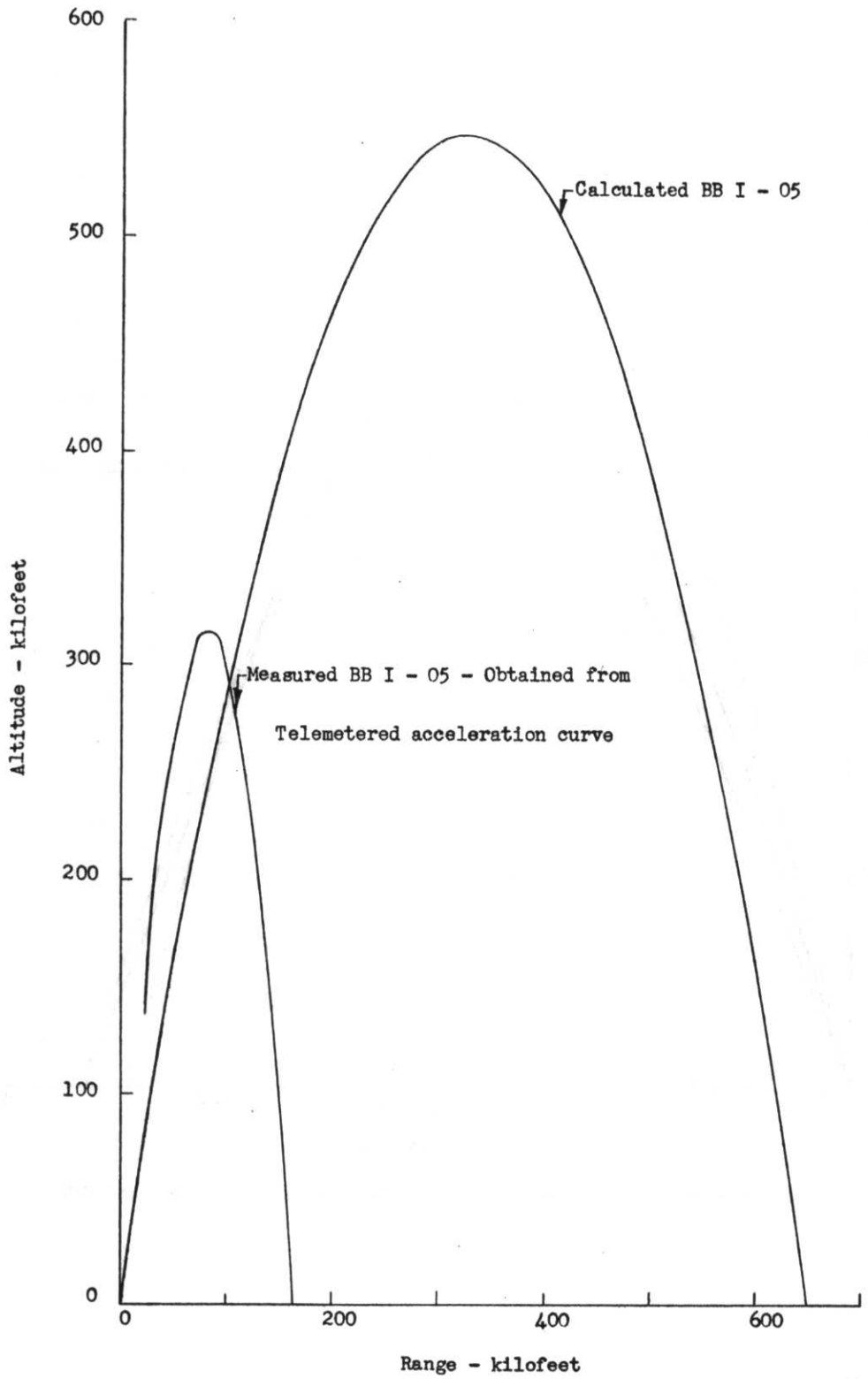


Figure 34B - Plots of measured and calculated trajectories for BB I - 05.

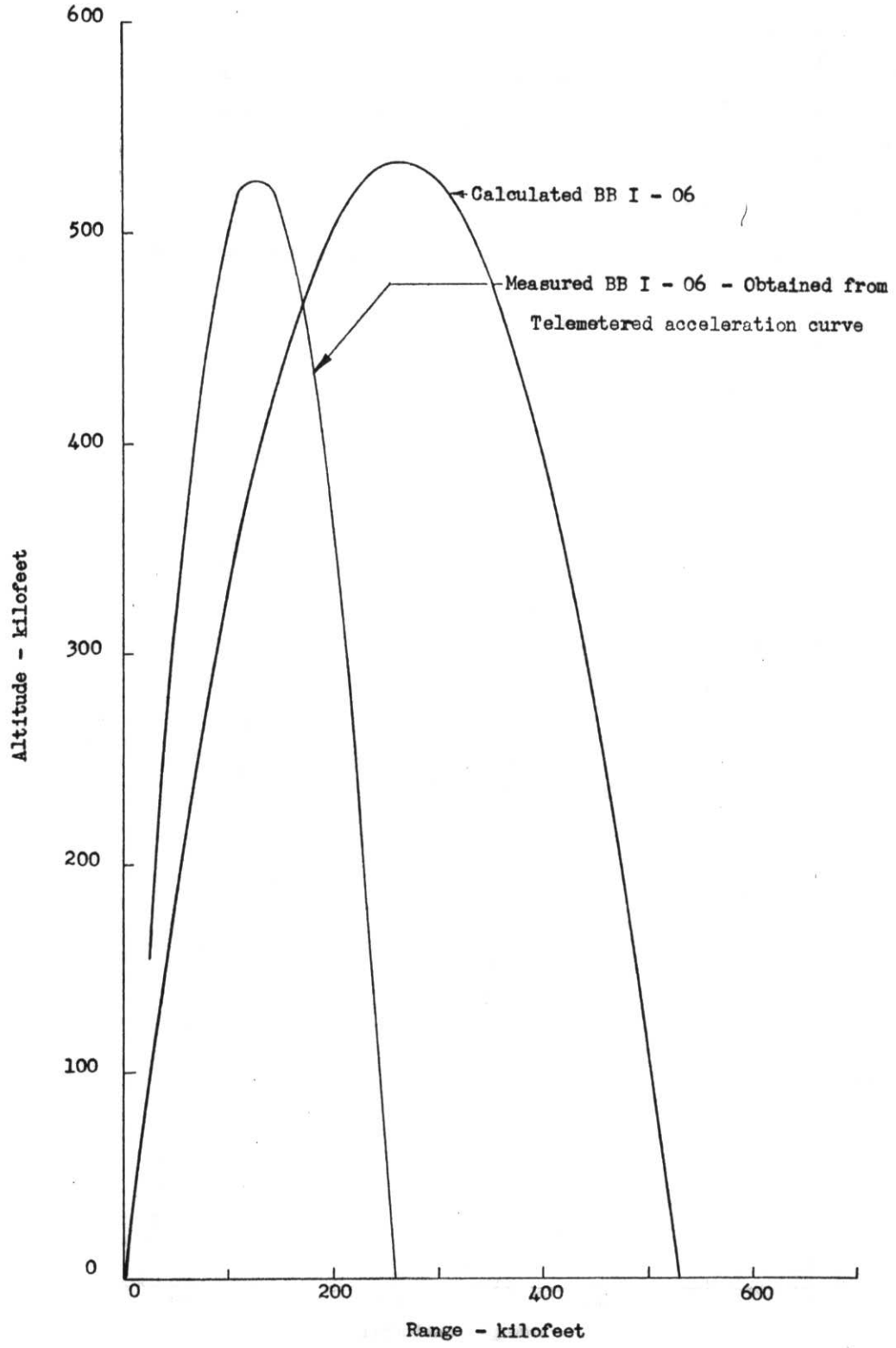


Figure 34C - Plots of measured and calculated trajectories for BB I - 06.

