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TITLE

FLIGHT TEST RESULTS OF BLACK BRANT ITA \(CC II 17 AND 18\) FIRED AT CHURCHILL RESEARCH RANGE, JUNE 1963

System Number:

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CARDE T.N. 1588/64

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PCC D46-02-10-01

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by

J.R. Delisle

DEFENCE RESEARCH BOARD

CANADIAN ARMAMENT RESEARCH AND DEVELOPMENT ESTABLISHMENT

Valcartier, Quebec

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August 1964

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CARDE TECHNICAL NOTE 1588/64 UNCLASSIFIED

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ABSTRACT

Two Black Brant IIA CC II 17 and 18 rocket vehicles were flight-tested at Churchill Rocket Range (CRR) on June 24, 1963 with the main objective of testing the new Canadair four-fin stabilizer assembly. Performance calculations, launch and wind data, flight-test results for these vehicles are presented. Radar beacon units were carried on these rounds, however radar data for only a portion of their flights were obtained.

Flight-test results indicated that the new Canadair four-fin stabilizer assembly performed satisfactorily and that both vehicles successfully carried a 250 pound instrumented nose cone to peak altitudes of over 100 miles.

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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, g's.

C_{D_b} - Base drag coefficient.

C_{D_o} - Zero lift drag coefficient.

C_{D_w} - Wave drag coefficient.

C_{D_f} - Skin friction drag coefficient.

$C_{L_{\alpha o}}$ - Vehicle, zero lift curve slope.

$C_{L_{\alpha b}}$ - Nose and body lift curve slope.

$C_{L_{\alpha f}}$ - Fins, zero lift curve slope.

D - Drag, lb.

H - Altitude, ft.

I_Z - Pitch moment of inertia, slugs ft^2.

I_X - Roll moment of inertia, slugs ft^2.

M - Mach No.

P - Engine pressure, lb. ft^2.

P_i - Ambient pressure, lb/ft^2.

R - Range, ft.

S - Wind sensitivity.

T_S - Skin temperature °C.

T - Thrust, lb.

t - Time, sec.

V - Velocity, ft/sec.

V_W - Wind velocity, ft/sec.

W - Weight, lb.

X_{cg} - Distance from apex of the nose cone to the vehicle center of gravity, in.

LIST OF SYMBOLS (Cont'd)

X_{cp} - Distance from the apex of the nose cone to the vehicle center of pressure, in.

$\ddot{X}$ - Longitudinal acceleration, g's.

$\ddot{Y}$ - Yaw acceleration, g's.

$\ddot{Z}$ - Pitch acceleration, g's.

θ - Launch or pitch position angle, degrees.

θ_W - Wind direction, degrees.

ψ - Yaw position angle, degrees.

ϕ - Roll position angle, degrees.

δ_{xoy} - Yaw angle of attack, degrees.

δ_{xoz} - Pitch angle of attack, degrees.

ω_o - Pitching frequency, c.p.s.

INTRODUCTION

In October 1960, CARDE flight tested two Black Brant IIA, CC II-13 and 14 rocket vehicles (Reference 1) at Churchill Rocket Range. Four additional Black Brant IIA rockets CC-II 15 and 16 and CC II-54 and 55, (References 2 and 3) were fired at Wallops Island, Va. in November 1961 and August 1962 respectively. The latter two were flight tested with a modified-version of the original BB IIA fins. As a continuation of this rocket vehicle test programme, two Black Brant IIAs, CC II-17 and 18, were successfully flight-tested at the Churchill Research Range (CRR) in June 1962 with a new four-fin stabilizer.

This Technical Note presents the aerodynamic characteristics, the performance calculations and the flight-test results of the Black Brant IIA CC II-17 and 18 rocket vehicles.

TEST OBJECTIVES

The flight test objectives were as follows:

1. To test the new Black Brant IIA four-fin stabilizer.

2. To obtain propellant ballistic data when the engine is dynamically fired at ambient temperature.

3. To obtain trajectory and dispersion data.

4. To measure the nose cone skin temperatures.

5. To measure the vehicle dynamic motions.

ROCKET VEHICLE

General

Black Brant IIA CC II-17 and 18 rocket vehicles in this test series used the original Canadair designed nose cone, the CARDE 15KS25000 solid propellant propulsion unit and the new Canadair designed four-fin stabilizer assembly. (Figures 1 and 2).

The rocket vehicle was aerodynamically stabilized by four large fixed fins and was uncontrolled in flight. The basic vehicle was 17.20 inches in diameter, 27.0 feet long and had a fin-span of 66.2 inches. The weights of these vehicles, (CC II-17 and 18) at launch were 2670 pounds and 2675 pounds respectively. The estimated static stability margin at burnout was 2.0 calibers (body diameter). The calculated performance was based upon a vehicle weight of 2675 pounds at launch and an 80 degree elevation angle (zero wind).

Nose Cone

The nose cone consisted of a standard Black Brant II cone-cylinder which housed a payload of 133 pounds. The total weight of the nose cone was 250 pounds and its center of gravity was located at station 74 (with the zero reference station at the apex of the nose cone) see Figure 3. A photograph of the nose cone is shown in Figure 4.

Rocket Motor

The CARDE 15KS25000 propulsion unit was used to power these vehicles. The total impulse at sea level was taken as 380,000 lb-sec. with a nominal burning time of 15.5 sec. Tabulated engine performance data is presented in Table I. In the performance calculations, the sea-level thrust was corrected for an increase in thrust at altitude by the term:

$$T = (2116.8 - P_i)\, A_e$$

where P_i - is the instantaneous ambient pressure during the rocket powered flight, lb/ft^2.

A_e - is the exit area of the nozzle, ft^2.

T - Thrust, lb.

The unburnt and burnt weights and the center of gravity locations of CC II-17 and 18 rocket engines are given im Table III. A photograph of the rocket engine and nozzle assembly is shown in Figure 5.

Igniter

The igniter assembly consisted of a flame tube and the main igniter charge attached to the head end enclosure of the engine. A photograph of the igniter assembly is shown in Figure 6. The McCormick Selph M-32 Mod. V squib (Figure 7) was used as the electrical initiator for the igniter. This squib had a resistance of 0.3 ohm and required a minimum firing current of 2.0 amps for satisfactory operation.

Fin Assembly

The new Black Brant II stabilizer consisted of a four-fin configuration mounted on a fabricated supporting body structure. A photograph of the fin assembly is shown in Figure 8. The basic fin, Figure 9, consisted of a single wedge of an 8.7% thickness to chord ratio and had a planform area of 4 sq. ft.

The fin was made up of a magnesium grid-core to which were attached the magnesium skins (.25 inch thick). An inconel cuff (.093 inch thick) was used to cap the leading edge of the fin. Each fin had ten locating holes in its base, one of them being located on the center line of the base and positioned in line with the fin center of pressure. This hole is used as a pivot point of the fin onto the body section and allows the fin incidence to be changed through a range of ± .5 degree.

A maximum spin rate of 8 r.p.s. can be obtain at maximum incidence and velocity.

AIRBORNE INSTRUMENTATION

The telemetry system (Figures 10 and 11) for these vehicles consisted of 10 FM-FM channels of information. IRIG channels A, C and E at ± 15% deviation and channels 7 to 13 at ± 7½% deviation were used. Channel A was used with a standard 30 x 30 PDM multicoder, channel E was used with a non standard 30 x 5 PAM sampling switch and the remaining eight were used as continuous FM channels.

The telemetry system had a radiative power output of 4 to 5 watts and operated at a transmitting frequency of 225.7 Mc. The telemetry components were packaged as a whole unit in a sealed container (Figure 12) to prevent high voltage spark over at high altitude. In the event of any telemetry component failure the entire unit could be replaced. A photograph of the instrumentation package for these vehicles is reproduced in Figure 13. An outline illustrating the location of the instruments in the nose cone of the rocket is presented in Figure 14. A list of the measured functions, instrument ranges and frequency of responses and channel allocations is given in Table II. A new wedge type of telemetry antenna was used on these vehicles and the tripole assembly onto the nose cone is shown in Figure 4. These vehicles carried the University of London ionization probes experiment and the CARDE MK 7 radar beacon to improve the tracking signal.

VEHICLE DATA

General

General information for these vehicles is given in Table III. Variation of the vehicle time dependent parameters during the powered phase of the rocket flight are presented in the following Figures and Tables:-

1) Thrust versus time, Figure 15. Table I.

2) Weight versus time, Figure 16. Table IV.

3) Pitch moment of inertia versus time, Figure 17. Table IV.

4) Roll moment of inertia versus time, Figure 18. Table IV.

5) Center of gravity versus time, Figure 19. Table IV.

6) Undamped pitching frequency versus time, Figure 20.

Spin

An aeroelastic study involving static testing of a fin panel indicated that the fin was approximately 100% effective. Each fin panel underwent an alignment checkout to determine its built-in error. Alignment data and structural influence coefficient in conjunction with programmed spin rates were computed to provide the spin history of the vehicles at various time intervals. Results of the spin rate history obtained for these vehicles are presented in Figures 21 and 22.

Wind Sensitivity

The wind sensitivity data for these vehicles were obtained from a computer study as reported in Reference 4. Wind sensitivity data for these vehicles are presented in Figure 23 and Table V. This information was passed to the range for determination of the wind effects on the rocket flights and to correct the launcher settings to provide a predetermined zero wind launch condition.

LAUNCHER

These vehicles were fired from an underslung zero-tip-off boom launcher. The rail system consisted of a single forward and two rear rail 15 foot in length. A layout of the launcher lugs arrangement for a four-fin vehicle is shown in Figure 24. Launcher rails layout and alignment data are shown in Figure 25.

STABILITY

The values of the derivative of the lift coefficients at zero lift ($C_{L_{\alpha o}}$) and the static stability margin (as determined by the locations of the center of gravity and center of pressure of the vehicle) were determined using References 5, 6, 7, 8 and 9. The center of gravity of various vehicle components were taken from the vehicle checkout data and are given in Table III. The values of the zero lift curve slope coefficients ($C_{L_{\alpha o}}$ based upon the body cross-sectional area A_b) and the center of pressure versus Mach No. for the nose cone and the afterbody, the fins and the complete vehicle are presented in Figures 26 to 28. The vehicles were fired at a static stability margin of 2.0 calibers (body diameter) at the burnout condition. Figure 29 presents the static stability margin versus Mach No. Tabulated data on lift coefficient, center of pressure, center of gravity and stability margin are given in Table VI.

DRAG

The calculated wave and base drag coefficients were calculated using References 8, 10 and 11 as functions of Mach No. are presented in Figure 30. The skin friction drag was computed along with the flight history of the rocket. Figure 31 presents the variation of the skin friction drag coefficient as a function of Reynolds No. and Mach No. The total zero lift drag coefficient versus Mach No. is given in Figure 32.

Total drag versus time is shown in Figure 33. Values of Reynolds No. per foot versus time is given in Figure 34.

PERFORMANCE

The calculated performances of these rocket vehicles were based upon a vehicle launch weight of 2675 pounds and an elevation angle of 80 degrees (zero wind).

The calculated results are shown in the following:-

1) Calculated acceleration versus time. Figure 35.
2) Calculated velocity versus time. Figure 36.
3) Calculated altitude versus time. Figure 37.
4) Calculated altitude versus range. Figure 38.
5) Calculated Mach No. versus time. Figure 39.
6) Calculated dynamic pressure versus time. Figure 40. Table IV.

FLIGHT TESTING CC II-18 VEHICLE

General

CC II-18 rocket vehicle was flight-tested at the Churchill Research Range on June 24, 1963. Details of the launch conditions are given in Table VII. Telemetry signal was obtained from launch to impact and indicated a total flight time of 389 sec. Radar beacon signal was lost immediately at lift-off, however, radar skin tracked the vehicle from X+10.5 sec. to X+40 sec. to an altitude of 216,000 ft. Analysis of the wind and the radar data indicated that the vehicle was launched at an effective elevation angle of 83.5 degrees and azimuth of 098 degrees although the pre-flight requirements were for a nominal 80 degree elevation angle and an impact azimuth angle of 110 degrees (zero wind).

Telemetry Results

The telemetry signals were recorded on a magnetic tape and indicated a launch to impact time of 389 sec. The telemetry flight recordings of both the boost and the reentry phases for the CC II-18 vehicle are shown in Figures 41 to 44. A study of the recordings indicated the following:-

1. Roll Position Gyros

The outputs of both roll position gyros indicated that the vehicle started to roll at X+4 sec. in a counterclockwise direction.

The differentiated angular position data indicated that the vehicle reached a maximum spin rate of $\frac{1}{2}$ r.p.s. at approximately X+12 sec. which then reduced to 1/7 r.p.s. at X+30 sec. The vehicle maintained this spin rate for the remainder of the flight. A plot of the roll rate history for this vehicle is compared with the predicted roll data in Figure 22.

2. Magnetic Aspect Sensors

The output of the X magnetometer indicated that the probe saturated on account of its relative position to the direction of the lines of forces of the earth magnetic field at Churchill.

The phase displacement between the Y and Z magnetometer outputs indicated that the vehicle rotated in a counterclockwise direction. The heliflux roll rate data were in good agreement with the spin rate data obtained from the gyros (Figure 22).

3. Roll Rate

The roll rate gyro indicated that the vehicle rotated in a counterclockwise direction. The recorded spin rate from the roll rate gyro had a lower accuracy than the spin rate data obtained from both the magnetometers and the differentiated angular data obtained from the roll position gyros.

4. Engine Pressure

The Statham engine pressure output (40 Kc channel) indicated transducer noise for the first half second of flight. The remaining pressure output on this channel was excellent and a burnout time of X+19 sec. was recorded. The Bourns Pressure transducer output (commutated channel) recording showed irregularities in comparison to that obtained from the high frequency channel. The reduced engine pressure data will be reported on separately.

5. Longitudinal Accelerometer

The longitudinal accelerometer output (14.5 Kc channel) was normal and a peak value of 16.8 g's was recorded at X+14 sec. A plot of the reduced telemetered acceleration-time curve is given in Figure 45.

A study of a high speed galvo recording of the longitudinal accelerometer output indicated vibrational frequencies of approximately 160 c.p.s. with a maximum amplitude of 5 g's during the vehicle travel on the launcher. The amplitude of the oscillations rapidly damped down beyond this initial launch condition.

6. Lateral Accelerometers

The pitch accelerometer output (10.5 Kc channel) indicated a sustained acceleration from launch to X+13 sec. Between X+13 and X+21 sec. a maximum value of less $\frac{1}{2}$ g was recorded. The acceleration then damped down to zero at X+21 sec. and remained at zero until the re-entry phase.

A study of a high speed galvo recording of the pitch and yaw accelerometer outputs indicated vibrational frequencies of approximately 175 c.p.s. with a maximum amplitude of 3.5 and 1.5 g's respectively during the vehicle travel on the launcher. The amplitude of the oscillations rapidly damped down beyond this initial launch condition.

7. Pitch and Yaw Position Gyros

The pitch and yaw position gyros outputs (3.0 Kc and 5.4 Kc channels respectively) recorded very small vehicle motion in these planes. The outputs indicated that the instruments were drifting during the flight until an off-scale value was reached at approximately X+100 sec. Both instruments drifted in the same direction on this round.

8. Angle of Attack Indicator

The pitch and yaw outputs of the angle of attack indicator (3.0 Kc and a 2.5 Kc channels respectively) showed sinusoidal oscillations as the vehicle left the launcher which rapidly damped down to zero and remained at zero. The values of the angle of attack indicator ceases to be reliable after approximately X+20 sec. on account of the low dynamic pressure.

9. Skin Temperature

The maximum skin temperatures reached during the flight were 252°C at X+40 sec. on the conical section (Station 36) and 185°C at X+32 sec. on the cylindrical section (Station 94). Plots of the measured skin temperatures are presented in Figures 46 and 47 respectively. A maximum temperature of 314°C (conical section) was recorded at impact indicating a 100°C temperature rise during the last 20 seconds of the reentry phase. Plots of the measured skin temperatures during the vehicle total flight are shown in Figure 48.

FLIGHT TESTING CC II-17 VEHICLE

General

CC II-17 rocket vehicle was flight tested at the Churchill Research Range on June 24, 1963. Details of the launch condition are given in Table VII. Telemetry signal was obtained from launch to impact and indicated a total flight-time of 376 sec. An MPS-19 radar tracked the beacon signal from X+0 to X+50 secs to an altitude of 242,000 ft. then radar reported intermittent surge of the beacon return signal for a short period before the signal was lost completely. The MPQ-18 radar skin tracked the vehicle for the first 45 seconds of flight only. Analysis of the wind and the radar data indicated that the vehicle was launched at an effective elevation angle of 81 degrees and azimuth angle of 098 degrees, although, the pre-flight requirements were for a nominal 85 degrees elevation angle and an impact azimuth of 110 degrees (zero wind).

Telemetry Results

The telemetry signals were recorded on a magnetic tape and indicated a launch to impact time of 376 sec. The telemetry flight recordings of both the boost and the reentry phases for CC II-17 vehicle are shown in Figures 49 to 52.

1. Roll Position Gyros

The outputs of both roll position gyros indicated that the vehicle started to roll at X+2.5 sec. in a counterclockwise direction. The differentiated angular data indicated that the vehicle reached a maximum spin rate of $\frac{1}{2}$ r.p.s. at approximately X+15 sec. which then reduced to 1/3 r.p.s. at X+20 sec. The vehicle maintained this spin rate for the remainder of the flight. A plot of the roll rate history for this vehicle is compared with the predicted data in Figure 21.

2. Magnetic Aspect Sensors

The output of the X magnetometer as on CC II-18 indicated that the probe was saturated on account of its relative position to the direction of the lines of forces of the earth magnetic field at Churchill.

The phase displacement between the Y and Z magnetometer outputs indicated that the vehicle rotated in a counterclockwise direction. The heliflux roll rate data were in good agreement with the spin rate data obtained from the gyros Figure 21.

3. Roll Rate Gyro

The roll rate gyro indicated that the vehicle rotated in a counterclockwise direction. The recorded spin rate from the roll rate gyro had a lower accuracy than the spin rate data obtained from both the magnetometers and the differentiated angular data obtained from the roll position gyros.

4. Engine Pressure

The Statham engine pressure output (40 Kc channel) indicated similar transducer noise for the first half second of flight as occurred on CC II-18. The remaining pressure output on this channel was normal and a burnout time of X+18 sec. was recorded. The Bourns engine pressure output on the commutated channel showed irregularities in comparison with the output obtained from the high frequency channel. The reduced engine pressure data will be reported on separately.

5. Longitudinal Accelerometer

The longitudinal accelerometer output (14.5 Kc channel) was normal and a peak value of 17 g's was recorded at X+13.5 sec. A plot of the reduced telemetered acceleration-time is given in Figure 53.

A study, of a high speed galvo recording of the longitudinal accelerometer output indicated vibrational frequencies of approximately 160 c.p.s. with a maximum amplitude of 3 g's during the vehicle travel on the launcher.

The amplitude of these oscillations rapidly damped down beyond this initial launch condition. Additional vibrational peaks of very short duration were recorded at X+3 and X+9 seconds.

6. Lateral Accelerometers

The pitch and yaw accelerometer outputs (10.5 Kc and 7.5 Kc channels respectively) indicated that the lateral accelerations up to X+14 sec. were zero. Between X+14 and X+21 sec. sinusoidal acceleration were encountered and recorded a maximum value of less than ½ g. The accelerations then damped down to zero at X+22 sec. and remained at zero until the reentry phase.

A study of a high speed galvo recording of the pitch and yaw accelerometers' outputs indicated vibrational frequencies of approximately 160 c.p.s. with a maximum amplitude of 1.5 g's during the vehicle travel on the launcher. The amplitude of these oscillations rapidly damped down beyond this initial launch condition. Additional vibrational peaks of very short duration were recorded in phase with the longitudinal accelerometer peaks at X+3 and X+9 seconds.

7. Pitch and Yaw Position Gyros

The pitch and yaw position gyros outputs (3.0 Kc and 5.4 Kc channels respectively) recorded very small vehicle motion in these planes. The outputs indicated that instruments were drifting during the flight. Both gyros drifted to an off-scale value at X+60 sec. On this round the gyros drifted in an opposing direction whereas on CC II-18 both gyros drifted the same direction.

8. Angle of Attack

The pitch and yaw angle of attack outputs (3.0 Kc and 2.3 Kc channels respectively) showed sinusoidal oscillations as the vehicle left the launcher which damped down to zero at X+4 sec. and remained at zero. The value of the angle of attack indicator ceases to be reliable after approximately X+20 sec. on account of the low dynamic pressure.

9. Skin Temperature

The maximum skin temperatures reached during the flight were 238°C at X+43 sec. on the conical section (Station 36) and 150°C at X+27 sec. on the cylindrical section (Station 94). Plots of the skin temperatures are presented in Figures 54 and 55 respectively. A maximum temperature of 256°C (conical section) was recorded approximately at impact indicating a 50°C temperature rise during the last 20 seconds of the reentry phase. Plots of the measured skin temperatures during the total flight of the vehicle are shown in Figure 56.

TRAJECTORY DATA - CC II-17 AND 18 VEHICLES

Plots of radar trajectory data which were obtained for a portion of the flights are compared with reconstructed trajectories (obtained from telemetered acceleration data, wind corrected launch angle, and total flight time from the telemetry signal) and are presented in Figures 57 and 58 for CC II-18 and 17 vehicles respectively.

CC II-18 vehicle attained a maximum velocity of 6050 ft. sec. at X+17 sec., a peak altitude of 561,400 ft. A total flight time of 389 seconds was recorded. CC II-17 attained a maximum velocity of 5825 ft/sec. at X+17 sec., a peak altitude of 530,000 ft. A total flight time of 376 seconds was recorded.

DISCUSSION OF RESULTS

On CC II-18 rocket flight test, radar reported the loss of signal from the CARDE Mk 7 radar beacon at lift-off. On CC II-17 flight test, radar tracked the beacon signal for 49 seconds and then there was an intermitent surge of return signal for a short period before the signal was lost completely. Radar skin tracked both vehicles for approximately the first 45 seconds of flight. Sound ranging indicated that CC II-18 vehicle impacted 50 miles from Twin Lake station on the range but was inconsistent with radar data. No sound ranging information was obtained for CC II-17 vehicle. Telemetry signal indicated a total flight time of 389 and 376 seconds for CC II-18 and 17 respectively.

The wind and radar data for CC II-17 and 18 vehicles indicated that the vehicles were launched at effective elevation angles of 81 and 83.5 degrees respectively. The requested zero wind launch conditions were 85 and 80 degrees respectively.

The actual spin rate data from both the magnetometers and the gyros indicated that both vehicles rolled at a slightly higher rate than calculated (maximum discrepancy of 1/6 r.p.s.) but which were considered to be better than what could be expected for general research rockets.

Flight-test results indicated that the new Canadair four-fin stabilizer assembly performed satisfactorily and that both vehicles successfully carried a 250 pound instrumented nose cone to peak altitude of over a 100 miles. A 15 to 20 percent increase in peak altitude performance was obtained with the four-fin vehicles over the modified three-fin vehicles on account of a 50 pound reduction in structure weight.

Flight results indicated the four-fin stabilizer assembly to be a logical replacement of the modified three-fin assembly for the Black Brant II vehicles.

The new wedge type of telemetry antennas was proven to be effective. Excellent telemetry signal was obtained on both rounds, from launch to impact.

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TABLE I

Engine Propulsion Data (Temperature 73°F)

Time sec.	Average Thrust Sea Level lb.	Average Thrust Altitude Corrected lb.	Average Thrust Vacuum lb.
0-1	27,800	27,805	29,890
1-2	26,200	26,227	28,290
2-3	26,200	26,270	28,290
3-4	26,100	26,232	28,190
4-5	25,900	26,118	27,990
5-6	25,600	25,917	27,690
6-7	25,500	25,933	27,590
7-8	25,300	25,863	27,390
8-9	25,000	25,724	27,090
9-10	24,400	25,236	26,490
10-11	24,200	25,181	26,290
11-12	23,800	24,930	25,890
12-13	22,300	23,579	24,390
13-14	21,200	22,621	23,250
14-15	14,900	15,985	16,370
15-16	7,700	8,283	8,450
16-17	4,800	5,116	5,160
17-18	2,800	2,928	2,970
18-19	300	319	330
19-20	0	0	0

Propellant weight, lb 1,760
Propellant discharge, lb. 1,780
Total Impulse (S.L.), lb-sec. 380,000
Total Impulse (Vacuum), lb-sec. 412,000
Nozzle exit area, ft^2. .988
Nominal burning time, sec. 15.5

TABLE II

Telemetry Data

CC II 17 and 18

MEASUREMENTS	RANGE	IRIG CHANNEL	FREQ. RESPONSE	30 x 30 PDM CHANNEL #	30 x 5 PAM CHANNEL #
Yaw angle of Att.	± 5°	7	35 cps		
Pitch angle of Att.	± 5°	8	45 cps		
Roll attitude (P)	± 180°	9	59 cps		
Roll attitude (Y)	± 180°	10	80 cps		
Acceleration yaw	± 5g	11	110 cps		
Acceleration pitch	± 5g	12	160 cps		
Acceleration longitud.	-5 to + 25g	13	220 cps		
Pressure #1, engine	0-2000 psi	C	1200 cps		
MASTER PULSE	-	E	30 sps	29-30	
Voltage Reference	0 & 5v	E	30 sps	14-15	
X axis attitude (Mag)	0-5v	E	60 sps	1-16	
Y axis attitude (Mag)	0-5v	E	60 sps	2-17	
Z axis attitude (Mag.)	0-5v	E	60 sps	3-18	
Spare		E	60 sps	4-19	
Pitch attitude (P)	± 15°	E	60 sps	5-20	
Yaw attitude (Y)	± 15°	E	60 sps	6-21	
UCL Probe ϕ 285°	0-5v	E	60 sps	7-22	
UCL Probe ϕ 105°	0-5v	E	60 sps	8-23	
Pressure #2 engine	0-2000 psi	E	30 sps	9-	
Roll Rate	± 2 rps	E	30 sps	24	
X axis bias	+ 2.5v	E	30 sps	10-	
Y axis bias	+ 2.5v	E	30 sps	25	
Z axis bias	+ 2.5v	E	30 sps	11-	
Forw. R.F. Power	0-5v	E	30 sps	26	
Backw. R.F. Power	0-5v	E	30 sps	12-	
Ant. Bias Mon.	0-5v	E	30 sps	27	
Battery TM	0-32v	E	30 sps	13-	
Battery MOTORS	0-32v	E	30 sps	28	
TEMPERATURES					
STA. 36 ϕ 330	0-350°	A	5 sps	RdF-MH-200	1
STA. 36 ϕ 90	0-350°	A	5 sps	"	2
STA. 36 ϕ 210	0-350°	A	5 sps	"	3
Spare		A			7,8,9,16-21
STA. 94 ϕ 30	0-350°	A	5 sps	"	10
STA. 94 ϕ 150	0-350°	A	5 sps	"	11
STA. 94 ϕ 270	0-350°	A	5 sps	"	12
Magnetometer Block	0-200°	A	5 sps	RdF-MH-400	4
Gyro frame	0-200°	A	5 sps	"	5
Batt. frame	0-200°	A	5 sps	"	6
TM Xmitter	0-200°	A	5 sps	"	13
TM sco's	0-200°	A	5 sps	"	14
TM Commut.	0-200°	A	5 sps	"	15
CALIBRATIONS	100 ohms/step	A	5 sps		22 to 29
Sync.	1000 ohms	A	5 sps		30

TABLE III

Vehicle Data

CC II-17 and 18

Weights and Centers of Gravity	CC II-17 Vehicle		CC II-18 Vehicle	
Items	Weight lb.	C of G Sta. in.	Weight lb.	C of G Sta. in.
Nose cone and payload	248.5	74.19	251.5	74.30
Motor (unburnt)	2261	204.32	2266	204.32
Motor (burnt estimated)	481.	214.38	486.	214.28
Fin assembly	156.	307.05	156.	306.92
Complete vehicle (unburnt)	2668.	198.17	2675.	198.14
Complete vehicle (burnt)	888.	191.27	895	191.25

Vehicle Parameters

Overall length, inches	321.26
Body diameter, inches	17.21
Body area, ft^2.	1.614
Length of conical section, inches	86.0
Length of cylindrical section, inches	24.0
Cone semi apex angle, degrees	5.73
Gross payload volume, ft^3.	6.00
Parallel length of casing	184.0
Fin gross span, inches	66.2
Fin net span, inches	49.0
Fin root chord, inches	36.10
Fin tip chord, inches	10.80
Fin leading edge sweep back angle, degrees	50.
Fin trailing edge sweep back angle, degrees	10.
Fin planform area (each), ft^2.	4.
Nozzle length, inches	21.
Nozzle throat diameter, inches	5.25
Nozzle exit diameter, inches	13.46
Nozzle exit area, ft^2.	.988
Pitch moment of inertia (unburnt) slugs ft^2.	2770.
Pitch moment of inertia (burnt) slugs ft^2.	1600.
Roll moment of inertia, (unburnt) slugs ft^2.	36.
Roll moment of inertia, (burnt) slugs ft^2.	20.

TABLE IV

Time Dependent Data

CG II-17 and 18

Time sec.	Weight lb.	Pitch Inertia Slugs ft^2	Roll Inertia Slugs ft^2	q lb/ft^2	Mach No.	X_{cg} in.	$X_{cp}-X_{cg}$ in.
0	2,675	2,770	36.0	0	0	198.32	78.08
1	2,545	2,705	35.1	106	.268	197.95	78.95
2	2,422	2,640	34.2	413	.543	197.58	77.92
3	2,299	2,575	33.3	941	.817	197.21	83.79
4	2,176	2,510	32.4	1,602	1.086	196.84	87.30
5	2,054	2,445	31.5	2,419	1.367	196.47	85.85
6	1,933	2,380	30.6	3,343	1.656	196.10	81.60
7	1,813	2,315	29.7	4,311	1.950	195.23	76.24
8	1,693	2,250	28.8	5,483	2.295	195.36	71.03
9	1,575	2,185	27.9	6,613	2.651	194.99	66.41
10	1,460	2,120	27.0	7,756	3.044	194.62	61.63
11	1,346	2,055	26.2	8,783	3.464	194.25	55.58
12	1,234	1,990	25.4	9,684	3.932	193.88	49.99
13	1,129	1,925	24.6	10,513	4.481	193.52	45.04
14	1,029	1,860	23.8	11,024	5.090	193.16	40.19
15	959	1,795	23.0	10,630	5.643	192.80	36.82
16	922	1,730	22.2	8,870	5.863	192.44	35.96
17	904	1,665	21.4	6,935	5.914	192.08	36.03
18	895	1,600	20.6	5,322	5.860	191.75	36.65
19	895	1,600	20.0	3,981	5.761	191.75	37.22
20	895	1,600	20.0	3,013	5,677	191.75	37.68

TABLE V

Wind Sensitivity Data

CC II-17 and 18

Altitude Z ft.	S/V sec/ft	Altitude Z ft.	S/V sec/ft	Altitude Z ft.	S/V sec/ft
15	.00667	250	,00221	4,000	.00046
20	.00599	300	.00210	4,500	.00042
25	.00551	350	.00193	5,000	.00039
35	.00497	450	.00171	7,000	.00030
40	.00474	500	.00161	8,000	.00026
45	.00457	550	.00152	9,000	.00025
50	.00440	600	.00147	10,000	.00021
55	.00428	700	.00135	12,000	.00018
60	.00409	800	.00114	14,000	.00015
65	.00402	900	.00108	16,000	.00011
70	.00387	1,000	.00104	18,000	.00010
80	.00369	1,200	.00095	20,000	.00009
90	.00359	1,400	.00092	25,000	.00005
100	.00339	1,600	.00085	30,000	.00003
120	.00327	1,800	.00079	35,000	.00001
140	.00295	2,000	.00074	40,000	0
160	.00328-	2,500	.00063	50,000	0
180	.00271	3,000	.00056	60,000	0
200	.00255	3,500	.00051		

Burnout velocity, ft/sec. 5,743 K ($\Theta_f = K\,\Theta_o$) = 1.50
Elevation for which K may be used 70° to 90°. Launcher leaving velocity 92 ft/sec. Sensitivity leaving launcher .669. ϕ_o = (90°-elevation angle).

TABLE VI

Aerodynamic Data

CC II 17 and 18

Mach No.	$C_{L\alpha}$ Nose	X_{cp} Nose in.	$C_{L\alpha}$ Fin Rigid	X_{cp} Fin in.	$C_{L\alpha}$ Comb. Rigid	X_{cp} Comb. in.	$C_{D_{W+B}}$ Power On	C_{D_f} Power On	C_{D_o} Total Power On
0	2.00	57.3	18.2	300.5	20.2	276.4	.70	.21	.91
.2	2.00	57.3	18.5	300.5	20.5	276.8	.70	.21	.91
.5	2.00	57.3	19.0	300.5	21.0	277.4	.70	.21	.91
1.0	2.00	57.3	25.6	301.8	27.6	283.2	1.34	.19	1.53
1.2	2.12	64.0	25.5	302.3	27.62	284.0	.886	.160	1.046
1.5	2.28	68,0	20.0	304.8	22.28	280.6	.687	.150	.837
2.0	2.46	74.3	14.1	305.1	16.56	270.8	.489	.140	.629
2.5	2.59	79.8	11.3	305.4	13.89	263.3	.382	.120	.502
3.0	2.77	84.7	9.8	305.6	12.57	256.9	.302	.100	.402
3.5	3.03	88.8	8.6	305.8	11.63	249.3	.250	.095	.345
4.0	3.27	92.2	7.8	306.0	11.07	243.0	.206	.089	.295
4.5	3.40	95.2	7.2	306.0	10.60	238.4	.185	.085	.270
5.0	3.48	97.4	6.6	306.0	10.08	234.0	.164	.081	.245
5.5	3.51	99.1	6.1	306.0	9.61	230.4	.152	.075	.227
6.0	3.50	100.0	5.7	306.0	9.20	227.6	.140	.070	.210
6.5	3.49	100.6	5.4	306.0	8.89	225.4	.133	.062	.195
7.0	3.49	100.9	5.1	306.0	8.59	222.7	.126	.059	.185
Ref. Area ft^2:	1.614		1.614		1.614		1.614	1.614	1.614

TABLE VII

Launch Data

CC II-17 and 18

	CC II-18	CC II-17
Firing date	24 June 1963	24 June 1963
Time of firing	13.00 CDT	17.00 CDT
Launch site	CRR	CRR
Agency	CARDE	CARDE
Actual Launcher Elevation Angle	80.3°	75.8°
Actual Azimuth Angle	081.3°	077.3°
Effective Elevation Angle	83.5°	81°
Effective Azimuth Angle	098°	098°
Nominal Elevation Angle	80°	85°
Nominal Azimuth Angle	110°	110°
Ambient Temperature	66°F	70°F
Motor Temperature	70°F	72°F
Payload, lb.	134	132
Launch Weight, lb.	2675	2668

TABLE VIII

Meteorological and Wind Data

CC II-17 and 18

Churchill Range Test Summary

Test No.: 138
Support of: CARDE
Date: 24 June 1963
Scheduled time: 1300 CDT
Actual Time: 1300:17 CDT
Vehicle: Black Brant IIA - CC II-18
Objective: Vehicle Test.

Surface Observations

Clear, Visibility 15, Wind 235°/15 knots Shifting, Bar. Pressure 1019.6 mbs, Temperature 66.2°F, Dew Point 38.6°, Relative Humidity 36%.

Supporting Pibals

1. Time: 1035 CDT Altitude: 4,200 ft.
2. Time: 1106 CDT Altitude: 4,200 ft.
3. Time: 1138 CDT Altitude: 4,200 ft.
4. Time: 1205 CDT Altitude: 4,200 ft.
5. Time: 1118 CDT Altitude: 23,000 ft.

Rawinsonde

1. Time: 0913 CDT Altitude: 105,030 ft.

Vehicle Predicted Performance

Impact	Apogee
Azimuth 110°	Azimuth 110°
Impact range 170.7 K yds	Altitude 161.1 yds
Flight time +360 sec.	Range 85.5
	Time +185 sec.

Radar MPQ 18

AOS: T + 10.5 sec. Time 1300:27.5	Altitude 18,000 ft. Slant range 11,000 yds Azimuth 2025 mils
LOS: T+ 39.5 sec. Time 1301:07	Altitude 216,000 ft. Range 68.3 K yds Azimuth 1730 mils

Radar reports beacon failure at lift off

CC II-18

Rawinsonde Time-Altitude Data

Contact	Pressure millibars	Altitude meters	Elapsed Time (min.)
1	1018.9	22	0.0
5	1013	70	
10	937	720	2.2
15	865	1,380	4.2
20	797	2,010	6.3
25	733	2,680	8.6
30	672	3,370	10.8
35	616	4,140	13.1
40	563	4,710	15.2
45	513	5,420	17.5
50	467	6,120	19.8
55	424	6,810	22.2
60	385	7,500	24.5
65	348	8,210	27.0
70	314	8,900	29.4
75	282	9,620	31.5
80	254	10,310	33.7
85	227	11,080	35.7
90	202	11,830	38.2
95	180	12,590	40.8
100	159	13,430	43.4
105	140	14,290	46.0
110	122	15,200	48.8
115	105	16,200	52.0
120	90	17,200	55.7
125	74	18,480	59.2
130	60	19,860	63.5
135	45	21,760	68.4
140	30	24,460	75.3
145	16	28,710	87.3

Aerovane Data

Time sec.	Speed m.p.h.	Direction degrees
T-600	8	243
T-480	20	222
T-420	21	255
T-300	15	250
T-240	12	235
T-180	11	240
T-120	10	228
T- 60	10	265
T- 10	14	265
T- 5	14	263
T+ 0	14	268
T+ 5	15	258
T+ 10	14	241
T+ 15	13	245
T+ 20	13	242
T+ 25	14	236
T+ 30	13	250
T+ 35	11	245
T+ 40	11	237
T+ 45	10	250
T+ 50	11	261
T+ 55	10	252
T+ 60	11	235
T+120	10	234
T+180	17	234
T+240	12	232
T+300	14	218
T+420	16	245
T+480	12	250
T+600	11	234

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Rawinsonde Wind Data

Name of Station PAA/CRR	Latitude 58° 44' N	Longitude 93° 49' W	Vehicle CC II 18 Date 24/6/63
Local Standard Time CST	El. of Station 22		Test No. 138
Method of OBS. Rawin	Type of Equip. GMD-1A		Type of Balloon ML-518 Release Time 0913

Time	Rawin	Elevation angle degrees		Distance from	Azimuth	Wind	
min.	ht. above surface (meters)	Observed	Smoothed	observation point (meters)	angle degrees	Direction degrees 360°- N sfc. 270	Speed meters/sec.
1	320	43.9		300	96.0	284	6
2	630	40.4		700	104.0	292	7
3	1,000	37.8		1,200	107.0	298	9
4	1,340	36.5		1,800	113.2	312	10
5	1,630	34.0		2,300	118.7	315	11
6	1,940	31.4		3,100	122.7	317	14
7	2,200	28.9		3,900	126.1	318	15
8	2,500	26.8		4,900	128.2	316	17
9	2,800	25.2		4,900	125.3	301	17
10	3,100	24.0		6,900	126.7	294	18
11	3,420	23.0		8,000	125.1	295	19
12	3,700	22.2		9,100	124.1	292	20
13	4,000	21.2		10,300	122.1	292	23
14	4,330	20.0		11,800	121.2	296	25
15	4,650	19.1		13,300	121.0	296	26
16	4,960	18.2		15,000	120.2	292	25
17	5,170	17.6		16,200	119.3	293	27
18	5,570	16.9		15,200	118.8	294	30
19	5,860	16.4		19,500	118.3	293	30
20	6,170	15.67		21,800	117.8	290	33
21	6,490	15.17		23,700	116.9	286	30
22	6,770	14.87		25,300	116.1	284	30
23	7,060	14.42		27,200	115.3		
24		14.03			114.6	286	34
25	7,640	13.62		31,200	114.2		
26						293	38
27	8,210	12.78		35,750	114.1		
28						298	37
29	8,790	12.16		40,200	114.6		
30		11.90				303	45
31	9,460	11.55	11.50	45,600	115.7		
32		11.05				307	43
33	10,100	11.16	11.03	50,700	116.7		
34		10.87				285	40
35	10,800	10.87	10.77	55,400	115.7		
36		10.57				287	45