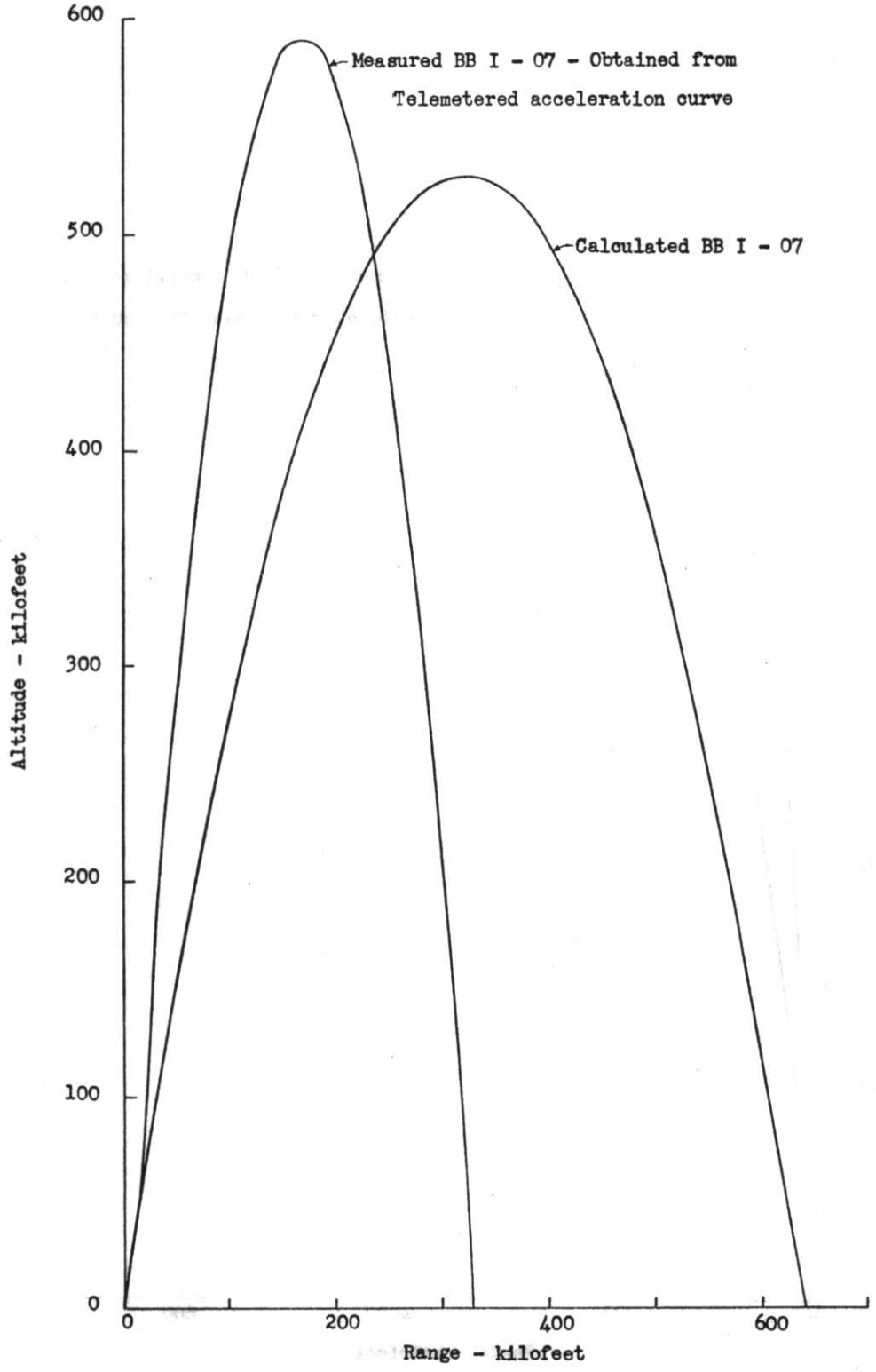
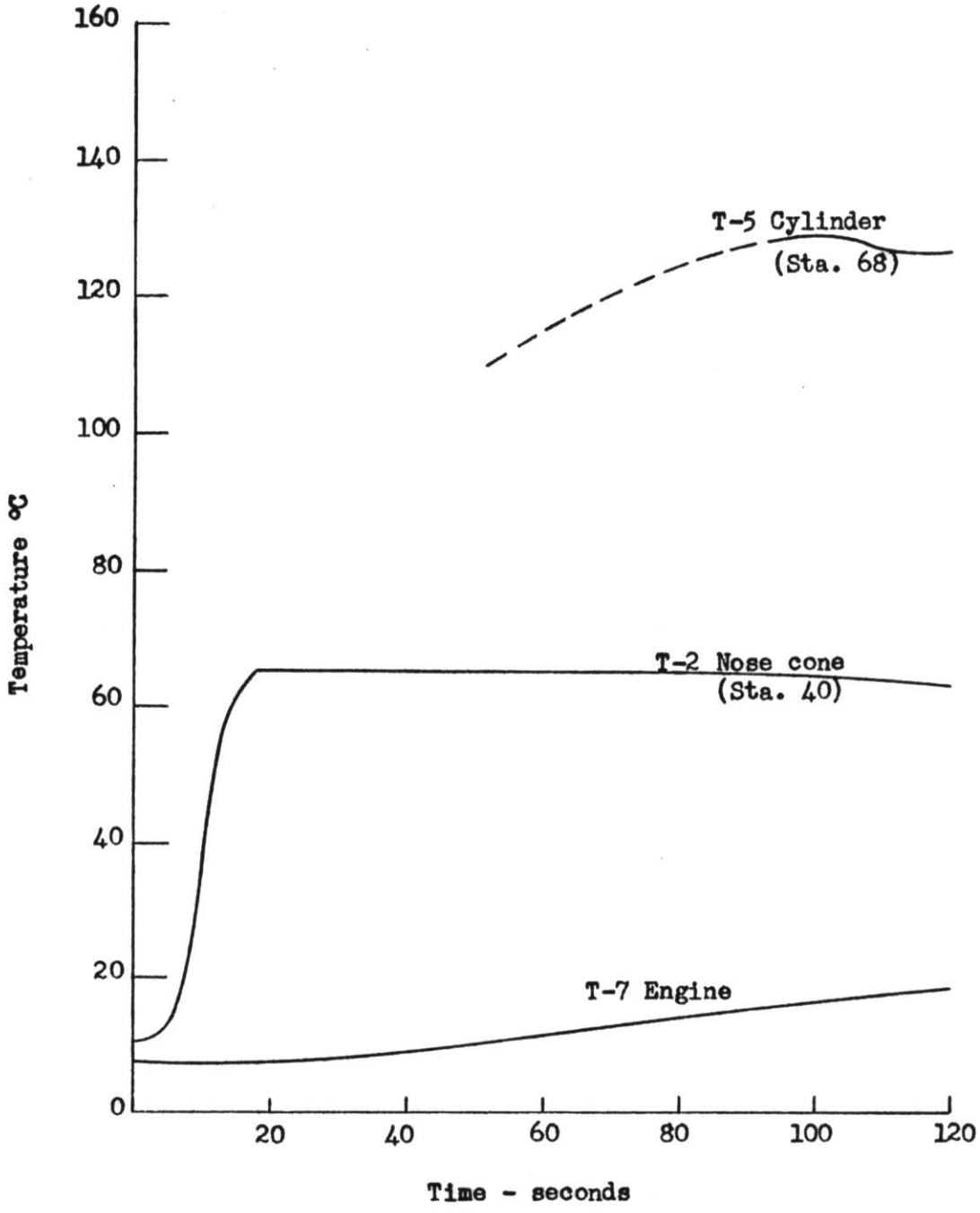
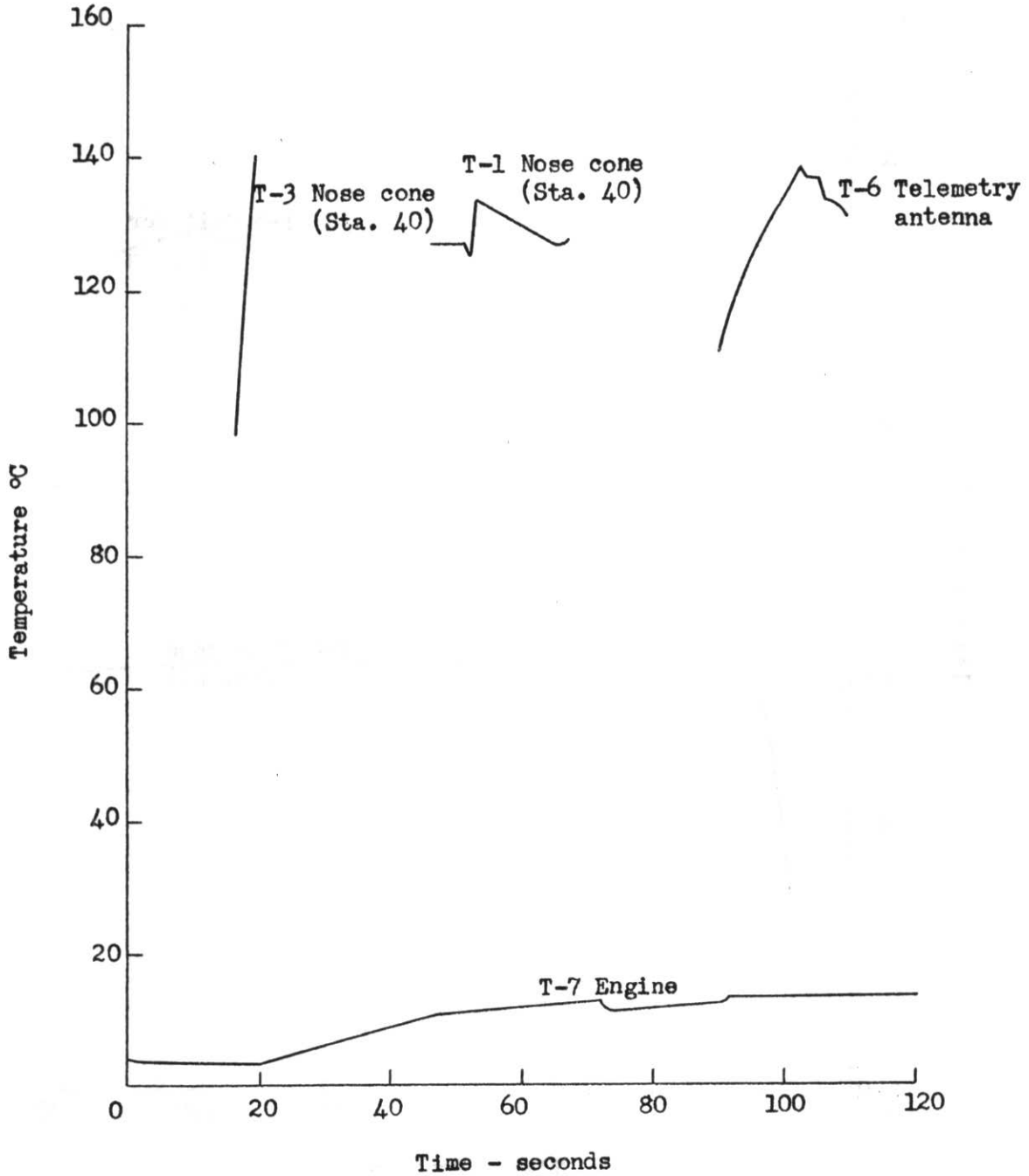


Figure 34D - Plots of measured and calculated trajectories for BB I - 07.