Rawinsonde Wind Data (Cont'd)

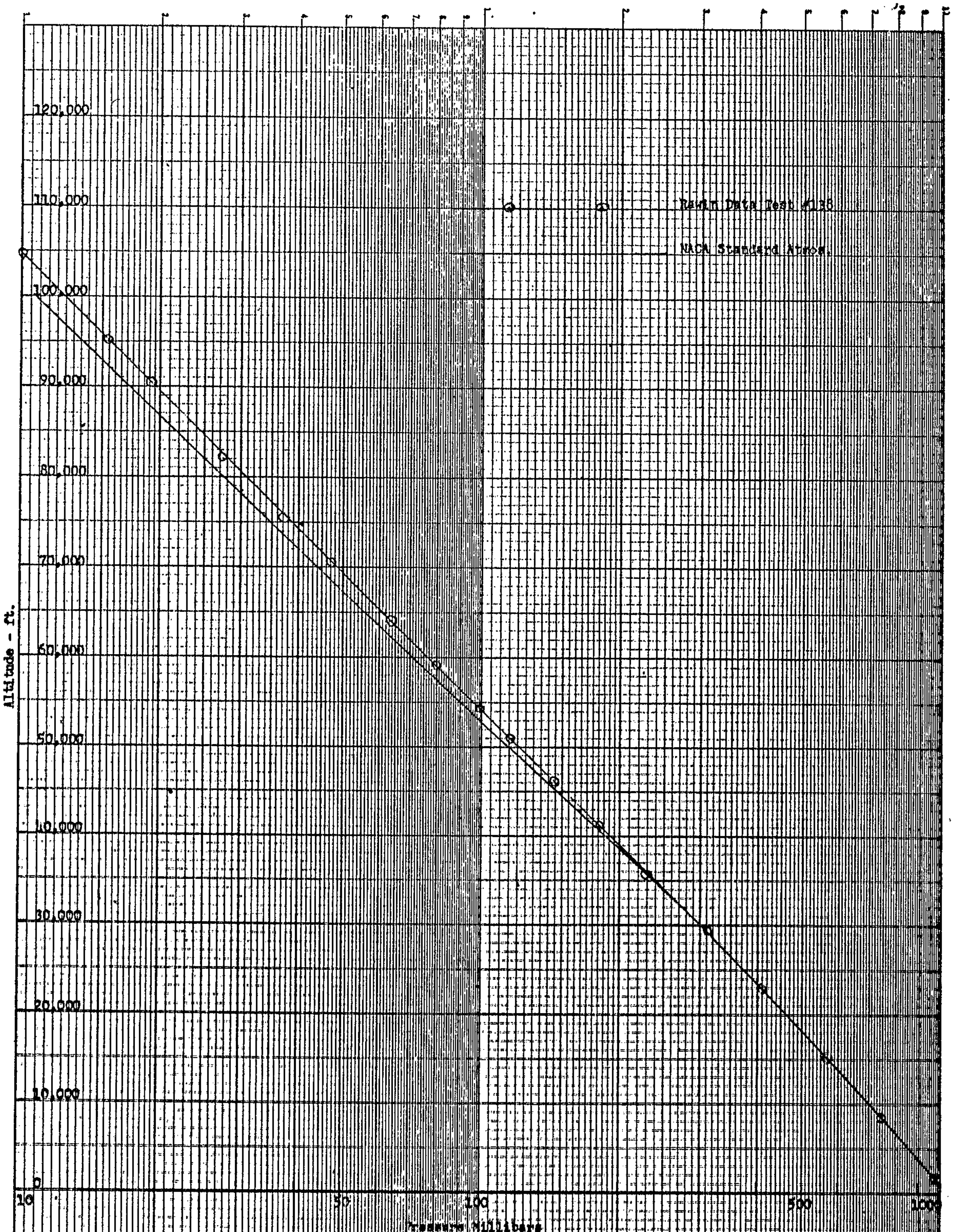
Time min.	Rawin ht. above surface (meters)	Elevation angle degrees Observed	Elevation angle degrees Smoothed	Distance from observation point (meters)	Azimuth angle degrees	Wind Direction degrees 360°- N sfc. 270	Wind Speed meters/sec.
37	11,490	10.51	10.44	60,700	115.0		
38		10.25				282	39
39	12,090	10.09	10.19	65,250	114.2		
40		10.22				267	19
41	12,620	10.34	10.30	67,300	113.3		
42		10.34				274	26
43	13,300	10.32	10.38	70,300	112.5		
44	13,620	10.48	10.37	72,000	112.2	277	24
45	13,980	10.35	10.46	73,100	111.9		
46	14,290	10.54	10.48	74,700	111.5	268	21
47		10.54					
48	14,940	10.77	10.68	76,600	110.7	263	17
49		10.74					
50	15,590	10.87	10.88	78,300	110.1	269	14
51		11.04					
52	16,200	11.04	11.10	79,800	109.8	270	9
53		11.23					
54	16,800	11.46	11.43	80,300	109.6	259	7
55		11.61					
56	17,400	11.68	11.71	81,250	109.2	267	8
57		11.83					
58	18,090	12.05		82,000	109.1	270	6
60	18,740	12.4		82,600	108.9	260	4
62	19,390	12.8		82,750	108.8	263	1
64	20,070	13.3		82,300	108.8	135	5
66	20,850	13.9		81,800	108.5	141	5
68	21,610	14.4		81,800	108.4	276	3
70	22,390	14.8		82,400	108.4	315	3
72	23,150	15.3		82,400	108.6	030	2
74	23,920	15.8		82,300	108.7	084	3
76	24,690	16.4		81,800	108.8	124	3
78	25,400	16.9		81,600	108.6	117	4
80	26,100	17.5		80,800	108.7	102	8
82	26,810	18.2		79,700	108.8	096	7
84	27,520	18.8		79,100	109.0	095	7
86	28,230	19.5		78,100	109.1	099	10
88	29,020	20.3		76,800	109.3	090	10
90	29,890	21.1		75,900	109.7	079	7
92	30,700	21.8		75,300	110.0	081	6
94	31,520	22.5		74,750	110.2	083	7
95	31,940	20.9		74,250	110.4		

Temperature and Pressure Versus Altitude
Adiabatic Charts

Test No. 138 **Release Time: 08.13 CST**

CC II-18

Altitude		Temp.	Pressure	Altitude		Temp.	Pressure
Km.	Feet	°F	Millibars	Km.	Feet	°F	Millibars
0	Sea Level	54.4	1,019	16.5	54,120	-56.2	100
.5	1,640	48.5	962	17.0	55,760	-55.3	94
1.0	3,280	41.4	906	17.5	57,400	-59.8	86
1.5	4,920	35.1	850	18.0	59,040	-56.6	80
2.0	6,560	29.7	800	18.5	60,680	-56.2	74
2.5	8,200	24.3	750	19.0	62,320	-56.2	69
3.0	9,840	22.5	707	19.5	63,960	-55.8	64
3.5	11,480	14.4	660	20.0	65,600	-55.3	59
4.0	13,120	11.2	620	20.5	67,240	-54.8	55
4.5	14,760	8.2	580	21.0	68,880	-54.6	50.5
5.0	16,400	4.1	542	21.5	70,520	-54.1	47.0
5.5	18,040	-2.2	508	22.0	72,160	-52.6	44.0
6.0	19,680	-8.7	476	22.5	73,800	-50.8	40.0
6.5	21,320	-14.6	443	23.0	75,440	-49.7	37.0
7.0	22,960	-22.0	412	23.5	77,080	-49.0	35.8
7.5	24,600	-28.5	385	24.0	78,720	-48.8	32.0
8.0	26,240	-34.6	352	24.5	80,360	-48.6	30.0
8.5	27,880	-40.6	333	25.0	82,000	-47.6	27.8
9.0	29,520	-46.3	310	25.5	83,640	-46.3	25.1
9.5	31,160	-51.7	288	26.0	85,280	-44.5	23.8
10.0	32,800	-54.8	266	26.5	86,920	-43.6	22.0
10.5	34,440	-54.8	247	27.0	88,560	-41.8	20.1
11.0	36,080	-56.8	229	27.5	90,200	-39.1	19.3
11.5	37,720	-51.7	212	28.0	91,840	-37.3	18.0
12.0	39,360	-47.2	197	28.5	93,480	-36.4	16.4
12.5	41,000	-46.3	182	29.0	95,120	-34.6	15.5
13.0	42,640	-47.2	170	29.5	96,760	-32.3	14.2
13.5	44,280	-48.1	157	30.0	98,400	-30.3	13.5
14.0	45,920	-50.0	146	30.5	100,040	-27.8	12.4
14.5	47,560	-51.7	136	31.0	101,680	-25.6	11.6
15.0	49,200	-52.6	125	31.5	103,320	-23.8	10.8
15.5	50,840	-52.4	116	32.0	104,960	-22.0	10.0
16.0	52,480	-54.4	108				



Pressure vs. altitude for CC III-16

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PILOT BALLOON OBSERVATION #1

Test Supported# 138 Date 24 June 1963 Time 1035 CDT

20 sec. Reading	Height Feet	Height Meters	Azimuth Degrees	Elevation Degrees	Direction Degrees	Speed Meters/sec.
1a(10 sec.)	192	59			255	5.8
1	384	117	75.3	45.7	264	5.2
2	766	234	84.2	48.4	269	5.3
3	1,184	350	82.5	44.9	257	7.3
4	1,498	457	80.2	41.8	255	8.2
5	1,848	563	78.4	39.7	255	8.3
6	2,198	670	77.8	38.3	251	7.3
7	2,538	774	75.7	38.6	240	6.2
8	2,877	877	73.7	39.0	237	6.0
9	3,215	980	71.9	39.3	237	6.1
10	3,549	1,082	70.9	39.5	253	6.5
11	3,883	1,184	72.0	38.8	264	7.6
12	4,216	1,285	73.3	38.3	274	7.8
13		1,386	75.7	38.1	284	7.4
14			78.9	37.8		
15						

PILOT BALLOON OBSERVATION #2

Test Supported# 138 Date 24 June 1963 Time 1106 CDT

20 sec. Reading	Height Feet	Height Meters	Azimuth Degrees	Elevation Degrees	Direction Degrees	Speed Meters/sec.
1a(10 sec.)	192	59			267	5.4
1	384	117	87.3	49.5	268	4.7
2	766	234	87.8	49.5	254	4.8
3	1,184	350	77.3	46.2	241	7.0
4	1,498	457	71.7	43.0	240	8.7
5	1,848	563	68.1	39.9	240	9.5
6	2,198	670	66.5	38.0	256	8.6
7	2,538	774	70.6	36.8	269	8.0
8	2,877	877	71.8	36.9	257	6.3
9	3,215	980	71.8	37.3	253	6.1
10	3,549	1,082	71.8	37.2	255	7.6
11	3,883	1,184	72.3	36.5	260	7.7
12	4,216	1,285	73.2	36.3	263	7.8
13		1,386	74.0	36.1		
14						
15						

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PILOT BALLOON OBSERVATION # 3

Test Supported# 138 Date 24 June 1963 Time 1138 CDT

20 sec. Reading	Height Feet	Height Meters	Azimuth Degrees	Elevation Degrees	Direction Degrees	Speed Meters/sec.
1a(10 sec.)	192	59			285	4.6
1	384	117	104.9	48.6	275	4.9
2	766	234	95.4	48.4	256	5.3
3	1,184	350	86.3	47.6	243	5.4
4	1,498	457	79.1	47.5	226	5.1
5	1,848	563	70.7	48.3	226	7.0
6	2,198	670	65.3	45.0	226	7.9
7	2,538	774	60.8	44.1	233	8.5
8	2,877	877	60.3	41.2	237	9.5
9	3,215	980	59.6	39.7	238	8.2
10	3,549	1,082	59.8	39.1	251	8.5
11	3,883	1,184	62.0	37.9	260	9.1
12	4,216	1,285	64.0	37.3	270	8.4
13			67.0	37.0		
14						
15						

PILOT BALLOON OBSERVATION #4

Test Supported# 138 Date 24 June 1963 Time 1205 CDT

20 sec. Reading	Height Feet	Height Meters	Azimuth Degrees	Elevation Degrees	Direction Degrees	Speed Meters/sec.
1a(10 sec.)	192	59			208	5.4
1	384	117	28.0	48.5	219	4.7
2	766	234	38.9	50.8	234	5.1
3	1,184	350	42.1	46.0	242	7.1
4	1,498	457	46.4	43.0	230	7.6
5	1,848	563	46.1	41.6	229	6.8
6	2,198	670	47.6	41.7	236	5.7
7	2,538	774	48.9	42.8	245	4.5
8	2,877	877	50.9	43.3	253	4.3
9	3,215	980	52.9	43.6	246	5.5
10	3,549	1,082	54.0	43.5	246	6.6
11	3,883	1,184	55.7	42.6	261	7.5
12	4,216	1,285	59.3	42.0	269	8.5
13			62.5	41.0		
14						
15						

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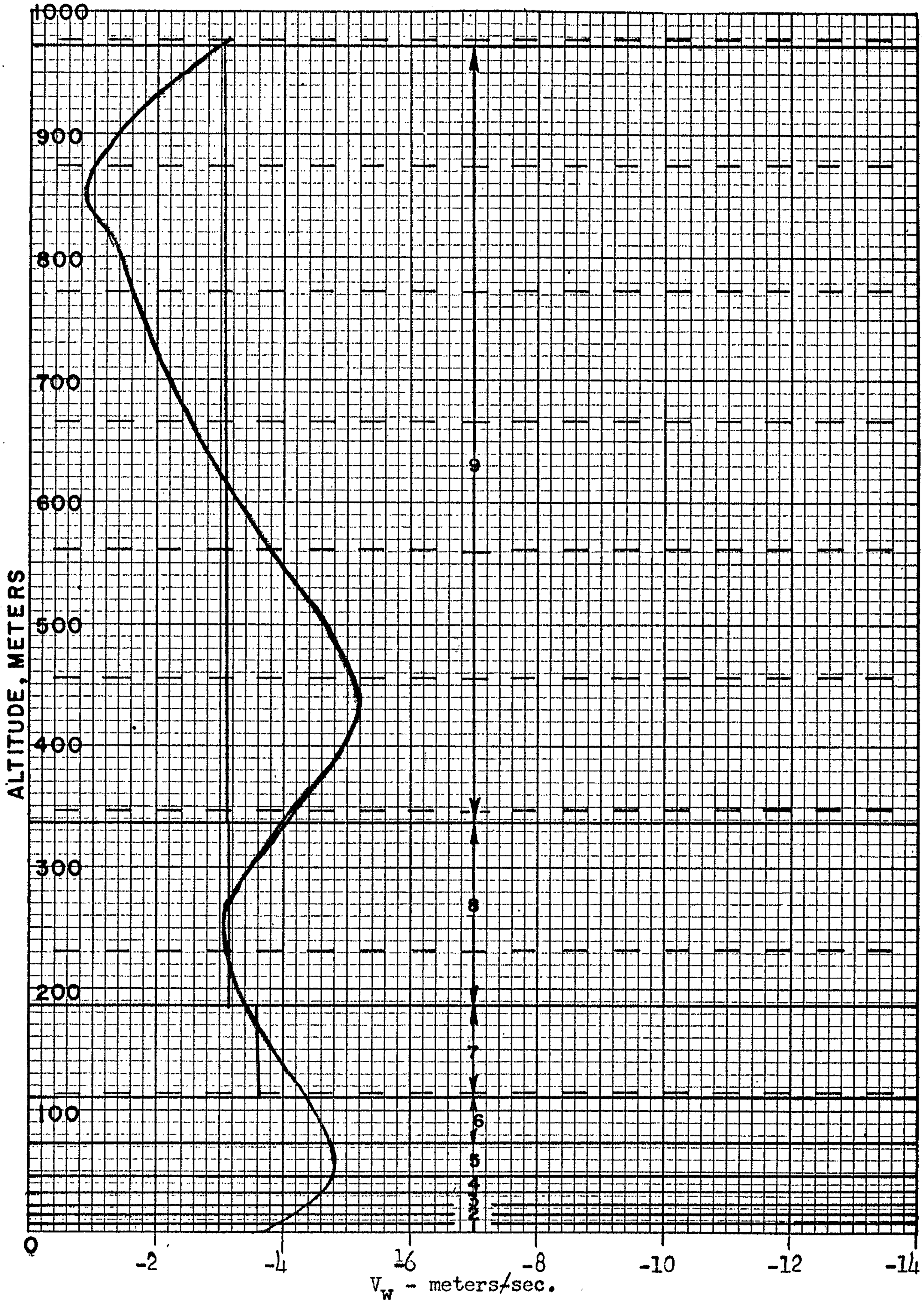
30.

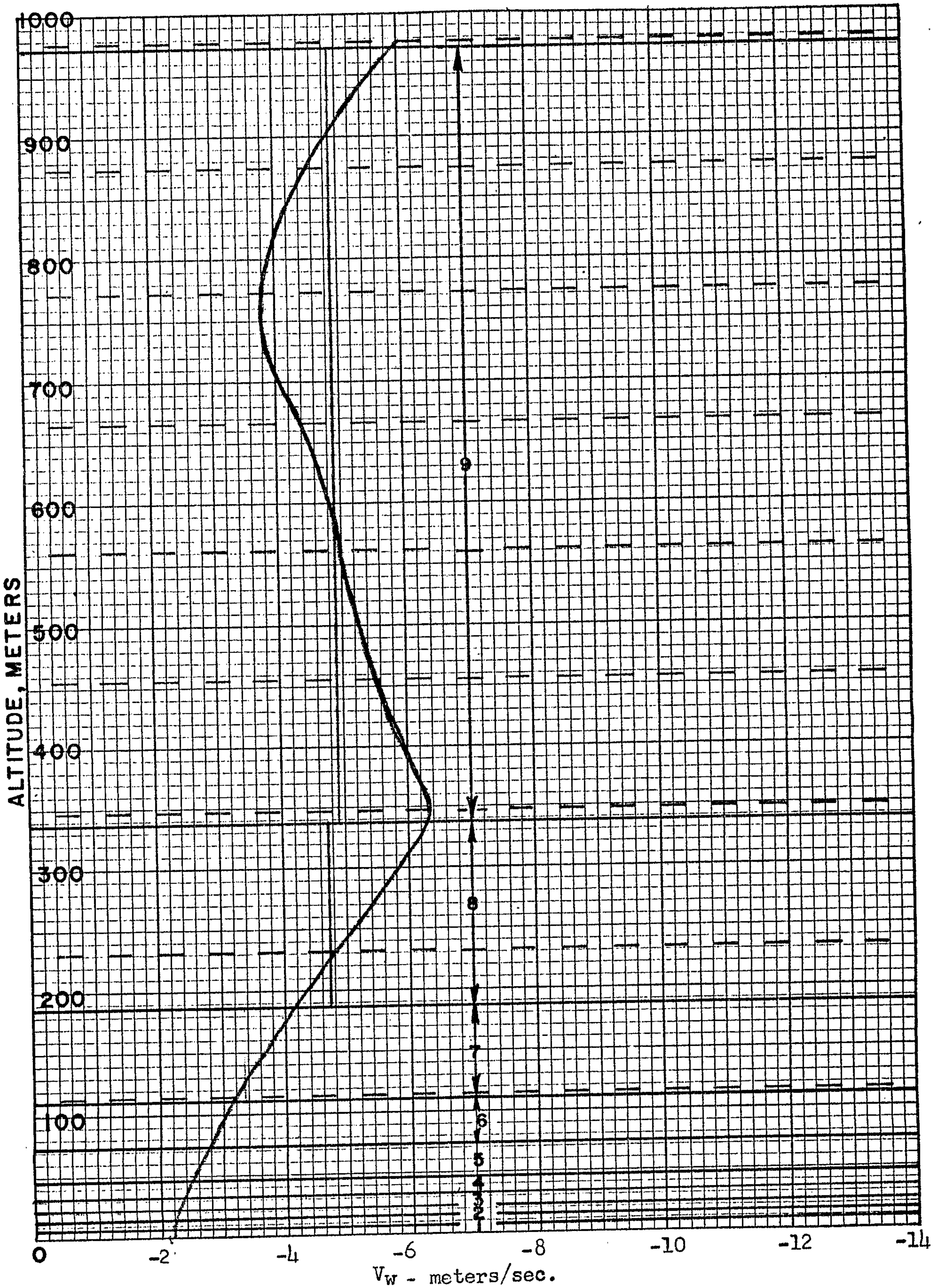
Wind Component Calculation Sheet

Vehicle CC II 18 Test 138 Date 24 June 63 Time 1205 CDT Location CRR

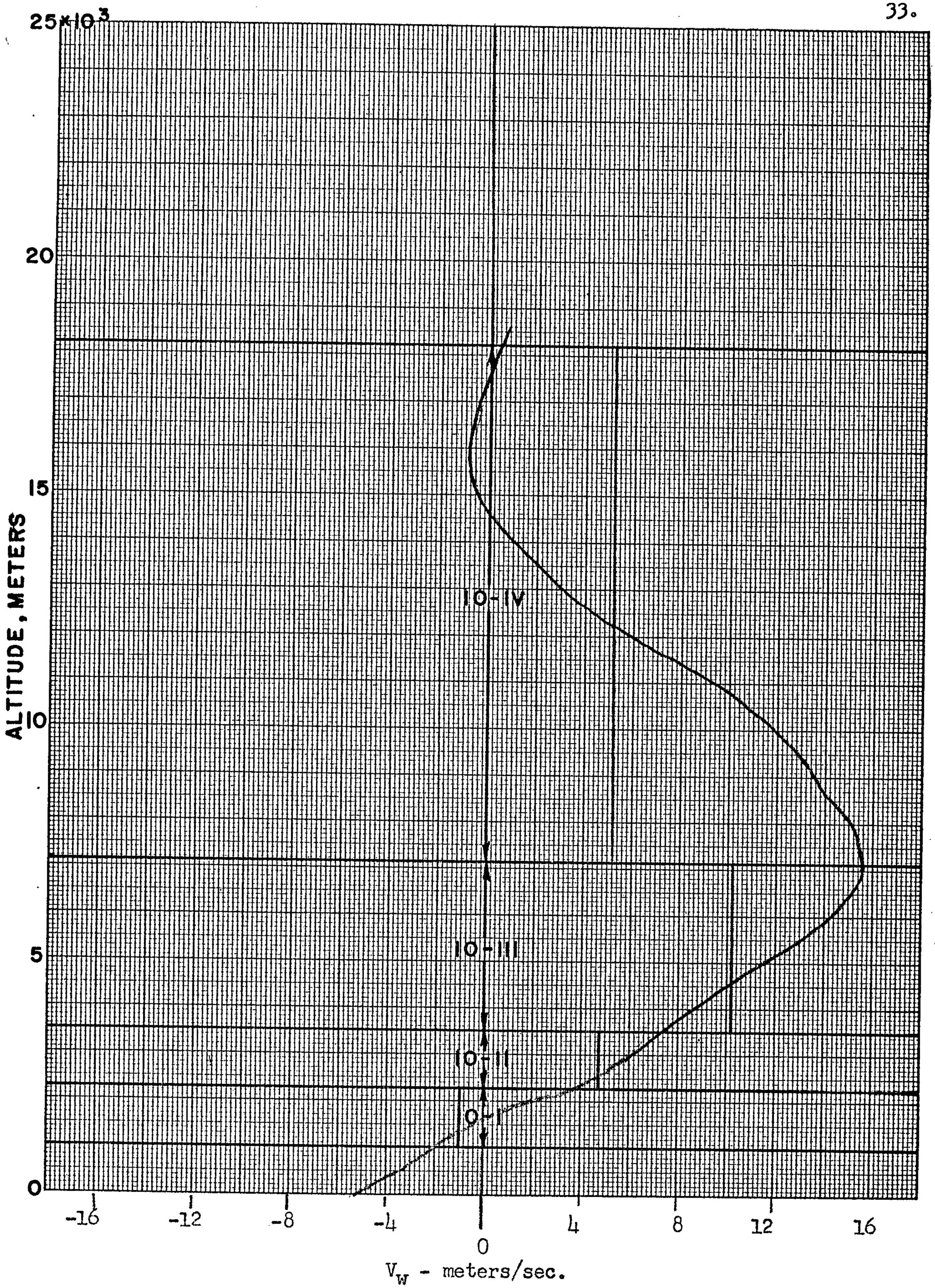
Altitude ft.	Direction degrees	degrees	Speed meters/sec.	N-S meters/sec.	E-W meters/sec.
0-117	208	28	5.4	-4.8	-2.5
0-234	219	39	4.7	-3.7	-3.0
117-350	234	54	5.1	-3.0	-4.1
234-457	242	62	7.1	-3.3	-6.3
350-563	230	50	7.6	-4.9	-5.8
457-670	229	49	6.8	-4.5	-5.1
563-774	236	56	5.7	-3.2	-4.7
670-877	245	65	4.5	-1.9	-4.1
774-980	253	73	4.3	-1.3	-4.1
877-1082	246	66	5.5	-2.3	-5.1
Aerovane					
T-10	265	85	6.3	- .6	-6.3
T+ 0	268	88	6.3	- .2	-6.3
T+10	241	61	6.3	-3.0	-5.5
T+20	242	62	5.8	-2.7	-5.1



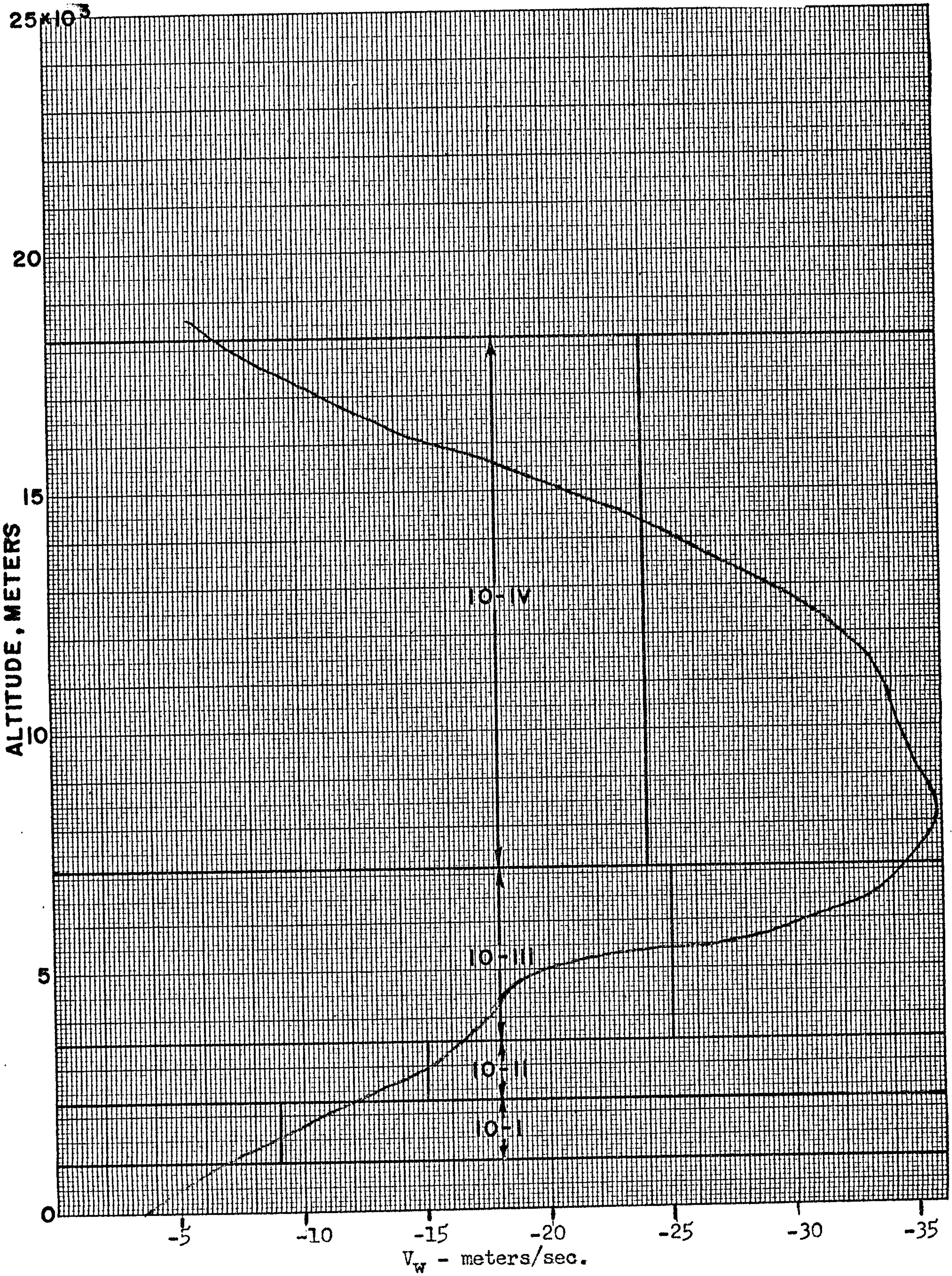
North-South wind profile of layers 1 to 9 for CC II-18 vehicle launch.



East-West wind profile of layers 1 to 9 for CC II-18 vehicle launch.



North-South wind profile of layers 10-I to 10-IV for CC II-18 vehicle launch



East-West wind profile of layers 10-I to 10-IV for CC II-18 vehicle launch

Wind Component Calculation Sheet

Vehicle CC II 18 Test 138 Date 24 June 63 Time 1356 CDT Location CRR

Altitude ft.	Direction degrees	degrees	Speed meters/sec.	N-S meters/sec.	E-W meters/sec.
0	210	30	7	-6.1	-3.5
300	220	40	7	-5.4	-4.5
580	227	47	7	-4.8	-5.1
870	227	47	8	-5.5	-5.9
1,130	245	65	8	-3.4	-7.3
1,410	254	74	8	-2.2	-7.7
1,700	261	81	9	-1.4	-8.9
2,000	272	88	11	+0.4	-11.0
2,280	279	81	14	+2.2	-13.8
2,590	290	70	14	+4.8	-13.1
3,200	290	70	17	+5.8	-16.0
3,800	290	70	19	+6.5	-17.8
4,400	287	73	19	+5.6	-18.1
4,960	299	61	22	+10.7	-19.2
5,500	297	63	29	+13.2	-25.8
6,330	293	67	34	+13.3	-31.3
7,410	292	68	37	+13.8	-34.3
8,700	290	70	36	+12.3	-33.8
10,500	290	70	35	+12.0	-32.9
12,030	281	79	33	+6.3	-32.4
14,700	269	89	22	- .4	-22.0
16,540	268	88	13	- .5	-13.0
18,530	276	84	6	+ .6	- 6.0

Calculation of Ballistic Wind

Vehicle CC II-18 Test #138 Location CRR

Date 24 June 1963 Time of Launch 1300 CDT

Wind Data

Aerovane Time T-10 to T+20

Pibal Run No. 4 Time 1205 CDT

Rawin Time 1356 CDT

Other Time

Layer	Weight (nr)	N-S	N-S Weighted	E-W	E-W Weighted
1	1	-3.7	-3.7	-2.2	-2.2
2	1	-4.0	-4.0	-2.2	-2.2
3	1	-4.3	-4.3	-2.3	-2.3
4	1	-4.6	-4.6	-2.4	-2.4
5	1	-5.0	-5.0	-2.5	-2.5
6	1	-4.6	-4.6	-2.8	-2.8
7	1	-3.6	-3.6	-3.3	-3.3
8	1	-3.1	-3.1	-4.7	-4.7
9	1	-3.1	-3.1	-4.9	-4.9
10-i	.5	-1.0	- .5	-9.0	-4.5
10-ii	.2	+4.7	+ .98	-15.0	-3.0
10-iii	.2	+10.2	+2.04	-25.0	-5.0
10-iv	.1	+ 5.1	+ .51	-24.0	-2.4
Sum	-	-	-32.97	-	-42.2
Ballistic Wind Components			-3.30		-4.22

Prediction of Wind Effect

Vehicle CC II-18 Test #138 Location CRR

Date 24 June 1963 Time of Launch 1300 CDT

= 1.13 °per m/sec. Kg = 1.50

$V_{abs, f}$ =

	N-S	E-W	Ø	
Ballistic Wind	-3.30	-4.22	5.36	218°
Launcher Settings	-	-	EL: 80.3°	AZ: 081.3°
	-	-	Θo: 9.7°	-
	2.47	14.38	KgΘo: 14.55°	-
Wind Effects	-3.73	-4.77	-	-
Predicted	-1.26	9.61	9.7°	97.5°
Actual Burnout	-1.32	+9.38	9.5°	98.0°
Error	- .06	.23	.2°	.50°

	Predicted	Actual
Range to impact		
Azimuth		

Churchill Range Test Summary

Test No.: 139
Support of: CARDE
Date: 24 June 1963
Scheduled time: 1700 CDT
Actual time: 1700:26 CDT
Vehicle: Black Brant IIA - CC II-17
Objective: Vehicle Test.

Surface Observations

Clear, Visibility 15, Wind 228°/15 knots Shifting, Bar, Pressure 1018.7 mbs, Temperature 70.1°F, Dew Point 41.6 , Relative Humidity 35%.

Supporting Pibals

1. Time: 1520 CDT Altitude: 4,200 ft.
2. Time: 1557 CDT Altitude: 4,200 ft.
3. Time: 1630 CDT Altitude: 4,200 ft.

Rawinsonde

1. Time: 1356 CDT Altitude: 106,400 ft.

Vehicle Predicted Performance

Impact	Apogee
Azimuth 110	Azimuth 110
Range 90.0 K yds	Altitude 173.3 K yds
Flight time +360 sec.	Range 46.6 K yds
	Time +185 sec.

Radar MPQ/18 and MPS-19

AOS:	T + 0 sec.	Time 1700:26.75	Surface Slant Range 8,519 yds Azimuth 2,001 mils
LOS:	T +45 sec.	Time 1701:12	Altitude 176,000 ft. Slant Range 62.8 K yds Azimuth 1,853 mils

Radar reports beacon failure shortly after lift-off.

Rawinsonde Wind Data

Name of Station PAA/CRR	Latitude 58° 44' N	Longitude 93° 49' W	Vehicle CC II-18 Date 24/6/63
Local Standard Time CST	El. of Station 22		Test No. 139
Method of OBS. Rawin	Type of Equip. GND-1A		Type of Balloon ML-518 Release Time 1256

Time	Rawin	Elevation angle degrees		Distance from	Azimuth	Wind	
	ht. above surface	Observed	Smoothed	observation point	angle	Direction degrees 360°- N	Speed meters/sec.
min.	(meters)			(meters)	degrees	sfc. 270	07
1	300	29.7		500	39.9	220	7
2	580	34.0		800	40.4	227	7
3	870	32.0		1,300	44.5	227	8
4	1,130	32.2		1,800	49.0	245	8
5	1,410	32.0		2,200	53.0	254	8
6	1,700	31.9		2,700	57.3	261	9
7	2,000	31.2		3,200	61.9	272	11
8	2,280	29.9		3,900	68.5	279	14
9	2,590	28.9		4,700	74.9	290	14
10	2,870	28.3		5,300	81.1	295	15
11	3,200	27.1		6,200	85.9	296	17
12	3,500	26.2		7,100	89.0	288	18
13	3,800	24.8		8,200	91.7	290	19
14	4,110	23.8		9,300	93.8	287	19
15	4,400	22.8		10,400	95.0	287	19
16	4,700	22.1		11,500	96.5	294	19
17	4,960	21.4		12,600	98.2	299	22
18	5,200	20.3		14,000	100.7	299	28
19	5,500	19.15		15,800	102.3	297	29
20	5,730	18.19		17,300	103.9	296	29
21	6,030	17.32		19,200	104.9	295	34
22	6,330	16.37		21,400	105.9	293	34
23	6,620	15.71		23,300	106.4	292	34
24	6,910	15.09		25,400	107.0	293	36
25	7,200	14.47		27,600	107.4		
26						292	37
27	7,820	12.57		32,000	108.1		
28						293	36
29	8,430	12.86		36,300	108.6		
30						290	36
31	9,100	12.44		40,600	108.8		
32						295	35
33	9,700	11.90	12.00	44,800	109.5		
34		11.80				294	28
35	10,250	11.63	11.65	48,200	109.8		
36						290	43

Rawinsonde Wind Data (Cont'd)

Time min.	Rawin ht. above surface (meters)	Elevation angle degrees: Observed	Elevation angle degrees: Smoothed	Distance from observation point (meters)	Azimuth angle degrees	Wind: Direction degrees 360°= N sfc. 210	Wind: Speed meters/sec. 7
37	10,970	11.34	11.35	53,400	109.8		
38						288	34
39	11,680	11.17	11.22	57,400	109.7		
40						281	33
41	12,380	11.20	11.12	61,300	109.2		
42						283	33
43	13,030	11.06	10.98	65,300	108.9		
44						284	26
45	13,690	10.88	10.99	68,400	108.7		
46	14,000	11.08	11.01	69,800	108.4	274	24
47		11.06					
48	14,700	11.14	11.14	72,400	107.7	269	22
49		11.23					
50	15,300	11.07	11.20	74,900	107.1	273	18
51		11.29					
52	15,900	11.26	11.35	76,700	106.9	270	14
53		11.49					
54	16,540	11.63	11.59	78,100	106.4	268	13
55		11.66					
56	17,190	11.74	11.79	79,750	106.2	278	14
57		11.97					
58	17,870	12.01		81,300	106.1	279	11
59		12.18					
60	18,530	12.3		82,300	106.0	276	6
62	19,240	12.7		82,800	105.9	266	4
64	19,940	13.1		83,100	105.8	254	2
66	20,610	13.5		83,300	105.7	180	1
68	21,310	14.0		83,000	105.6	124	2
70	22,020	14.5		82,800	105.6	074	2
72	22,750	15.0		82,600	105.8	075	2
74	23,460	15.5		82,400	105.8	125	4
76	24,200	16.1		81,700	105.6	136	4
78	24,910	16.6		81,500	105.5	116	4
80	25,640	17.2		80,800	105.5	096	4
82	26,360	17.9		80,600	105.6	086	7
84	27,110	18.5		79,250	105.9	072	8
86	27,920	19.1		78,900	106.4	061	9
88	28,730	19.9		77,700	107.0	094	10
90	29,520	20.7		76,600	106.8	111	10
92	30,340	21.6		75,200	106.9	097	10
94	31,130	22.4		74,200	107.3	072	10
96	31,920	23.2		73,200	108.0	076	6
97	32,330	23.7		72,400	108.1		

CC II-17

Rawinsonde Time-Altitude Data

Contact	Pressure millibars	Altitude meters	Elapsed Time (min.)
1	1019.4	22	0.0
5	1008	110	
10	942	690	2.3
15	879	1,250	4.3
20	818	1,830	6.5
25	758	2,450	8.6
30	700	3,080	10.6
35	647	3,690	12.6
40	594	4,350	14.8
45	544	5,010	17.3
50	497	5,710	19.8
55	452	6,410	22.3
60	410	7,130	24.8
65	370	7,890	27.2
70	332	8,630	29.6
75	297	9,400	31.9
80	264	10,180	34.8
85	234	10,950	37.1
90	205	11,800	39.4
95	178	12,700	42.0
100	154	13,680	45.0
105	132	14,700	48.2
110	112	15,790	51.7
115	93	17,000	55.4
120	76	18,300	59.3
125	61	19,760	63.5
130	47	21,480	68.5
135	34	23,620	74.5
140	22	26,600	82.7
145	9.5	32,450	97.3