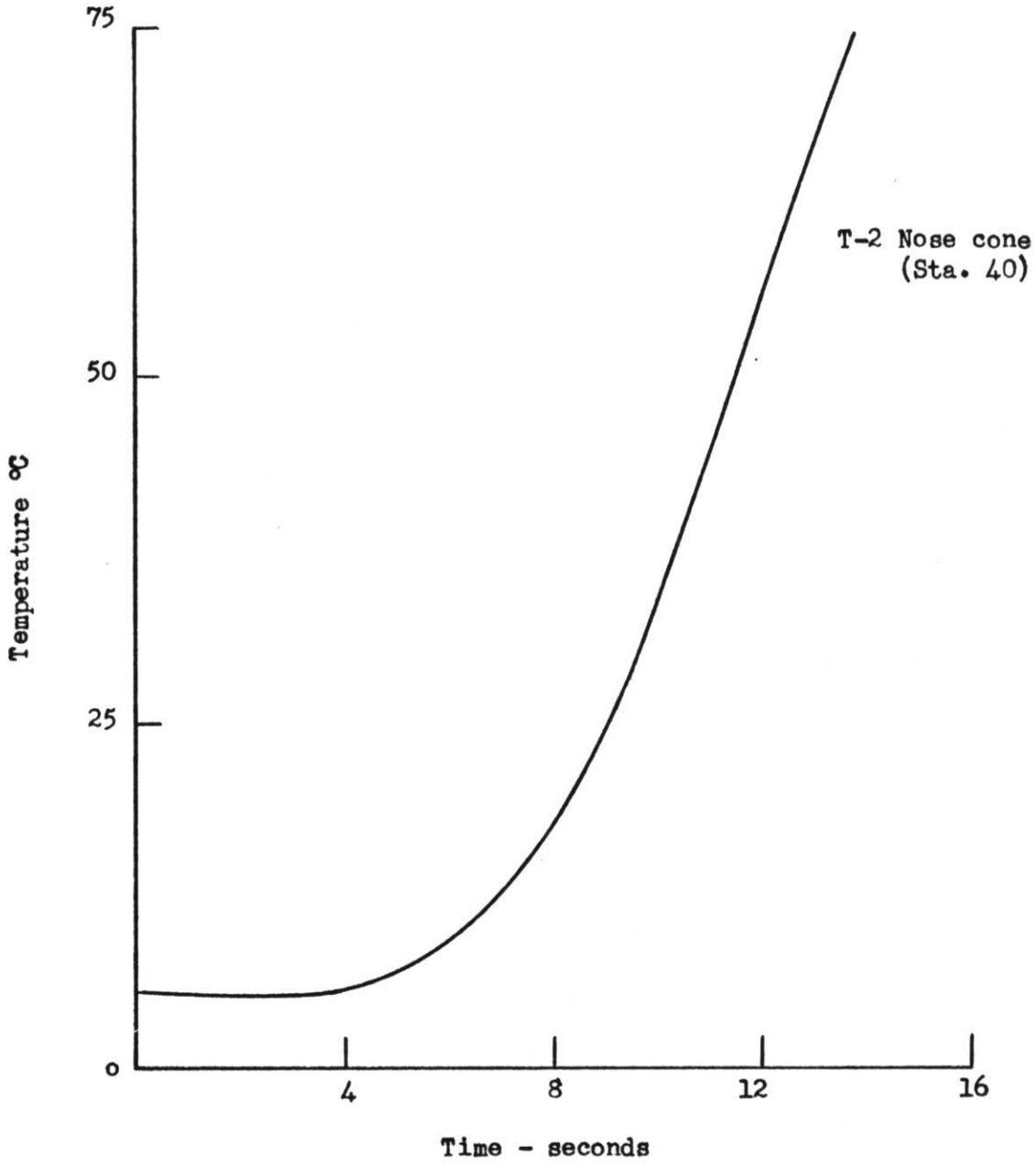
Plots of measured temperatures BB I - 01.

Figure 35A



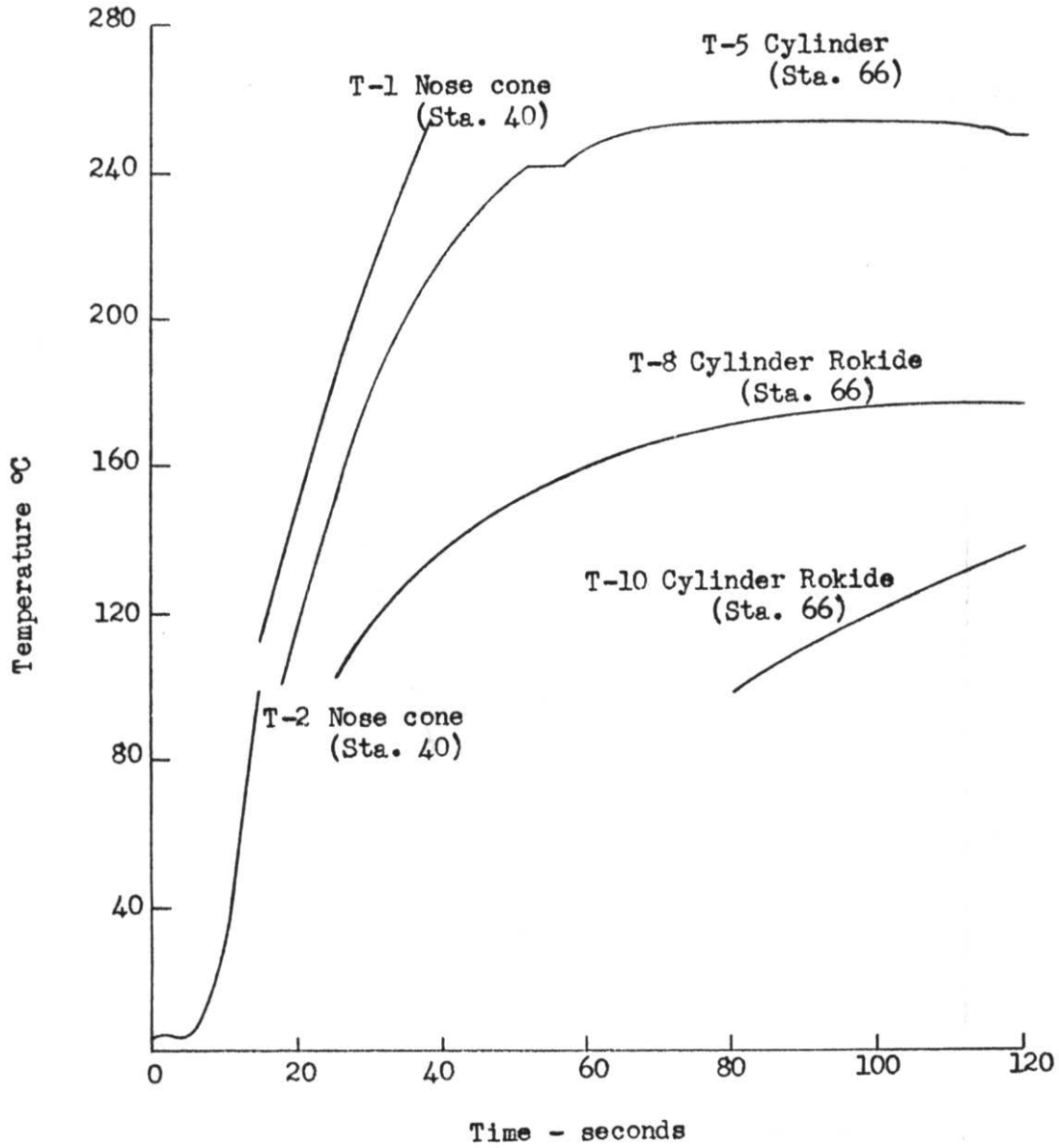
Plots of measured temperatures BB I - 02.

Figure 35B



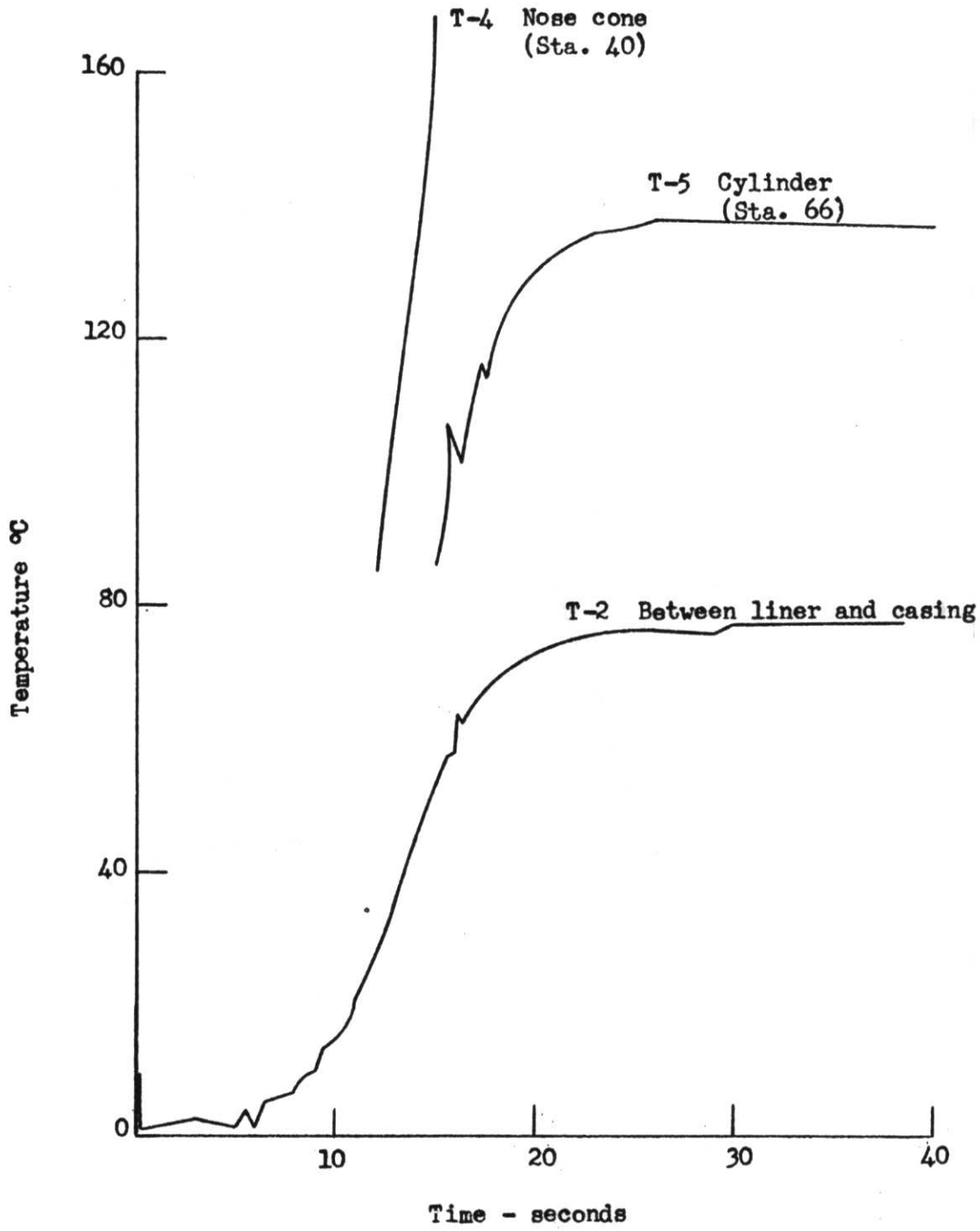
Plot of measured temperature BB I - 03.