Aerovane Data

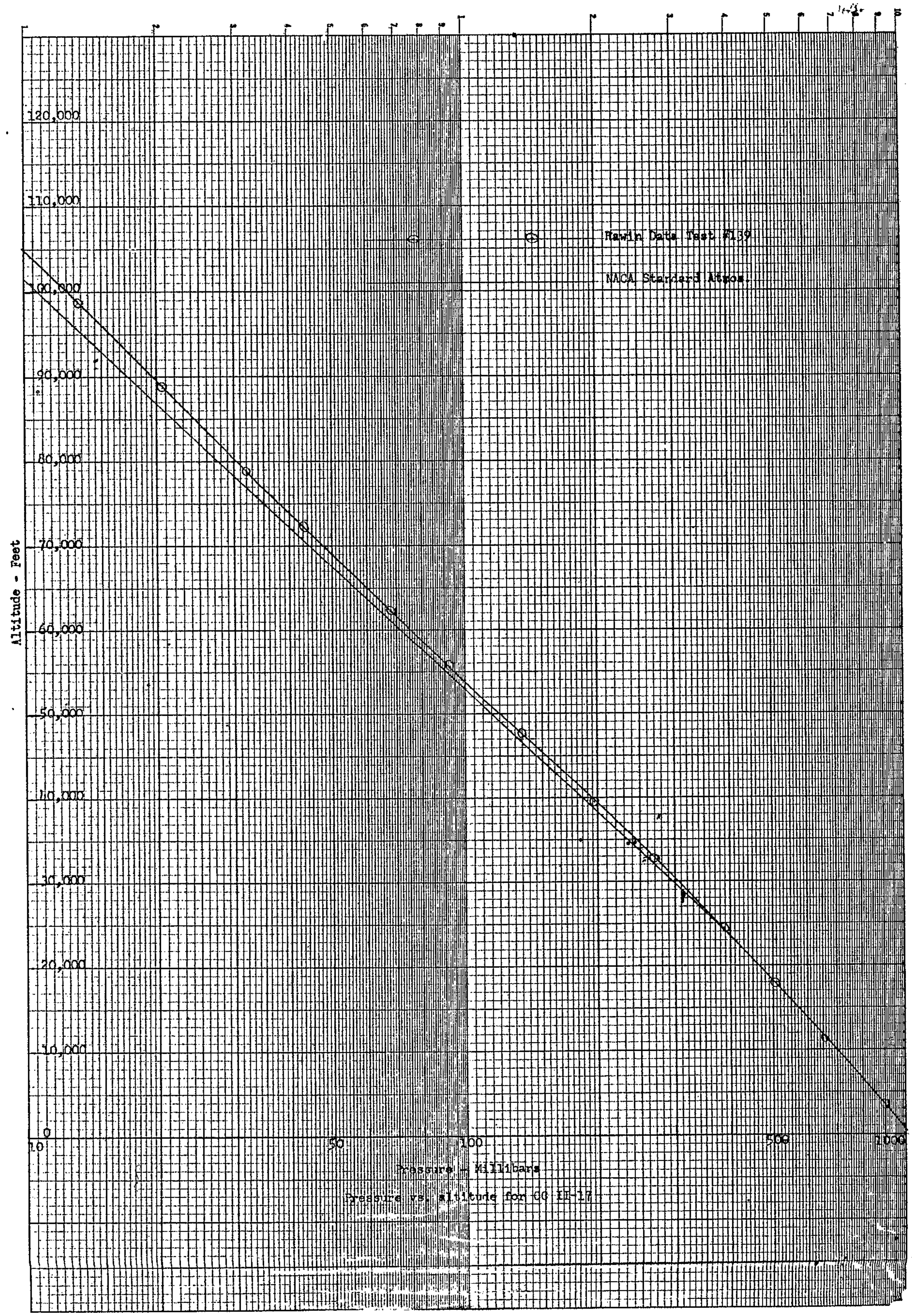
Time sec.	Speed m.p.h.	Direction degrees
T-600	11	200
T-480	14	216
T-420	16	210
T-300	19	210
T-240	15	213
T-180	15	210
T-620	20	216
T- 60	18	216
T- 10	14	216
T- 5	15	217
T- 0	15	216
T+ 5	16	215
T+ 10	17	230
T+ 15	13	222
T+ 20	16	213
T+ 25	15	210
T+ 30	13	220
T* 35	17	220
T+ 40	13	200
T+ 45	14	232
T+ 50	18	232
T+ 55	17	218
T+ 60	16	224
T+120	12	216
T+180	20	216
T+240	19	223
T+300	12	228
T+420	12	232
T+480	12	225
T+600	10	220

Temperature and Pressure Versus Altitude
Adiabatic Charts

Test No. 139 **Release Time: 12.56 CST**

CC II-17

Altitude		Temp.	Pressure	Altitude		Temp.	Pressure
Km.	Feet	°F	Millibars	Km.	Feet	°F	Millibars
1.0	3,281	46.9	906	17.0	55,777	-56.9	93
1.5	4,922	38.6	854	17.5	57,417	-58.1	86.3
2.0	6,562	34.7	803	18.0	59,058	-59.8	79.7
2.5	8,203	31.9	753	18.5	60,698	-58.9	74.2
3.0	9,843	24.8	707	19.0	62.339	-58.0	68.4
3.5	11,484	18.9	663	19.5	63,979	-56.7	63.5
4.0	13,124	16.3	622	20.0	65,620	-57.3	59
4.5	14,765	12.2	583	20.5	67,261	-54.2	54.5
5.0	16,405	9.1	545	21.0	68,901	-53.1	50.5
5.5	18,045	6.1	511	21.5	70,542	-52.2	47.0
6.0	19,686	1.2	478	22.0	72,182	-51.7	43.5
6.5	21,326	-5.8	447	22.5	73,823	-51.0	40.3
7.0	22,967	-13.0	417	23.0	75,463	-50.4	37.2
7.5	24,607	-19.7	391	23.5	77,104	-49.0	32.0
8.0	26,248	-27.6	364	24.0	78,744	-58.0	32.0
8.5	27,888	-34.6	338	24.5	80,385	-48.5	29.8
9.0	29,529	-41.8	314	25.0	82,025	-47.9	27.8
9.5	31,169	-49.5	292	25.5	83,665	-47.2	25.7
10.0	32,810	-57.1	271	26.0	85,306	-46.5	23.8
10.5	34,451	-63.8	251	26.5	86,946	-43.8	22.2
11.0	36,091	-65.7	232.5	27.0	88,587	-41.8	20.8
11.5	37,732	-60.9	215	27.5	90,227	-39.5	19.3
12.0	39,372	-62.5	199	28.0	91,868	-36.9	17.8
12.5	41,013	-56.6	184	28.5	93,508	-34.8	16.5
13.0	42.653	-54.0	171	29.0	95,149	-32.4	15.3
13.5	44,294	-53.3	158	29.5	96,789	-30.3	14.3
14.0	45,934	-53.0	147.67	30.0	98,430	-28.5	13.4
14.5	47,575	-52.8	136	30.5	100,071	-27.4	12.5
15.0	49,215	-53.3	126.0	31.0	101,711	-25.8	11.6
15.5	50,855	-54.0	117	31.5	103,352	-23.6	10.85
16.0	52,496	-54.6	108.4	32.0	104,992	-22.2	10.1
16.5	54,136	-55.1	101				



Pressure vs. altitude for CC II-17

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PILOT BALLOON OBSERVATION #1

Test Supported#139 Date 24 June 1963 Time 1520 CDT

20 sec. Reading	Height Feet	Height Meters	Azimuth Degrees	Elevation Degrees	Direction Degrees	Speed Meters/sec.
1a(10 sec.)	192	59			225	8.4
1	384	117	44.5	31.5	219	7.9
2	766	234	39.4	34.0	213	8.1
3	1,184	350	36.8	32.5	216	9.4
4	1,498	457	37.8	31.9	224	11.8
5	1,848	563	40.0	29.4	225	14.0
6	2,198	670	40.9	27.7	223	12.9
7	2,538	774	41.1	27.0	227	10.3
8	2,877	877	42.3	27.1	230	9.7
9	3,215	980	43.0	27.2	223	9.8
10	3,549	1,082	42.4	27.3	223	9.6
11	3,883	1,184	42.9	27.4	231	9.6
12	4,216	1,285	43.5	28.1	235	8.3
13		1,386	44.2	28.3		
14			44.8	28.1		
15						

PILOT BALLOON OBSERVATION #2

Test Supported# 139 Date 24 June 1963 Time 1557 CDT

20 sec. Reading	Height Feet	Height Meters	Azimuth Degrees	Elevation Degrees	Direction Degrees	Speed Meters/sec.
1a(10 sec.)	192	59			238	9.6
1	384	117	58.0	27.9	236	10.7
2	766	234	56.3	27.3	236	11.2
3	1,184	350	56.7	27.6	232	12.6
4	1,498	457	53.5	25.3	234	13.4
5	1,848	563	56.2	25.1	240	12.8
6	2,198	670	56.5	24.3	230	13.3
7	2,538	774	56.7	24.0	237	13.6
8	2,877	377	56.7	23.4	238	12.6
9	3,215	980	57.0	22.5	240	15.0
10	3,549	1,082	57.1	22.8	239	11.3
11	3,883	1,184	57.3	23.0	235	13.0
12	4,216	1,285	56.7	22.7	228	15.3
13		1,386	55.7	22.4		
14						
15						

UNCLASSIFIED
46.

PILOT BALLOON OBSERVATION # 3

Test Supported# 139 Date 24 June 1963 Time 1630 CDT

20 sec. Reading	Height Feet	Height Meters	Azimuth Degrees	Elevation Degrees	Direction Degrees	Speed Meters/sec.
1a(10 sec.)	192	59			213	7.6
1	384	117	32.8	30.4	206	9.2
2	766	234	26.2	30.9	205	9.8
3	1,184	350	27.7	30.9	207	9.8
4	1,498	457	26.5	30.2	205	10.4
5	1,848	563	26.3	29.3	207	9.4
6	2,198	670	26.5	30.0	213	6.4
7	2,538	774	27.6	31.8	226	5.8
8	2,877	877	29.4	33.0	232	5.5
9	3,215	980	31.1	33.7	237	7.5
10	3,549	1,082	34.4	33.9	235	8.7
11	3,883	1,184	35.7	33.5	235	7.4
12	4,216	1,285	37.7	34.1	239	7.2
13			38.8	34.0		
14						
15						

Wind Component Calculation Sheet

Vehicle CC II-17 Test 139 Date 24 June 1963 Time 1630 CDT Location CRR

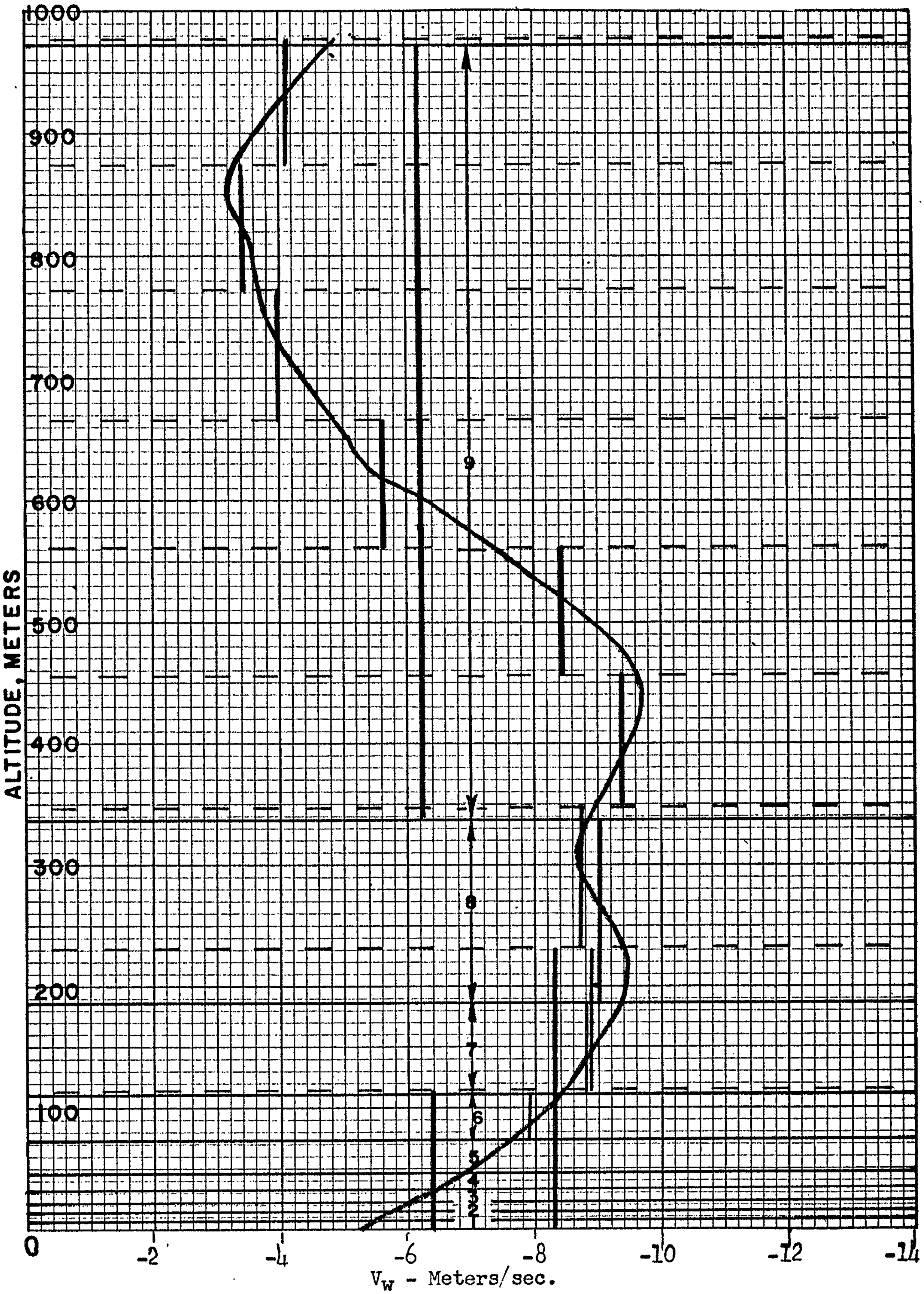
Altitude	Direction		Speed	N-S	E-W
0-117	213	33	7.6	-6.4	-4.1
0-234	206	26	9.2	-8.3	-4.0
117-350	205	25	9.8	-8.9	-4.1
234-457	207	27	9.8	-8.7	-4.4
350-563	205	25	10.4	-9.4	-4.4
457-670	207	27	9.4	-8.4	-4.3
563-774	213	33	6.4	-5.4	-3.5
670-877	226	46	5.8	-4.0	-4.2
774-980	232	52	5.5	-3.4	-4.3
877-1082	237	57	7.5	-4.1	-6.3
Aerovane					
T-10	228	48	6.3	-4.2	-4.7
T+0	216	36	6.7	-5.4	-3.9
T+10	260	80	7.6	-1.3	-7.5
T+20	214	34	7.2	-5.9	-4.0

UNCLASSIFIED

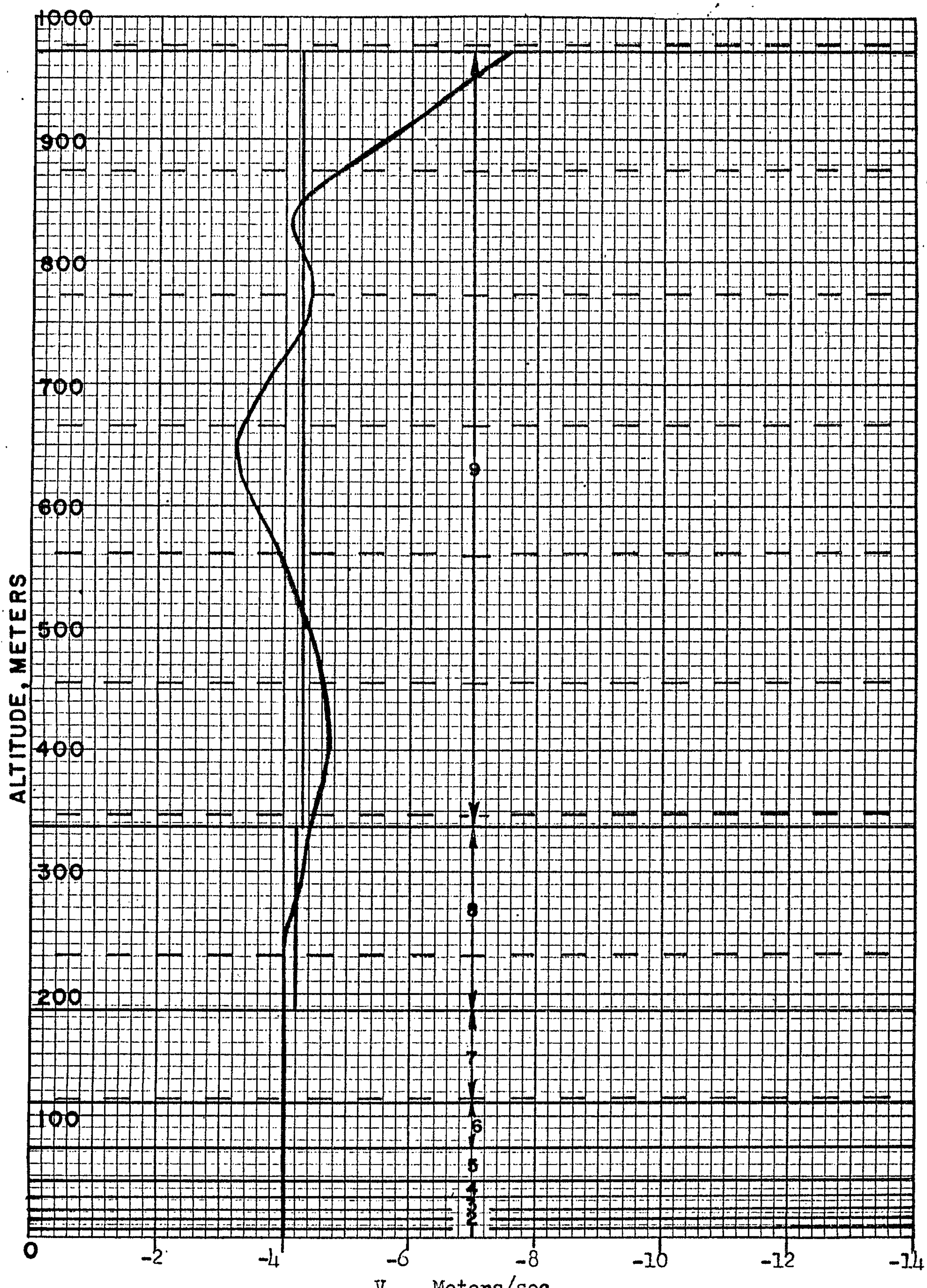
Wind Component Calculation Sheet

Vehicle CC II-17 Test 139 Date 24 June 1963 Time 1356 CDT Location CRR

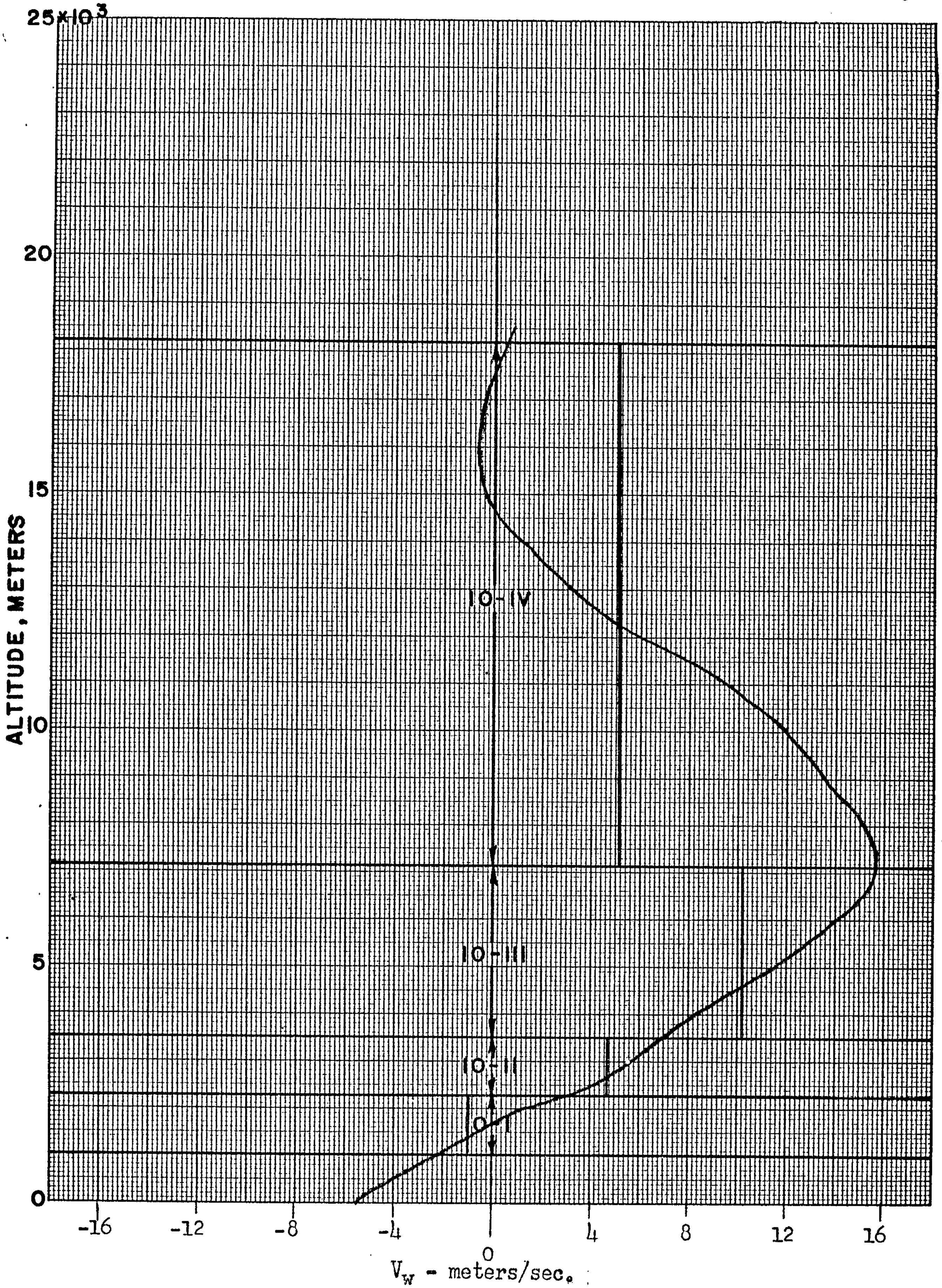
Altitude meters	Direction degrees	degrees	Speed meters/sec.	N-S meters/sec.	E-W meters/sec.
0	210	30	7	-6.1	-3.5
300	220	40	7	-5.4	-4.5
580	227	47	7	-4.8	-5.1
870	227	47	8	-5.5	-5.9
1,130	245	65	8	-3.4	-7.3
1,410	254	74	8	-2.2	-7.7
1,700	261	81	9	-1.4	-8.9
2,000	272	88	11	+0.4	-11.0
2,280	279	81	14	+2.2	-13.8
2,590	290	70	14	+4.8	-13.1
3,200	290	70	17	+5.8	-16.0
3,800	290	70	19	+6.5	-17.8
4,400	287	73	19	+5.6	-18.1
4,960	299	61	22	+10.7	-19.2
5,500	297	63	29	+13.2	-25.8
6,330	293	67	34	+13.3	-31.3
7,410	292	68	37	+13.8	-34.3
8,700	290	70	36	+12.3	-33.8
10,600	290	70	35	+12.0	-32.9
12,030	281	79	33	+ 6.3	-32.4
14,700	269	89	22	-..4	-22.0
16,540	268	88	13	- .5	-13.0
18,530	276	84	6	+ .6	- 6.0



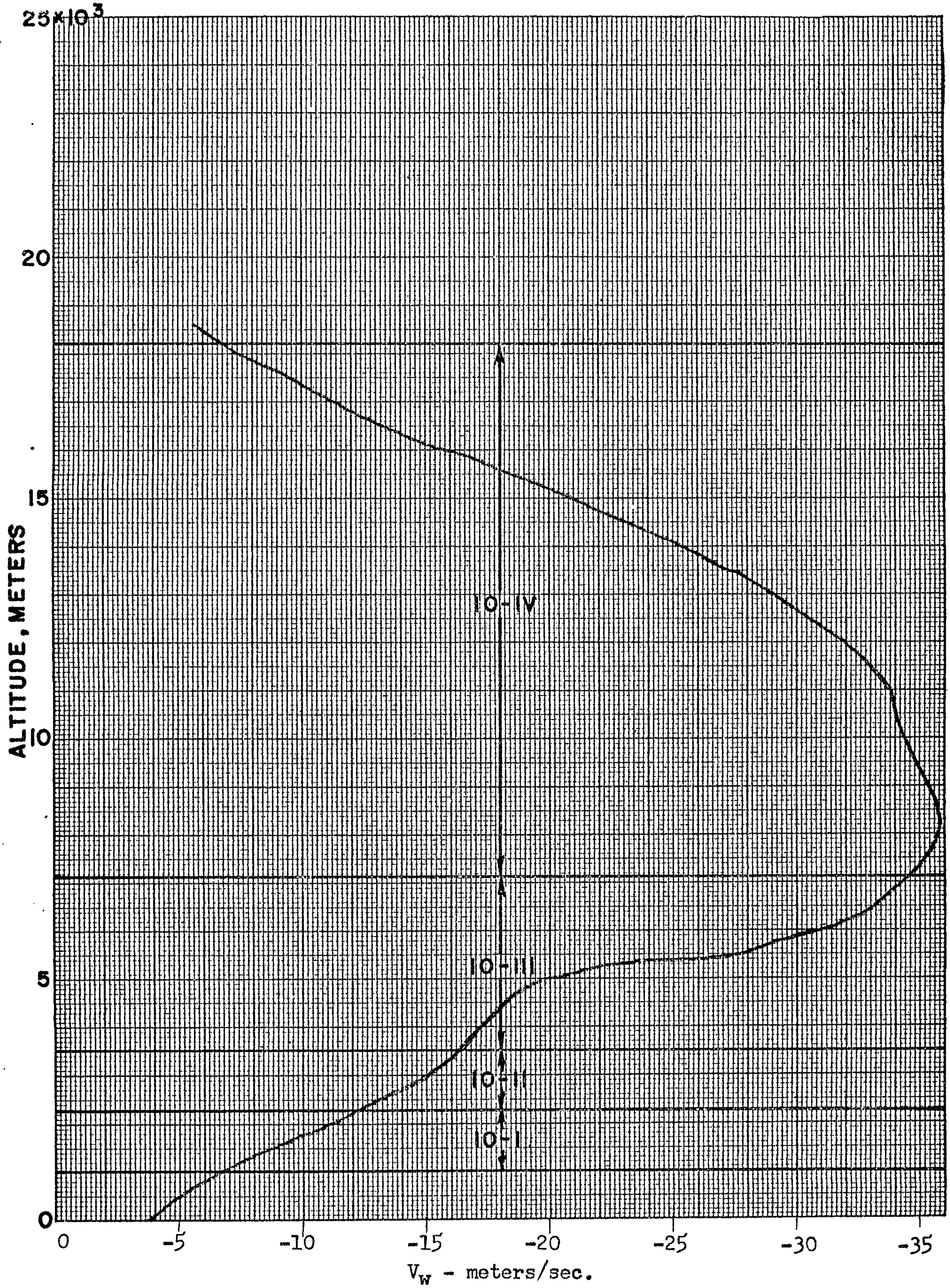
North-South wind profile layers 1 to 9 for CC II-17 vehicle launch



East-West wind profile of layers 1 ot 9 for CC II-17 vehicle launch



North-South wind profile of layers 10-I to 10-IV for CC II-17 vehicle launch



East-West wind profile of layers 10-I to 10-IV for CC II-17 vehicle launch

Calculation of Ballistic Wind

Vehicle CC II-17 Test 139

Location CRR

Date 24 June 1963

Time of Launch 1700 CDT

Wind Data

Aerovane — Time T-10 to T+20

Pibal Run No. 3 — Time

Rawin — Time 13.56 CDT

Other — Time

Layer	Weight (nr)	N-S	N-S Weighted	E-W	E-W Weighted
1	1	-5.1	-5.1	-4.0	-4.0
2	1	-5.5	-5.5	-4.0	-4.0
3	1	-5.9	-5.9	-4.0	-4.0
4	1	-6.3	-6.3	-4.0	-4.0
5	1	-7.0	-7.0	-4.0	-4.0
6	1	-7.9	-7.9	-4.0	-4.0
7	1	-8.8	-8.8	-4.0	-4.0
8	1	-8.8	-8.8	-4.2	-4.2
9	1	-6.2	-6.2	-4.3	-4.3
10-i	.5	-1.0	- .5	-9.0	-4.5
10-ii	.2	+4.7	+9.8	-15.0	-3.0
10-iii	.2	+10.2	+2.04	-25.0	-5.0
10-iv	.1	+5.1	+ .51	-24.0	-2.4
Sum	-	-	-58.47	-	-51.40
Ballistic Wind Components			-5.85		-5.14

Prediction of Wind Effect

Vehicle CC II-17 Test 139 Location CRR

Date Time of Launch 1700 CDT

= 1.13 °per m/sec. Kg = 1.50

$V_{abs,\ f}$ =

	N-S	E-W	Ø	
Ballistic Wind	-5.85	-5.14	7.79	221.5
Launcher Settings	-	-	EL: 75.8	AZ: 077.3
	-	-	Θo: 14.2	-
	4.68	20.68°	KgΘo: 21.3	-
Wind Effects	-6.61°	-5.81°	-	-
Predicted	-1.93°	14.87°	14.99°	97.5°
Actual	-1.80°	+12.84°	13.0°	098°
Error	-.13°	+2.03	1.99°	.5°

	Predicted	Actual
Range to impact		
Azimuth		

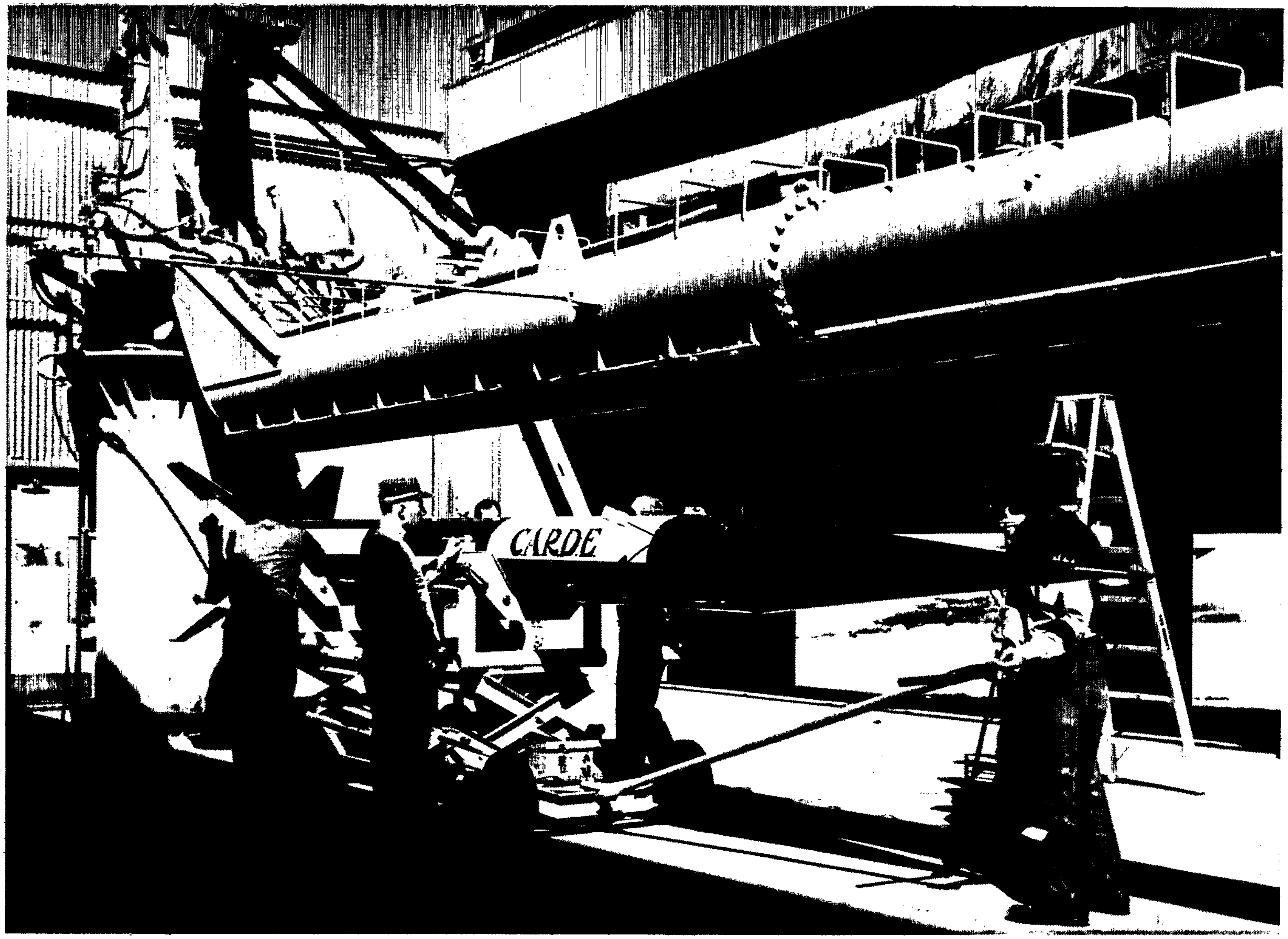


FIGURE 1 - Black Brant IIA four-fin Rocket vehicle.

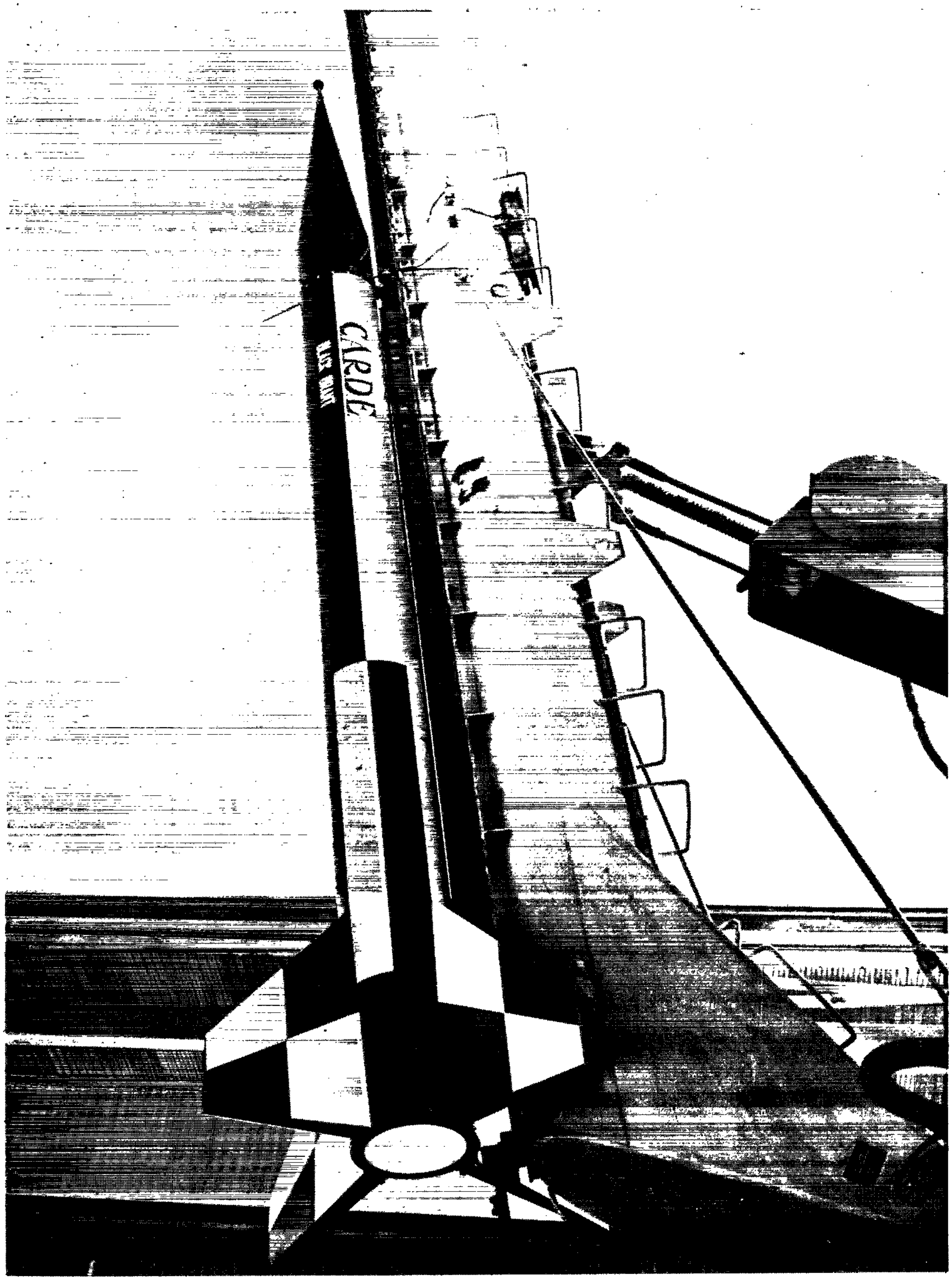
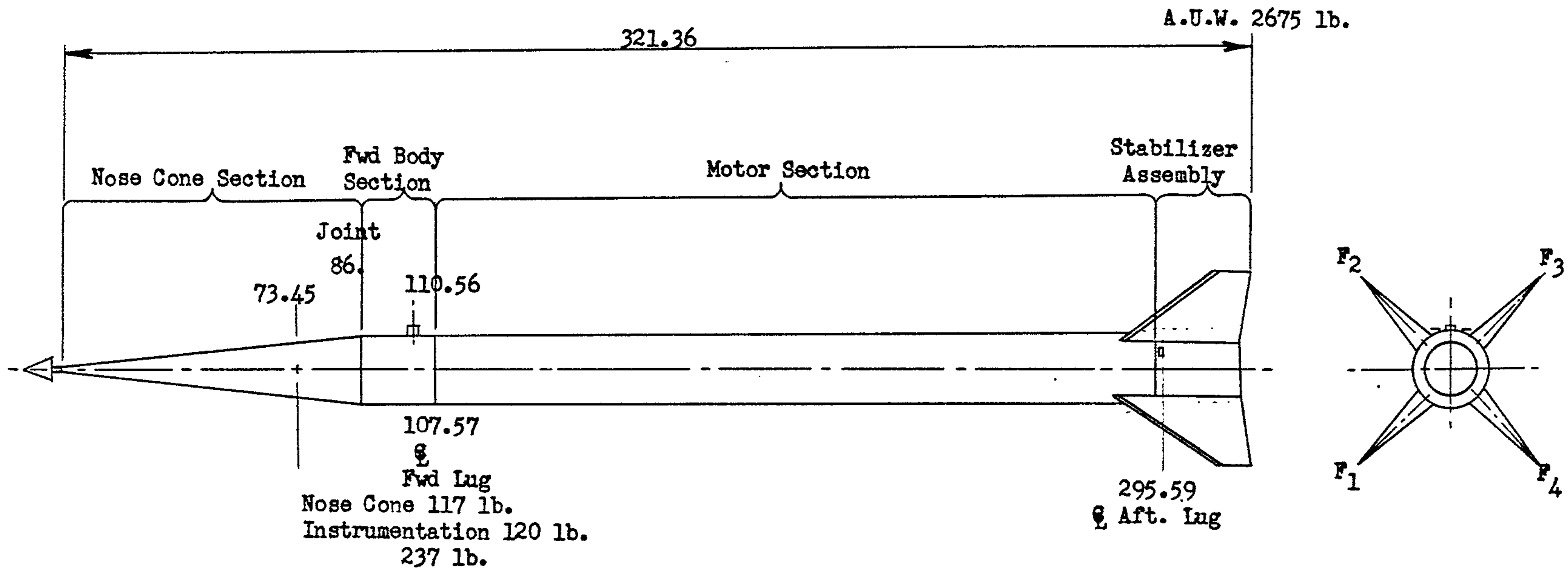


FIGURE 2 - Black Brant IIA four-fin vehicle on the launcher.