Figure 35C



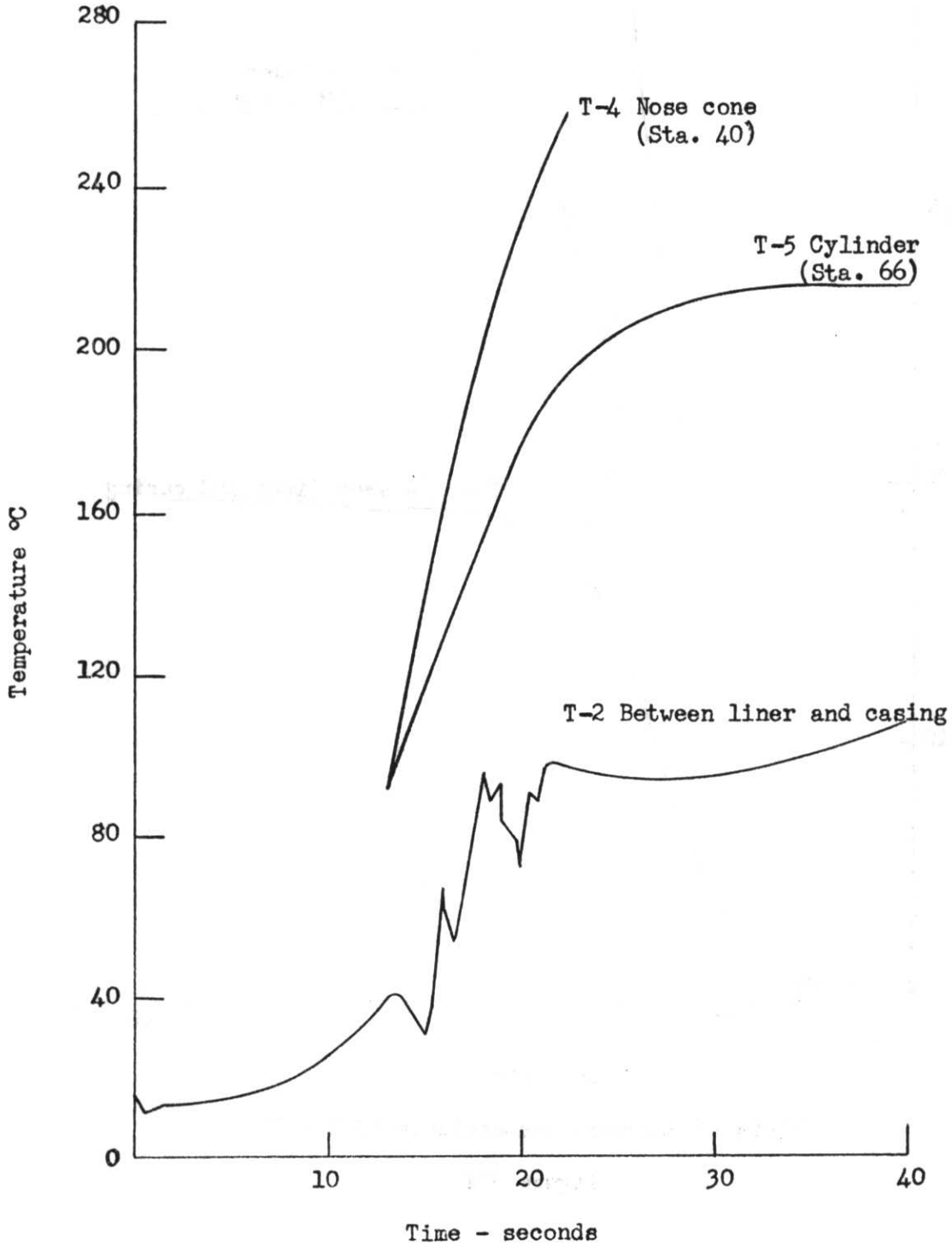
Plots of measured temperatures BB I - 04.

Figure 35D



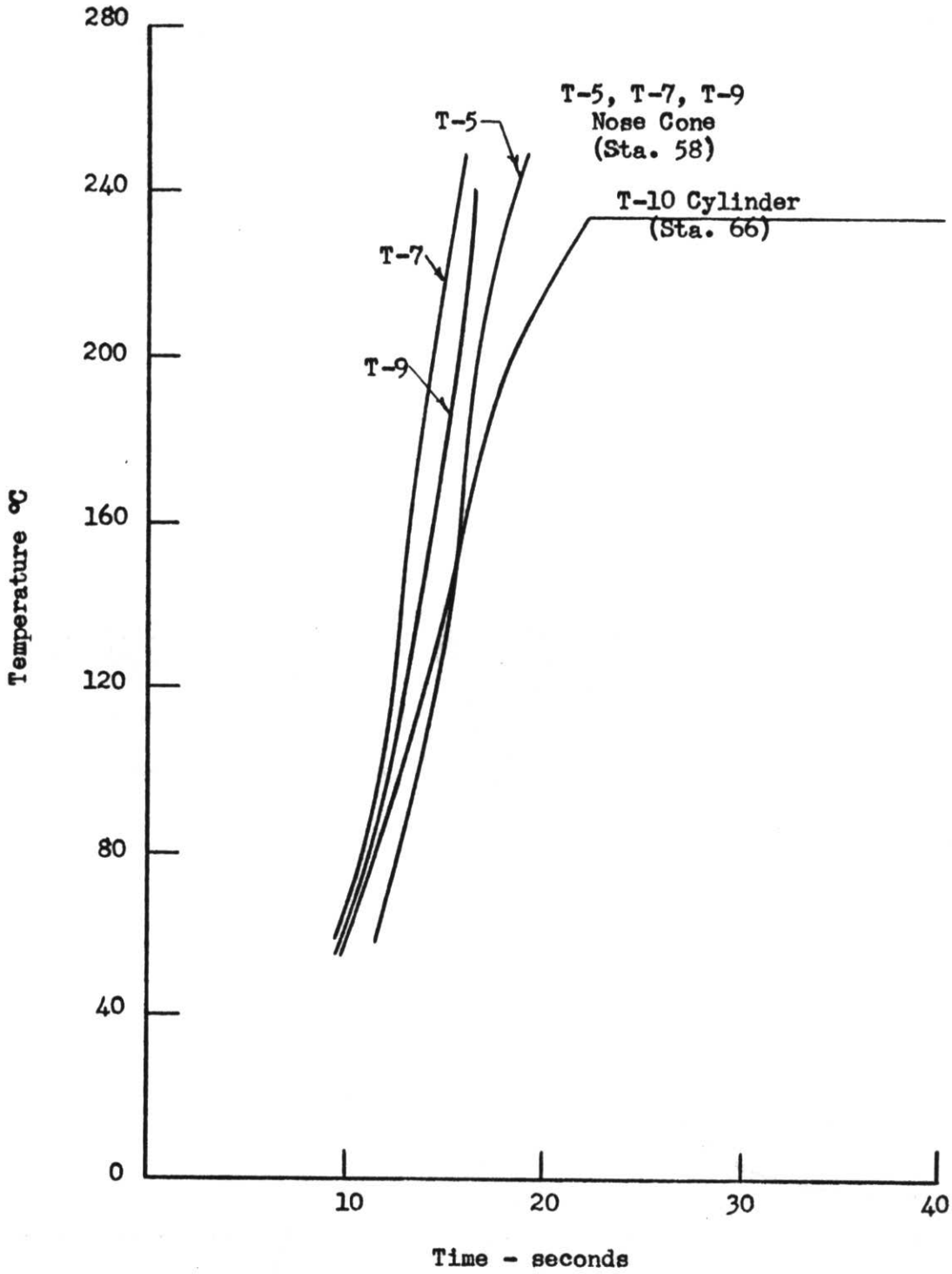
Plots of measured temperatures BB I - 05.

Figure 35E



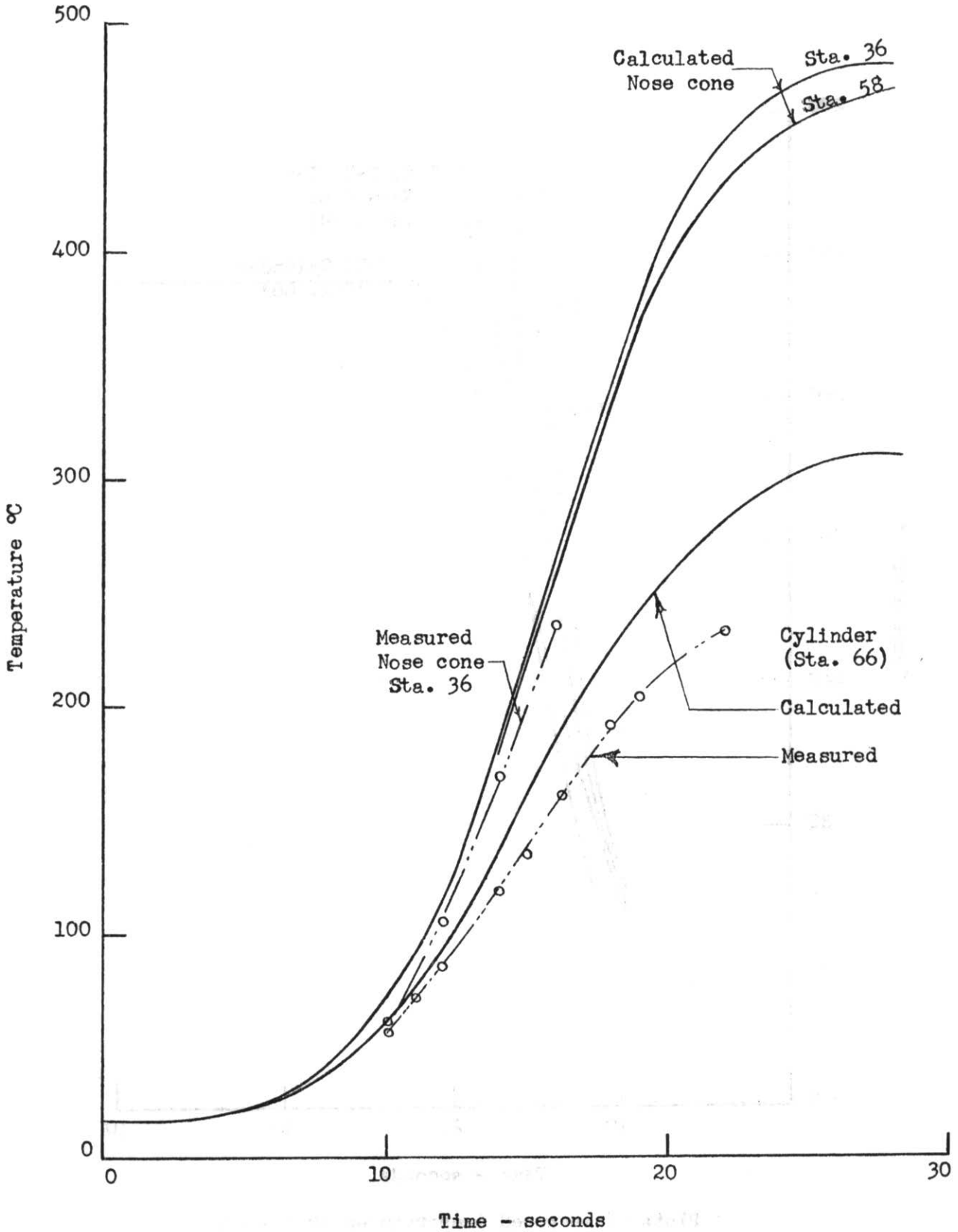
Plots of measured temperatures BB I - 06.

Figure 35F



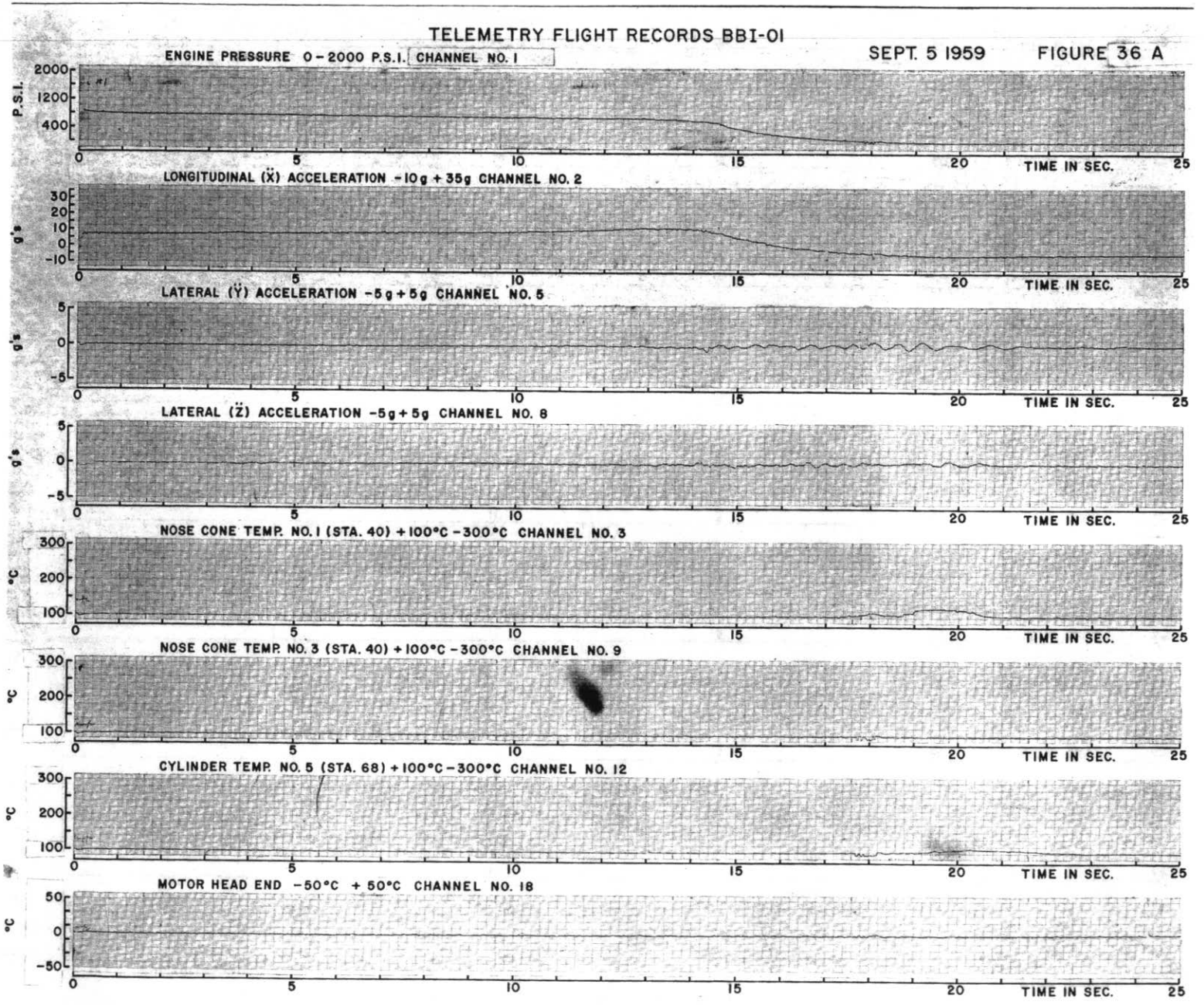
Plots of measured temperatures BB I - 07.