Vehicle configuration for CC II 17 and 18

FIGURE 3

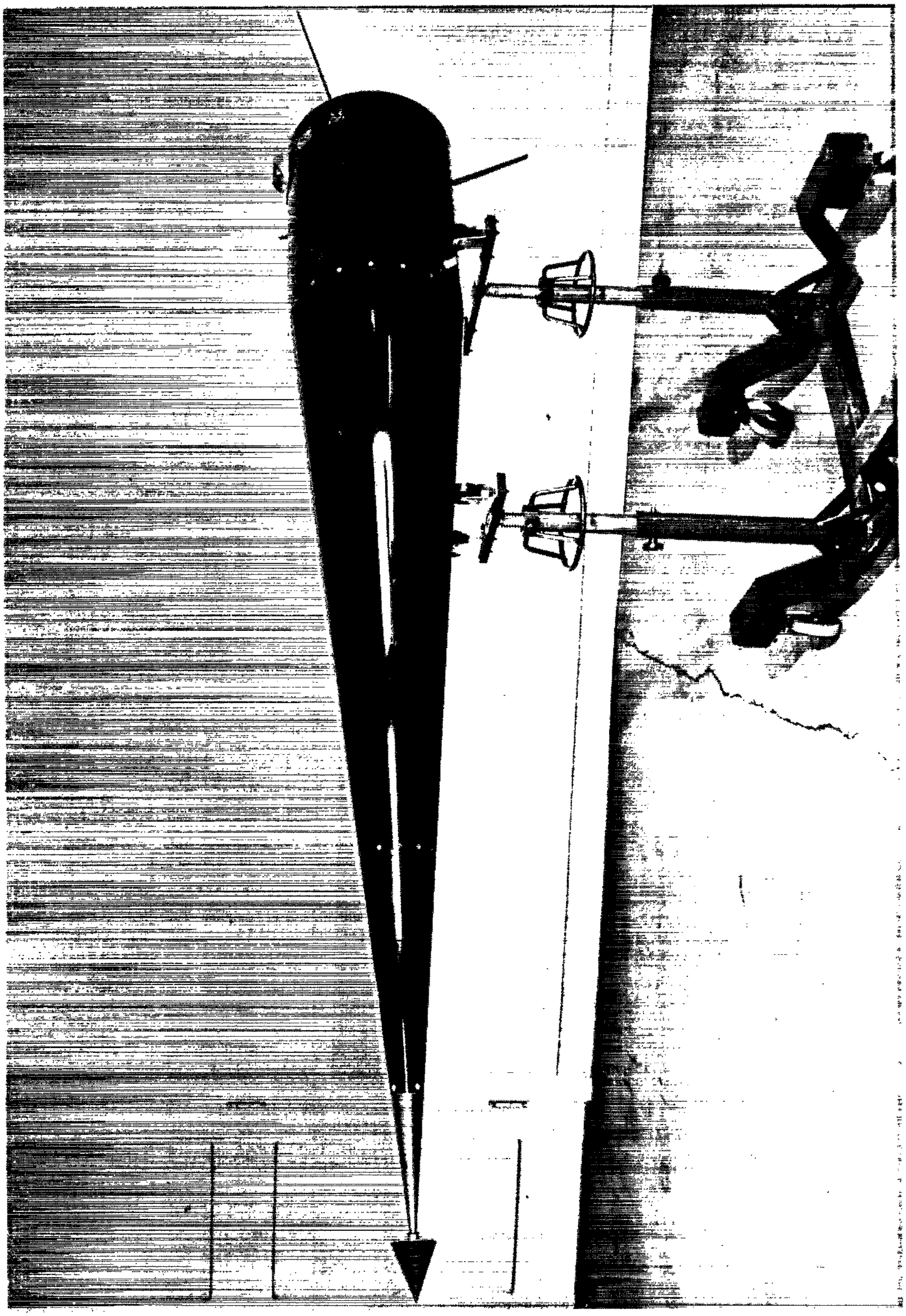
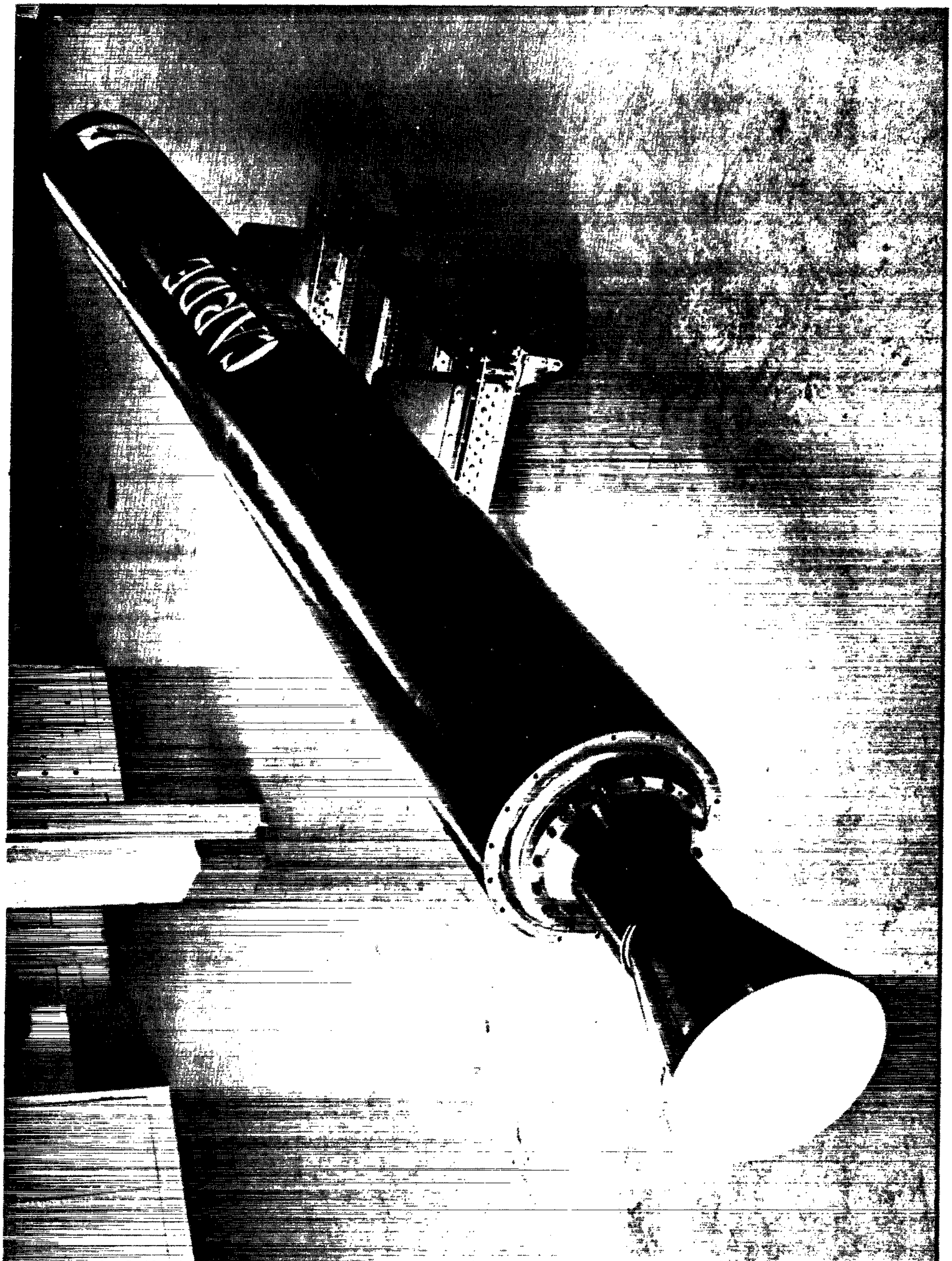
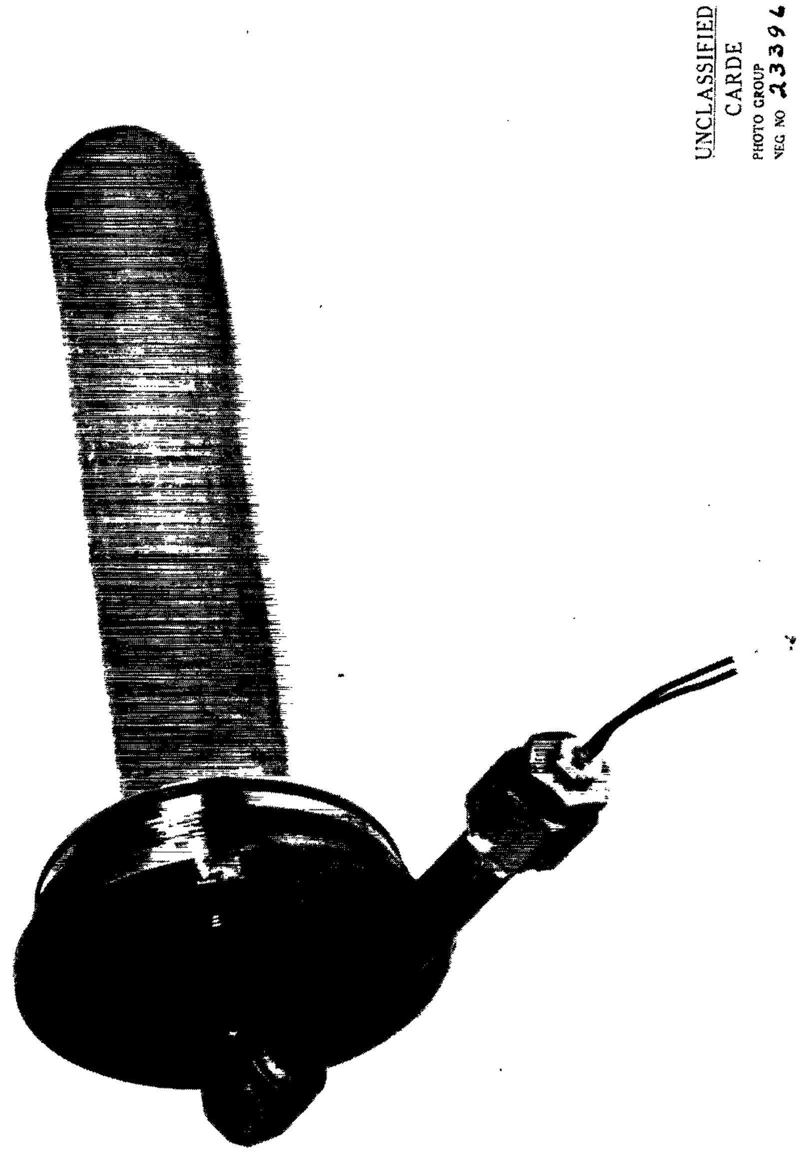


FIGURE 4 - Nose Cone.



Rocket engine and nozzle

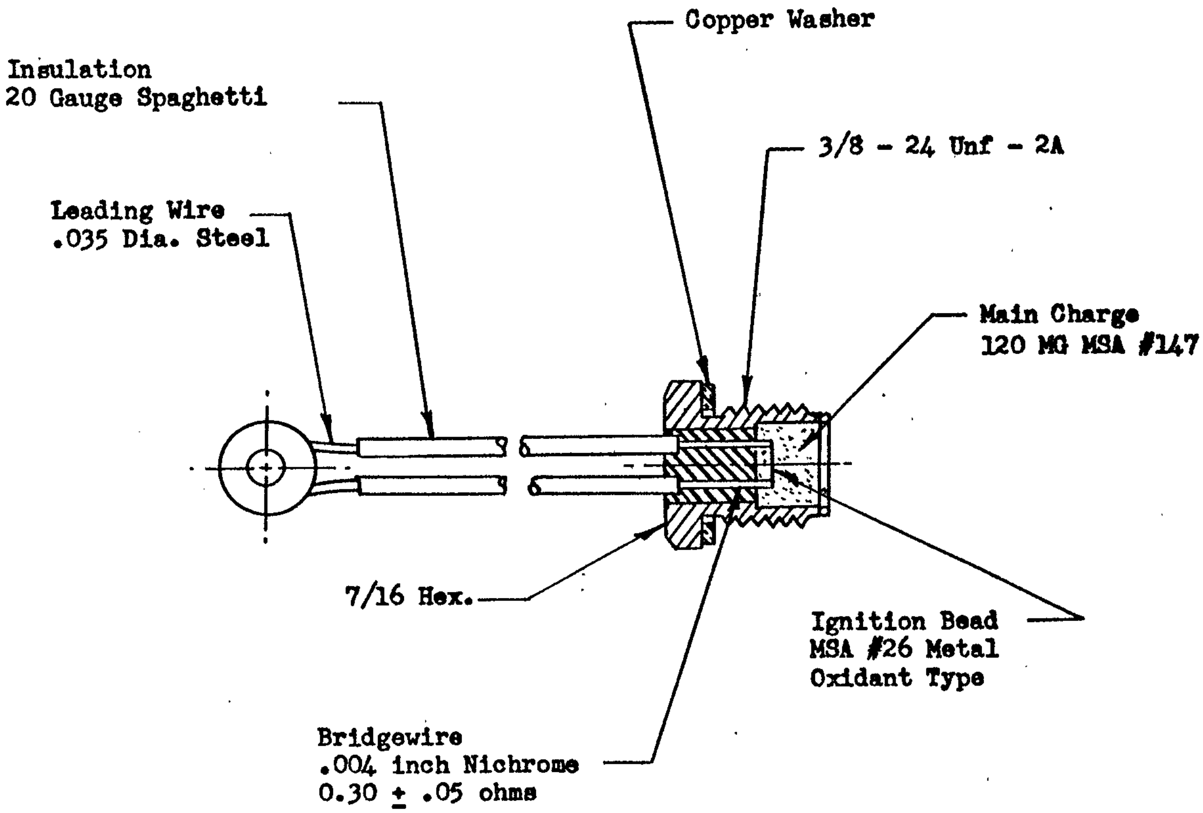
FIGURE 5



Igniter assembly

FIGURE 6

ELECTRIC SQUIB McCORMICK SELPH No. M-32 MOD. V



Firing current 5 amps (recommended)
2 amps (minimum)

No fire current 1.0 amp

Outline of (M-32 Mod. V) igniter siq squib.

FIGURE 7

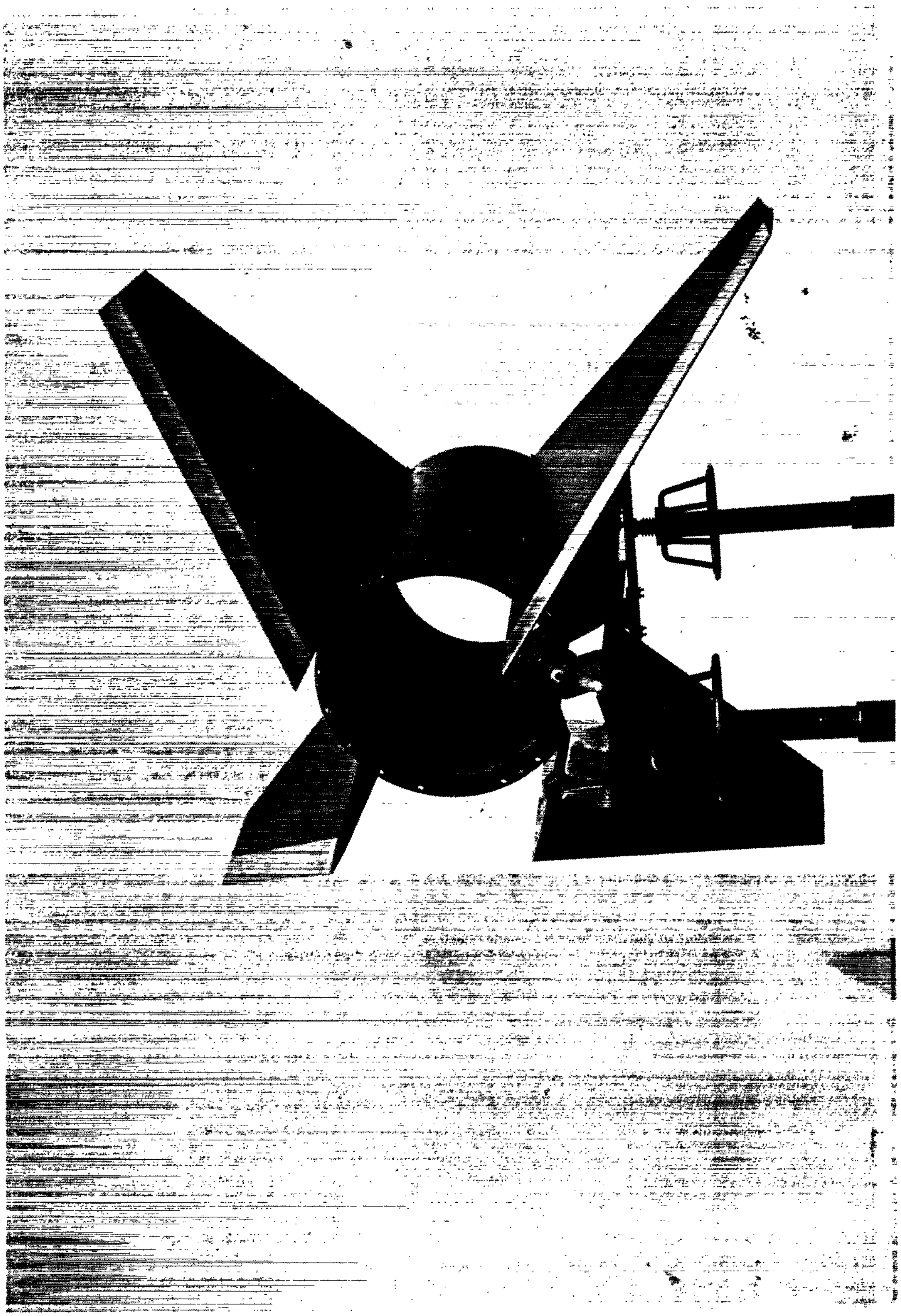
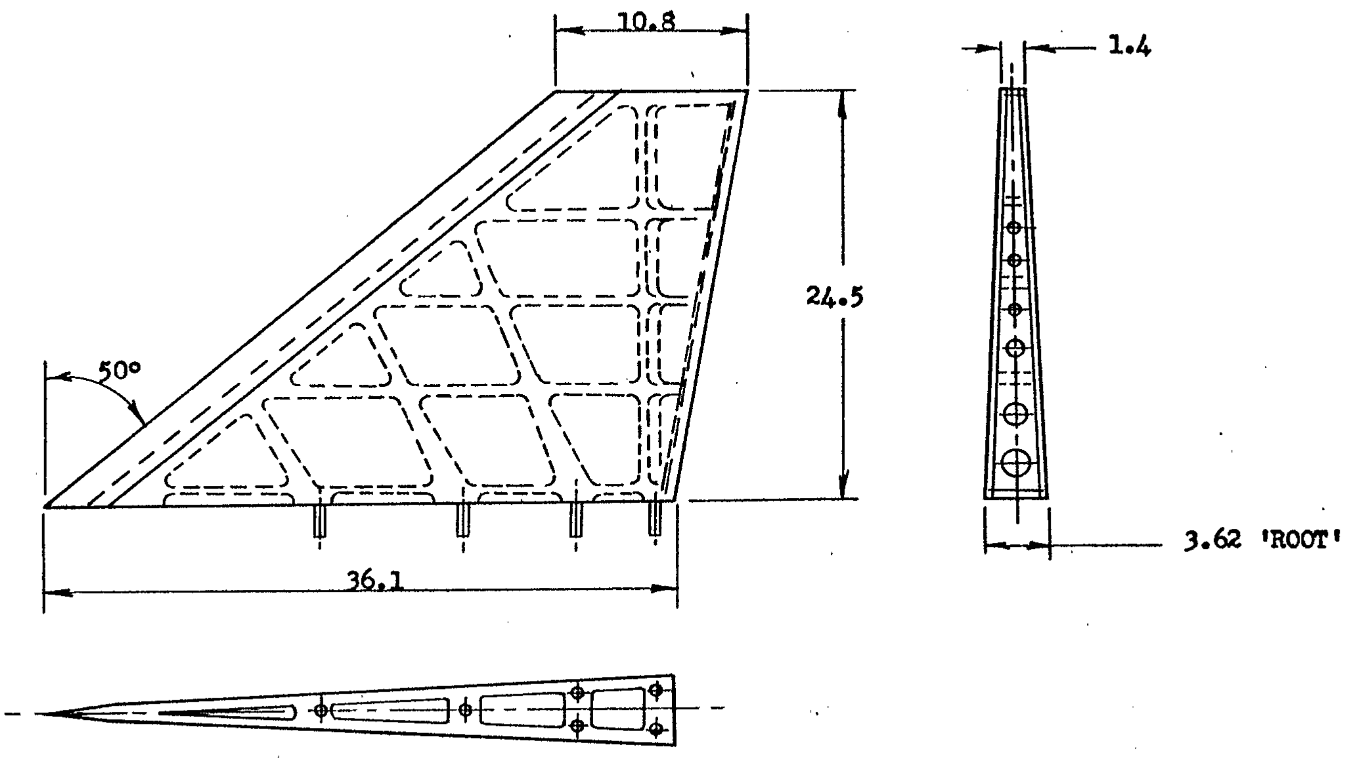