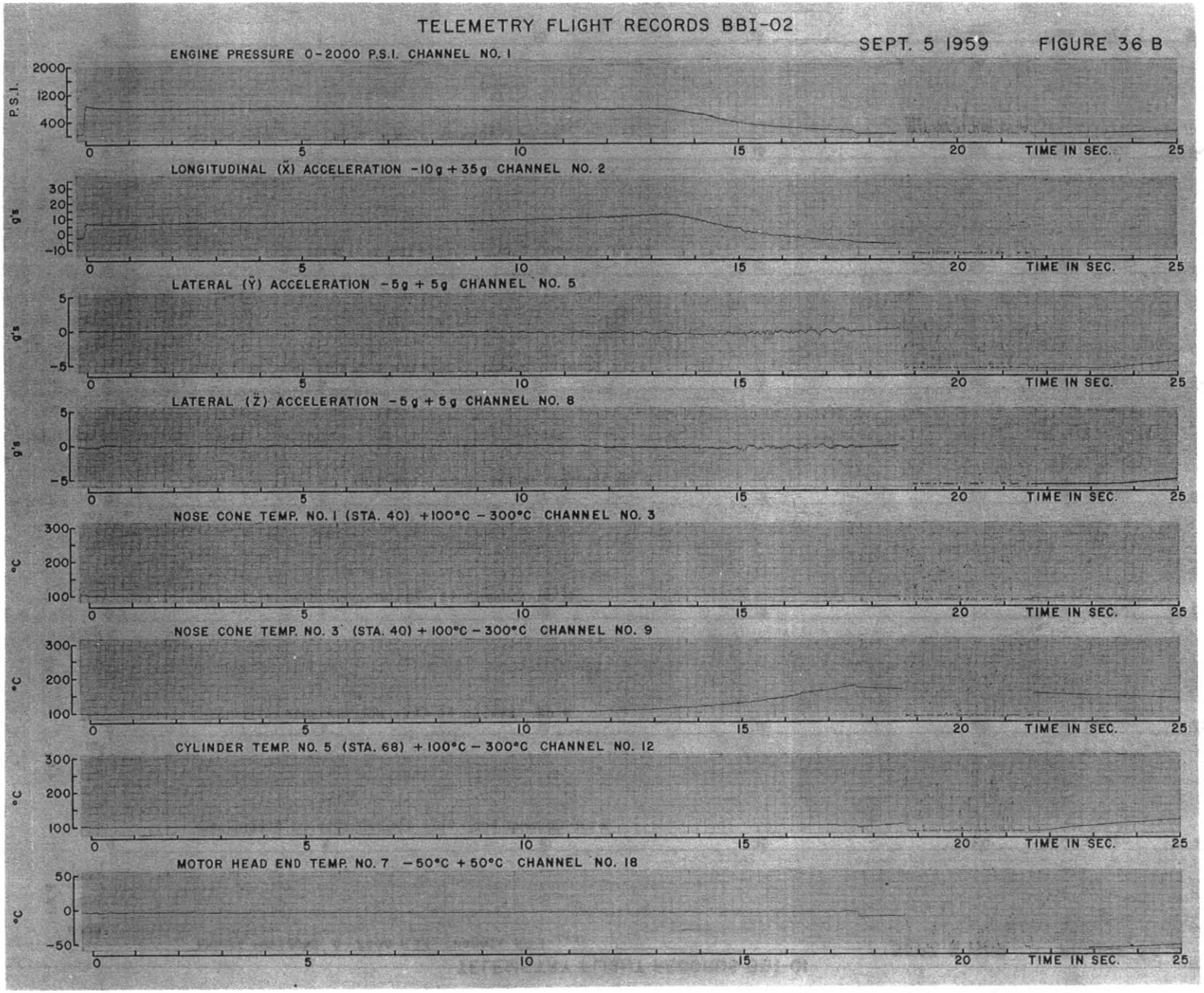
Figure 35G

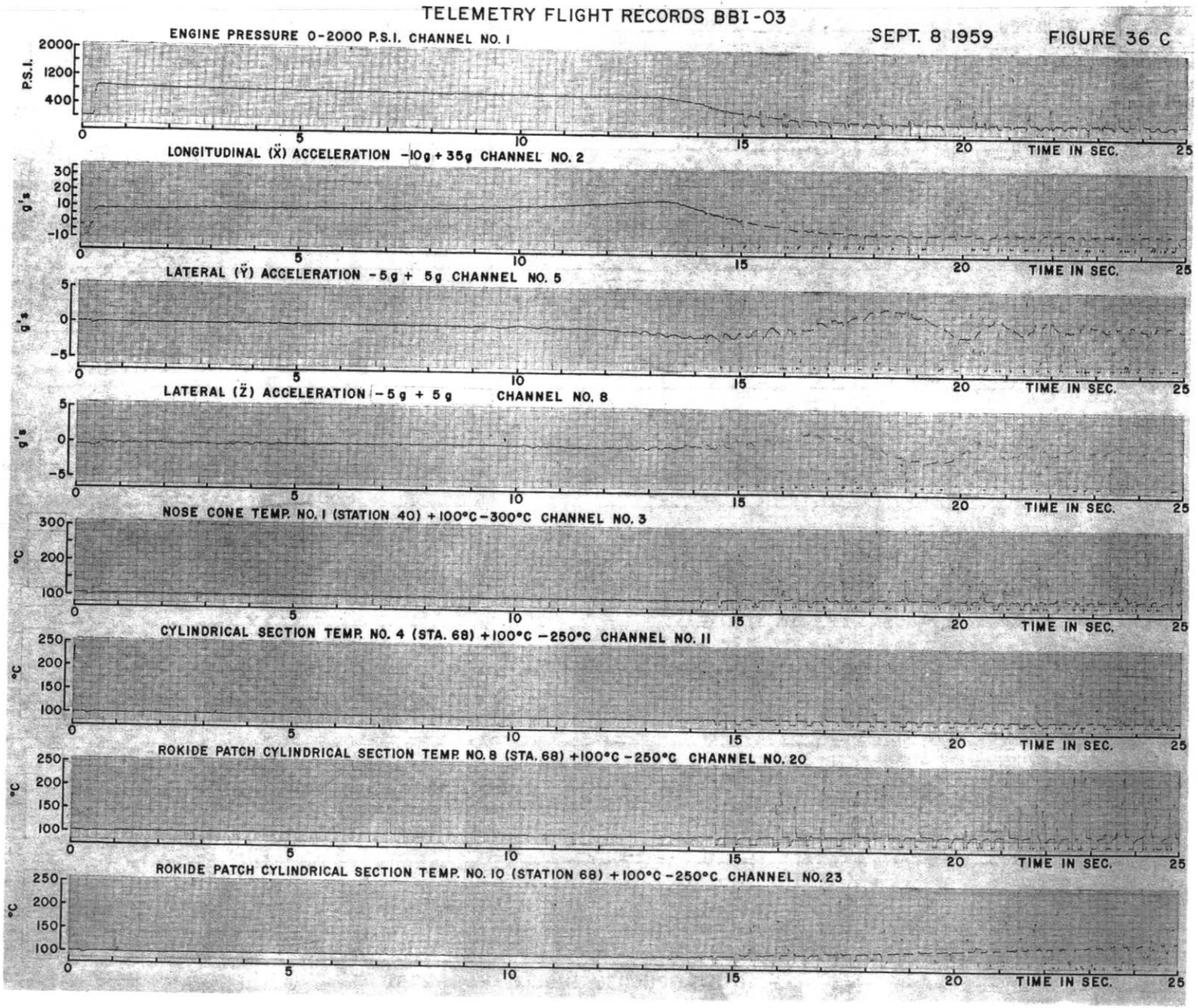


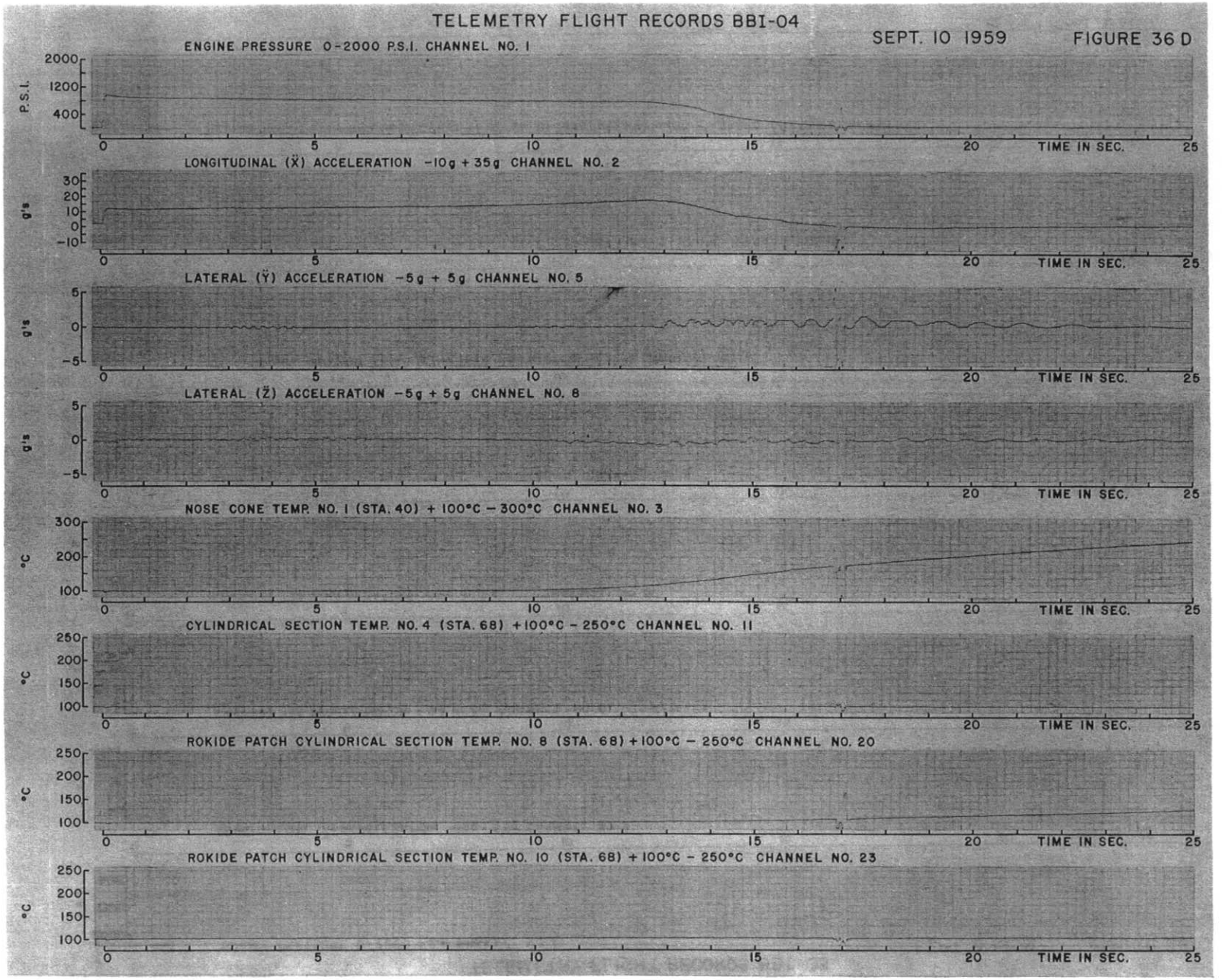
Comparison of measured and calculated nose cone skin temperatures BB I - 07.

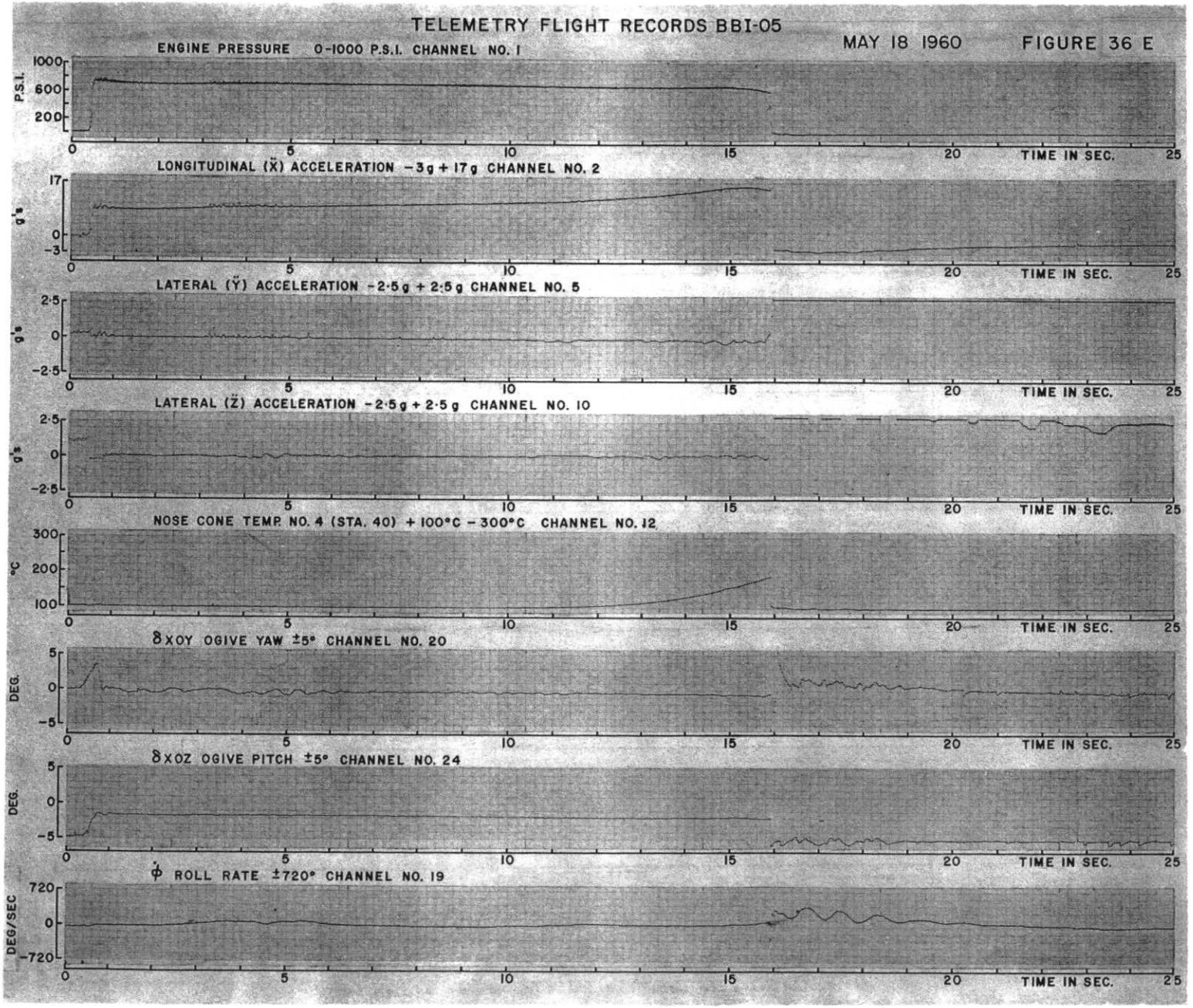
Figure 35H

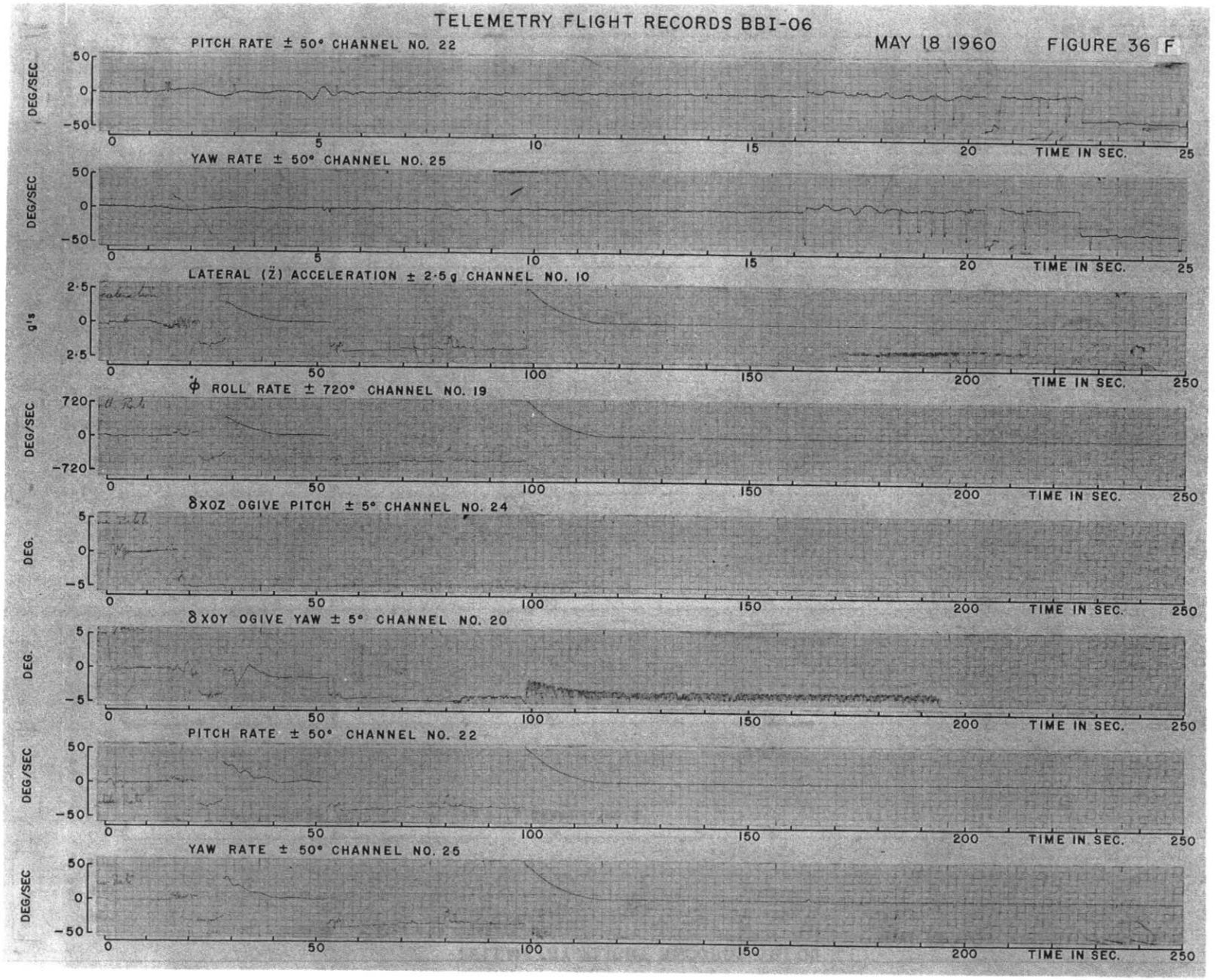

TELEMETRY FLIGHT RECORDS BBI-01
SEPT. 5 1959
FIGURE 36 A
ENGINE PRESSURE 0 - 2000 P.S.I. CHANNEL NO. 1
P.S.I.
2000
1200
400
LONGITUDINAL (Ẍ) ACCELERATION -10g + 35g CHANNEL NO. 2
g's
30
20
10
0
-10
LATERAL (Ÿ) ACCELERATION -5g + 5g CHANNEL NO. 5
g's
5
0
-5
LATERAL (Z̈) ACCELERATION -5g + 5g CHANNEL NO. 8
g's
5
0
-5
NOSE CONE TEMP. NO. 1 (STA. 40) + 100°C - 300°C CHANNEL NO. 3
°C
300
200
100
NOSE CONE TEMP. NO. 3 (STA. 40) + 100°C - 300°C CHANNEL NO. 9
°C
300
200
100
CYLINDER TEMP. NO. 5 (STA. 68) + 100°C - 300°C CHANNEL NO. 12
°C
300
200
100
MOTOR HEAD END -50°C + 50°C CHANNEL NO. 18
°C
50
0
-50
0
5
10
15
20
25
TIME IN SEC.

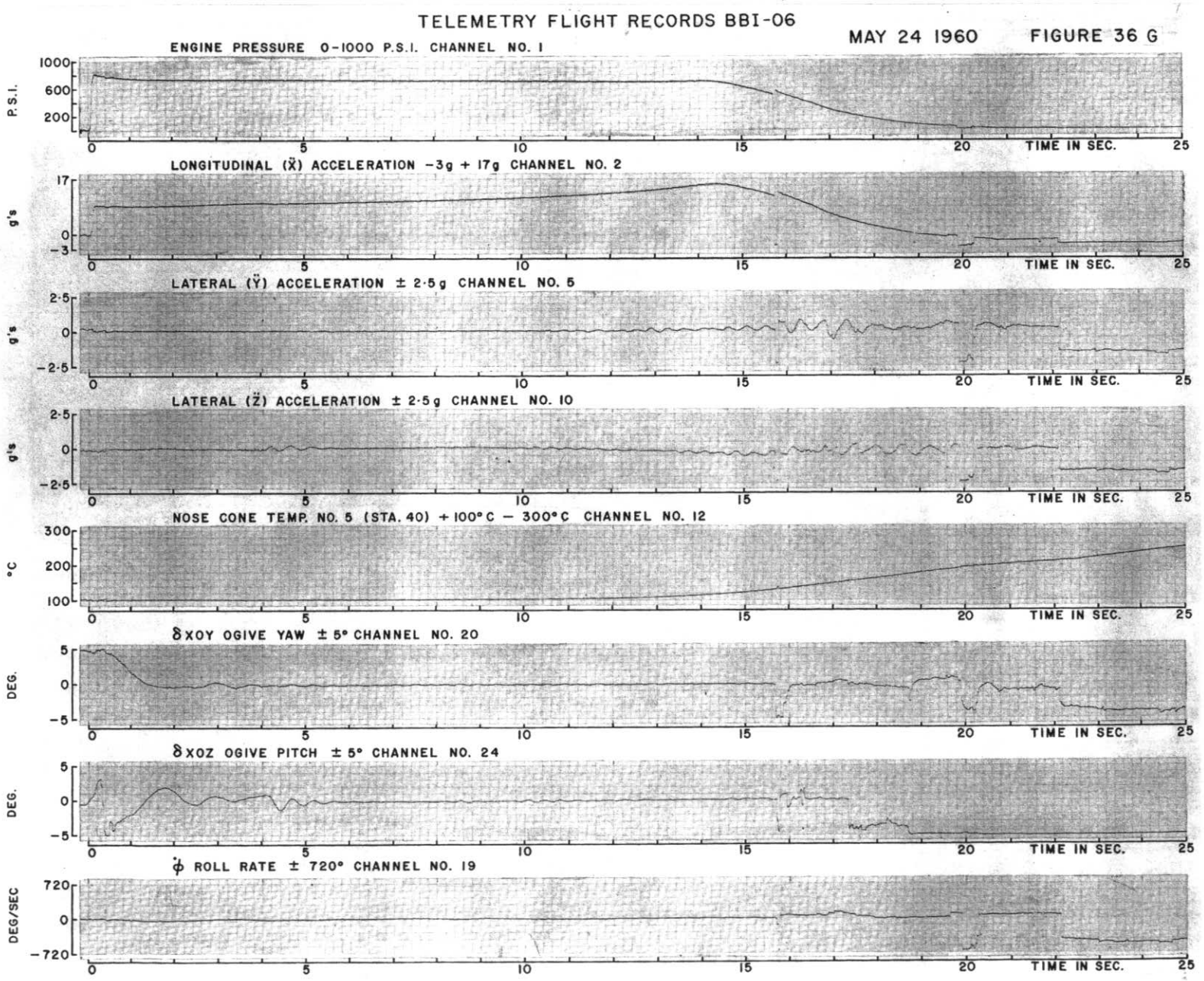

TELEMETRY FLIGHT RECORDS BBI-02
SEPT. 5 1959
FIGURE 36 B
ENGINE PRESSURE 0-2000 P.S.I. CHANNEL NO. 1
P.S.I.
2000
1200
400
LONGITUDINAL (X) ACCELERATION -10g + 35g CHANNEL NO. 2
g's
30
20
10
0
-10
LATERAL (Y) ACCELERATION -5g + 5g CHANNEL NO. 5
g's
5
0
-5
LATERAL (Z) ACCELERATION -5g + 5g CHANNEL NO. 8
g's
5
0
-5
NOSE CONE TEMP. NO. 1 (STA. 40) +100°C - 300°C CHANNEL NO. 3
°C
300
200
100
NOSE CONE TEMP. NO. 3 (STA. 40) + 100°C - 300°C CHANNEL NO. 9
°C
300
200
100
CYLINDER TEMP. NO. 5 (STA. 68) +100°C - 300°C CHANNEL NO. 12
°C
300
200
100
MOTOR HEAD END TEMP. NO. 7 -50°C + 50°C CHANNEL NO. 18
°C
50
0
-50
0
5
10
15
20
25
TIME IN SEC.

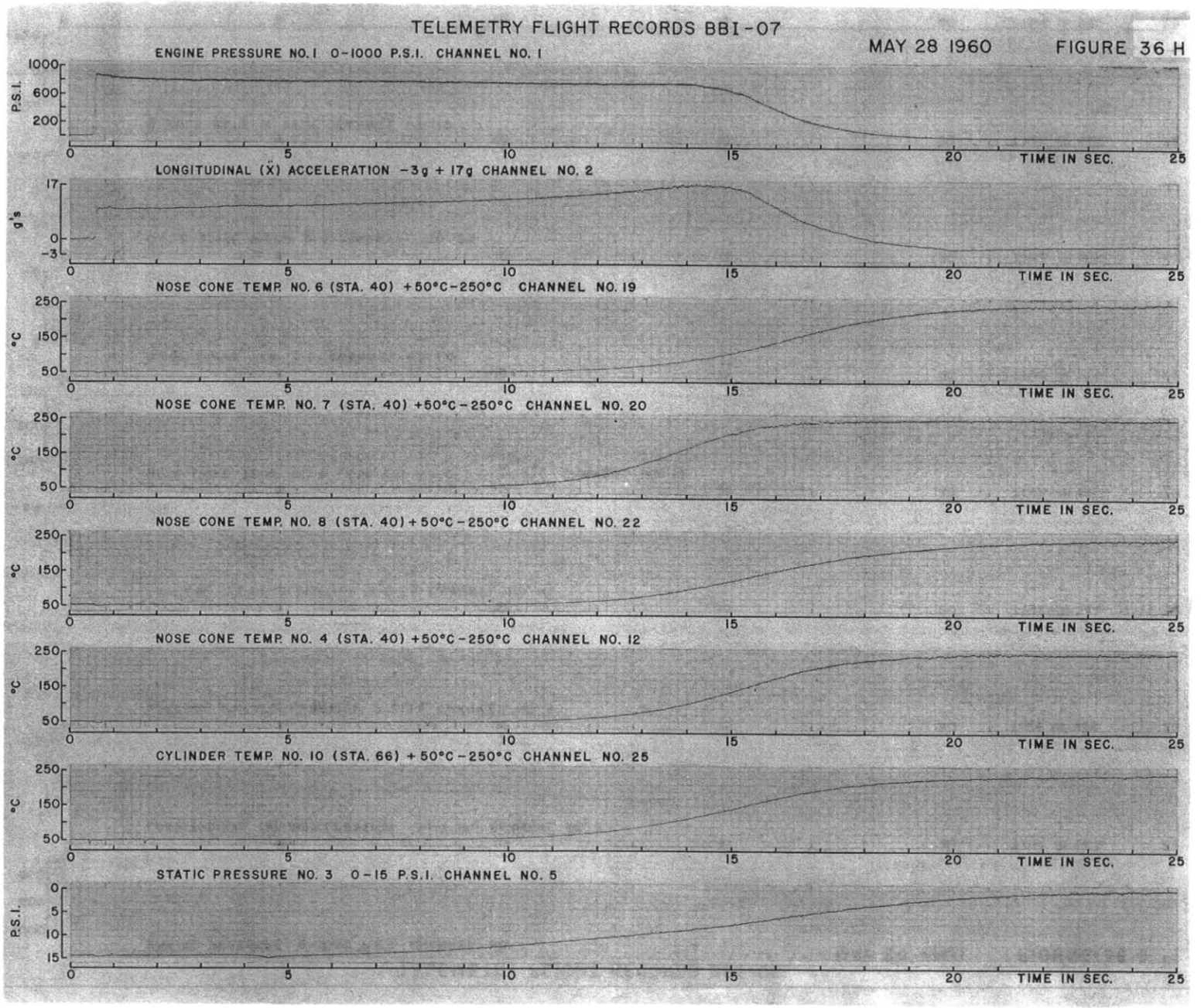

TELEMETRY FLIGHT RECORDS BBI-03
SEPT. 8 1959
FIGURE 36 C
ENGINE PRESSURE 0-2000 P.S.I. CHANNEL NO. 1
P.S.I.
2000
1200
400
LONGITUDINAL (Ẍ) ACCELERATION -10g + 35g CHANNEL NO. 2
g's
30
20
10
0
-10
LATERAL (Ÿ) ACCELERATION -5g + 5g CHANNEL NO. 5
g's
5
0
-5
LATERAL (Z̈) ACCELERATION -5g + 5g CHANNEL NO. 8
g's
5
0
-5
NOSE CONE TEMP. NO. 1 (STATION 40) +100°C-300°C CHANNEL NO. 3
°C
300
200
100
CYLINDRICAL SECTION TEMP. NO. 4 (STA. 68) +100°C -250°C CHANNEL NO. 11
°C
250
200
150
100
ROKIDE PATCH CYLINDRICAL SECTION TEMP. NO. 8 (STA. 68) +100°C -250°C CHANNEL NO. 20
°C
250
200
150
100
ROKIDE PATCH CYLINDRICAL SECTION TEMP. NO. 10 (STATION 68) +100°C -250°C CHANNEL NO. 23
°C
250
200
150
100
0
5
10
15
20
25
TIME IN SEC.


TELEMETRY FLIGHT RECORDS BBI-04
SEPT. 10 1959
FIGURE 36 D
ENGINE PRESSURE 0-2000 P.S.I. CHANNEL NO. 1
P.S.I.
2000
1200
400
LONGITUDINAL (Ẍ) ACCELERATION -10g + 35g CHANNEL NO. 2
g's
30
20
10
0
-10
LATERAL (Ÿ) ACCELERATION -5g + 5g CHANNEL NO. 5
g's
5
0
-5
LATERAL (Z̈) ACCELERATION -5g + 5g CHANNEL NO. 8
g's
5
0
-5
NOSE CONE TEMP. NO. 1 (STA. 40) + 100°C - 300°C CHANNEL NO. 3
°C
300
200
100
CYLINDRICAL SECTION TEMP. NO. 4 (STA. 68) +100°C - 250°C CHANNEL NO. 11
°C
250
200
150
100
ROKIDE PATCH CYLINDRICAL SECTION TEMP. NO. 8 (STA. 68) +100°C - 250°C CHANNEL NO. 20
°C
250
200
150
100
ROKIDE PATCH CYLINDRICAL SECTION TEMP. NO. 10 (STA. 68) + 100°C - 250°C CHANNEL NO. 23
°C
250
200
150
100
0
5
10
15
20
25
TIME IN SEC.


TELEMETRY FLIGHT RECORDS BBI-05
MAY 18 1960
FIGURE 36 E
ENGINE PRESSURE 0-1000 P.S.I. CHANNEL NO. 1
P.S.I.
1000
600
200
LONGITUDINAL (X) ACCELERATION -3g + 17g CHANNEL NO. 2
g's
17
0
-3
LATERAL (Y) ACCELERATION -2·5g + 2·5g CHANNEL NO. 5
g's
2·5
0
-2·5
LATERAL (Z) ACCELERATION -2·5g + 2·5g CHANNEL NO. 10
g's
2·5
0
-2·5
NOSE CONE TEMP. NO. 4 (STA. 40) + 100°C - 300°C CHANNEL NO. 12
°C
300
200
100
δXOY OGIVE YAW ±5° CHANNEL NO. 20
DEG.
5
0
-5
δXOZ OGIVE PITCH ±5° CHANNEL NO. 24
DEG.
5
0
-5
φ̇ ROLL RATE ±720° CHANNEL NO. 19
DEG/SEC
720
0
-720
0
5
10
15
20
25
TIME IN SEC.


TELEMETRY FLIGHT RECORDS BBI-06
MAY 18 1960
FIGURE 36 F
PITCH RATE ± 50° CHANNEL NO. 22
DEG/SEC
50
0
-50
0
5
10
15
20
TIME IN SEC.
25
YAW RATE ± 50° CHANNEL NO. 25
DEG/SEC
50
0
-50
0
5
10
15
20
TIME IN SEC.
25
LATERAL (Z̈) ACCELERATION ± 2·5 g CHANNEL NO. 10
g's
2·5
0
2·5
0
50
100
150
200
TIME IN SEC.
250
φ̇ ROLL RATE ± 720° CHANNEL NO. 19
DEG/SEC
720
0
-720
0
50
100
150
200
TIME IN SEC.
250
δXOZ OGIVE PITCH ± 5° CHANNEL NO. 24
DEG.
5
0
-5
0
50
100
150
200
TIME IN SEC.
250
δXOY OGIVE YAW ± 5° CHANNEL NO. 20
DEG.
5
0
-5
0
50
100
150
200
TIME IN SEC.
250
PITCH RATE ± 50° CHANNEL NO. 22
DEG/SEC
50
0
-50
0
50
100
150
200
TIME IN SEC.
250
YAW RATE ± 50° CHANNEL NO. 25
DEG/SEC
50
0
-50
0
50
100
150
200
TIME IN SEC.
250


TELEMETRY FLIGHT RECORDS BBI-06
MAY 24 1960
FIGURE 36 G
ENGINE PRESSURE 0-1000 P.S.I. CHANNEL NO. 1
P.S.I.
1000
600
200
LONGITUDINAL (Ẍ) ACCELERATION −3g + 17g CHANNEL NO. 2
g's
17
0
−3
LATERAL (Ÿ) ACCELERATION ± 2·5g CHANNEL NO. 5
g's
2·5
0
−2·5
LATERAL (Z̈) ACCELERATION ± 2·5g CHANNEL NO. 10
g's
2·5
0
−2·5
NOSE CONE TEMP. NO. 5 (STA. 40) + 100°C — 300°C CHANNEL NO. 12
°C
300
200
100
δXOY OGIVE YAW ± 5° CHANNEL NO. 20
DEG.
5
0
−5
δXOZ OGIVE PITCH ± 5° CHANNEL NO. 24
DEG.
5
0
−5
φ̇ ROLL RATE ± 720° CHANNEL NO. 19
DEG/SEC
720
0
−720
0
5
10
15
20
25
TIME IN SEC.


TELEMETRY FLIGHT RECORDS BBI-07
MAY 28 1960
FIGURE 36 H
ENGINE PRESSURE NO. 1 0-1000 P.S.I. CHANNEL NO. 1
P.S.I.
1000
600
200
LONGITUDINAL (Ẍ) ACCELERATION -3g + 17g CHANNEL NO. 2
g's
17
0
-3
NOSE CONE TEMP. NO. 6 (STA. 40) +50°C-250°C CHANNEL NO. 19
NOSE CONE TEMP. NO. 7 (STA. 40) +50°C-250°C CHANNEL NO. 20
NOSE CONE TEMP. NO. 8 (STA. 40) +50°C-250°C CHANNEL NO. 22
NOSE CONE TEMP. NO. 4 (STA. 40) +50°C-250°C CHANNEL NO. 12
CYLINDER TEMP. NO. 10 (STA. 66) +50°C-250°C CHANNEL NO. 25
°C
250
150
50
STATIC PRESSURE NO. 3 0-15 P.S.I. CHANNEL NO. 5
P.S.I.
0
5
10
15
0
5
10
15
20
25
TIME IN SEC.

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