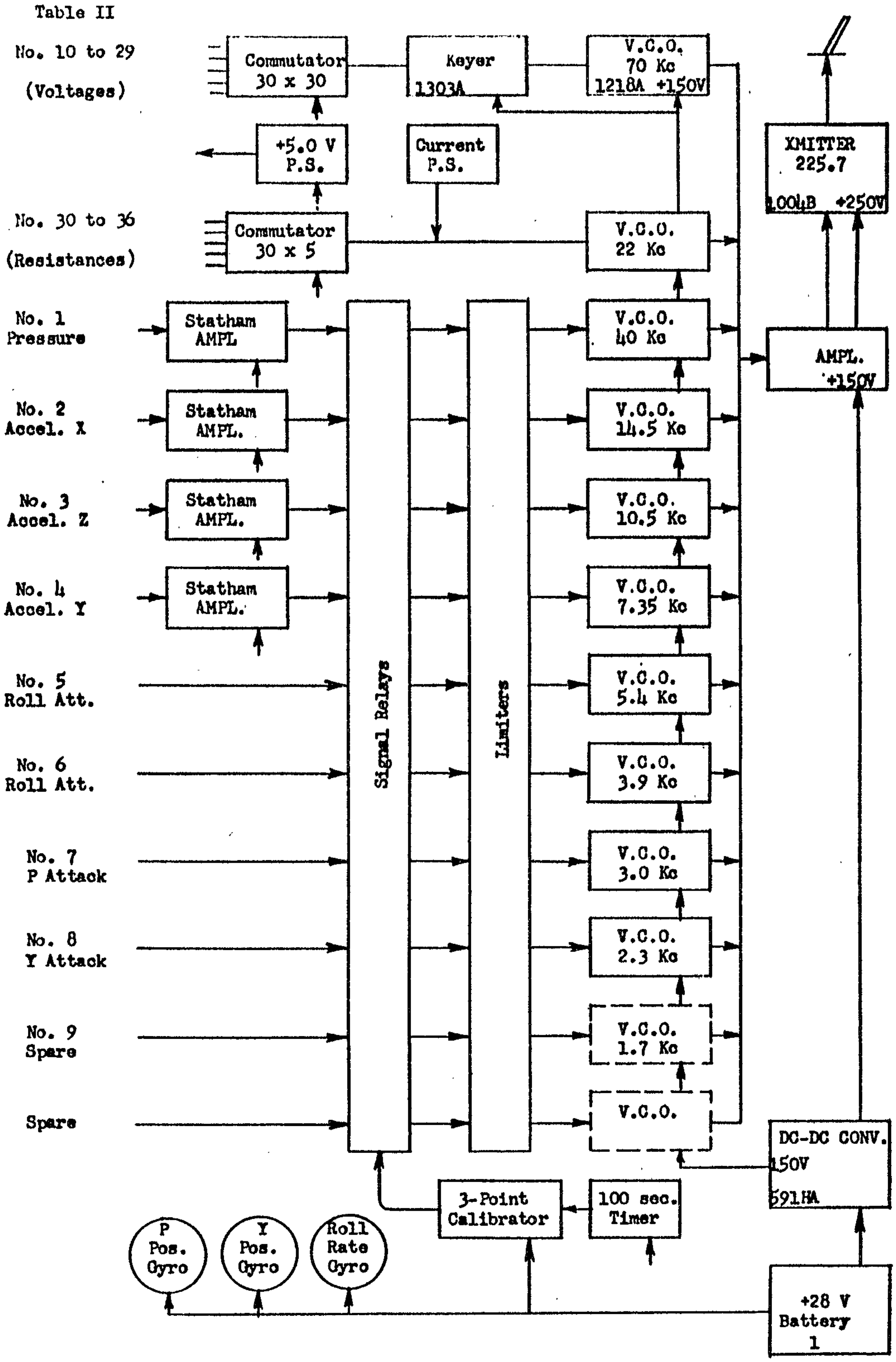
FIGURE 8 - Black Brant II four-fin assembly

"GRID" STRUCTURE FOR 8.7% SINGLE WEDGE FIN



Outline of fin

FIGURE 9



Block Diagram of Telemetry System For CC II 17 and 18 Vehicles

Figure 10

TELEMETRY SYSTEM
FOR
CC II 17 & 18 VEHICLES

PRESSURIZED PACKAGE

10 FM/FM CONTINUS CHANNELS

IRIG CHANNELS 7 TO 13 $\pm 7\frac{1}{2}$% DEVIATION

IRIG CHANNELS A, C & E ± 15% DEVIATION

CHANNEL A - 30 x 5 SAMPLING SWITCH

CHANNEL E - 30 x 30 PDM MULTICODOR

OPERATING VOLTAGE	28	VDC
NOMINAL LOAD CURRENT	4.1	AMPS
RADIATIVE POWER	5	WATTS
OPERATING FREQUENCY	225.7	MC

FIGURE 11

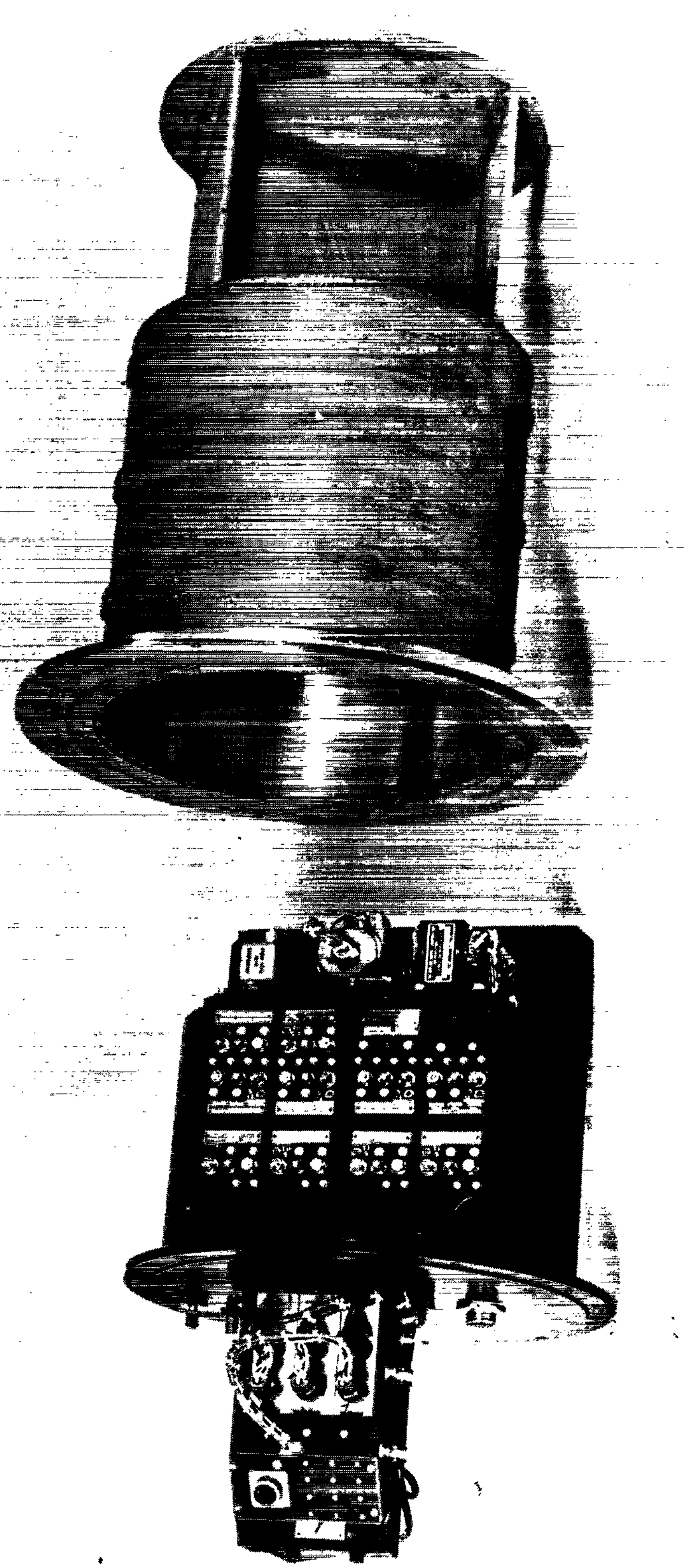


FIGURE 12 - Telemetry package for CC II 17 and 18 vehicles

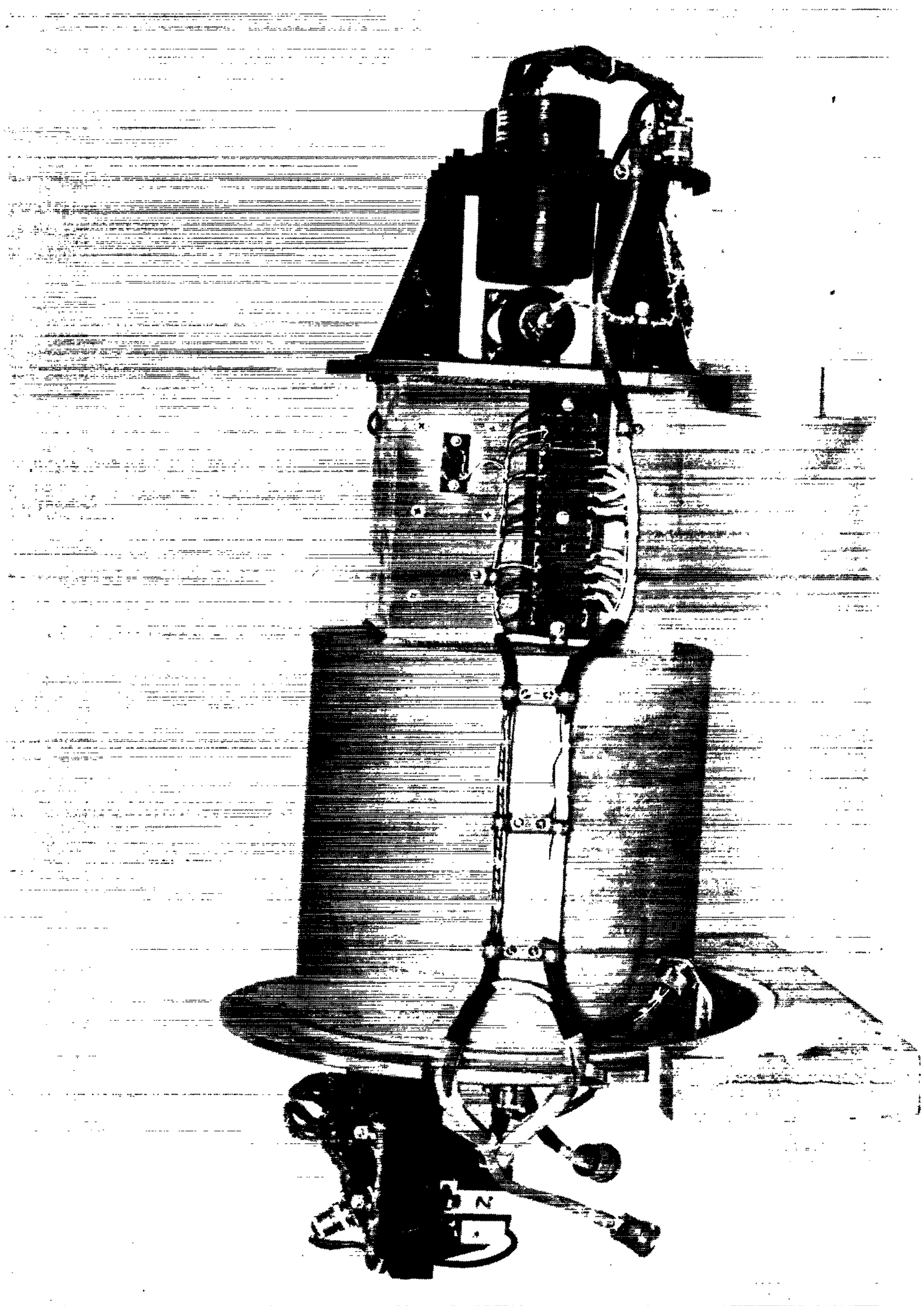
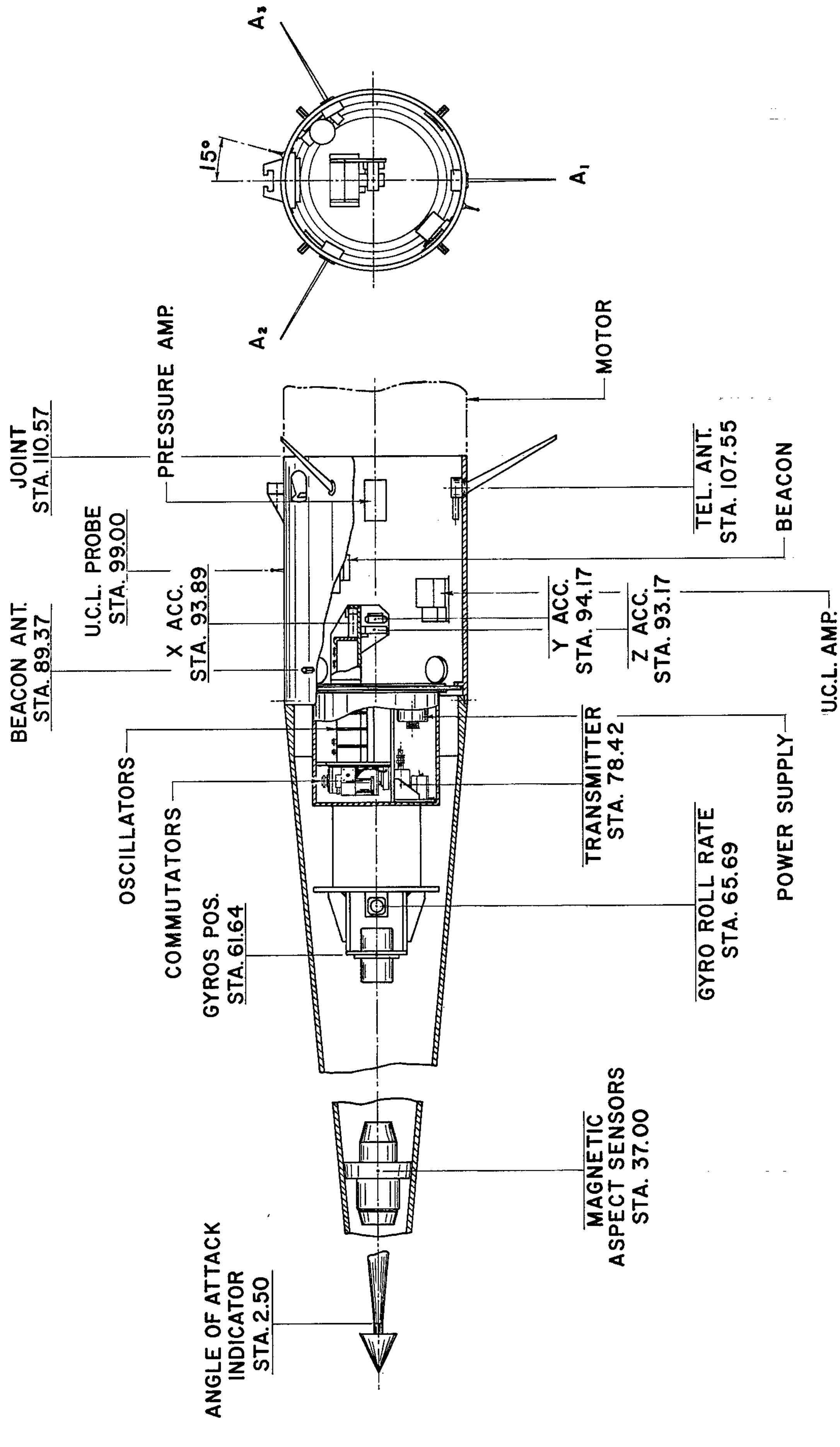
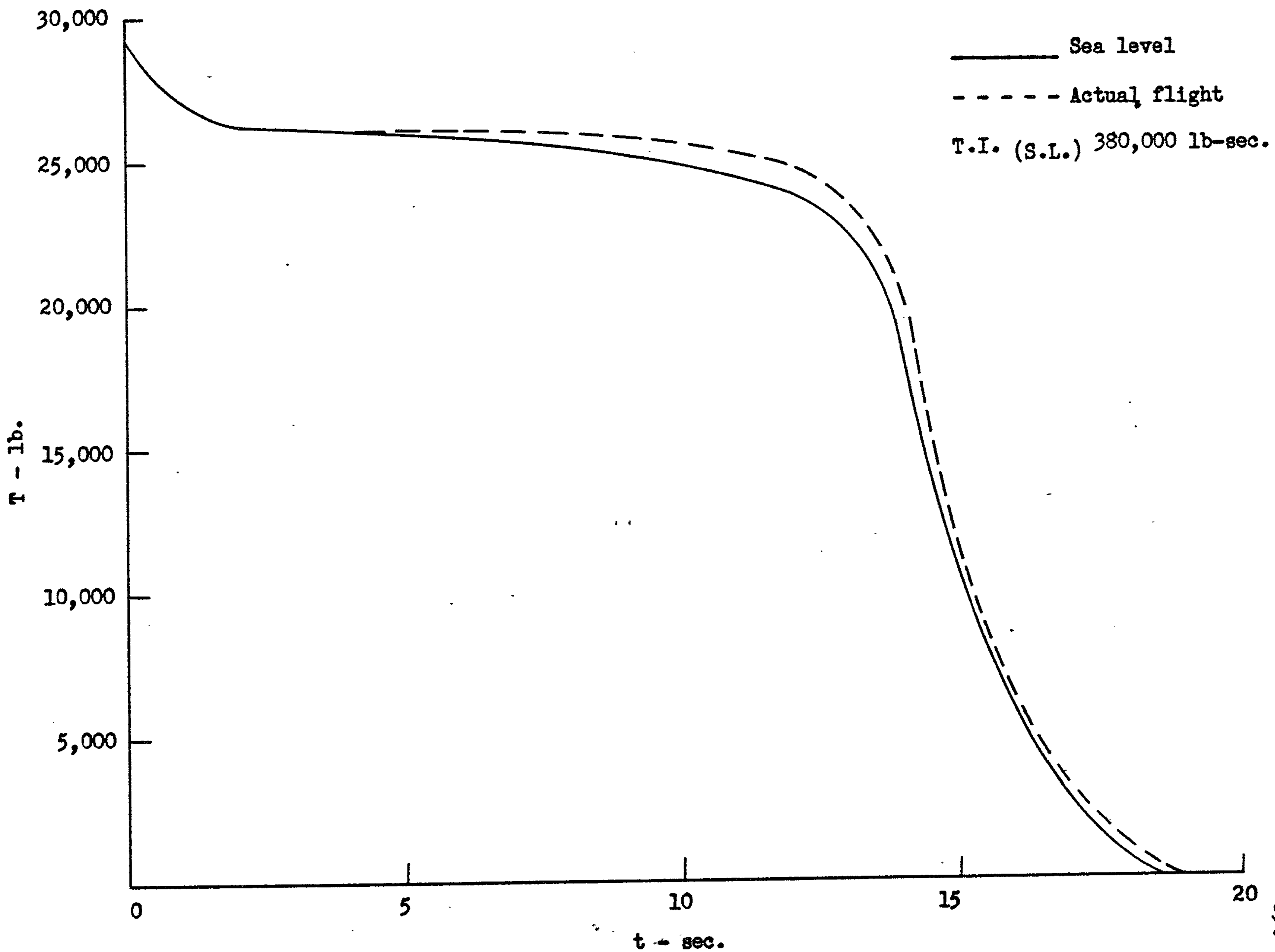


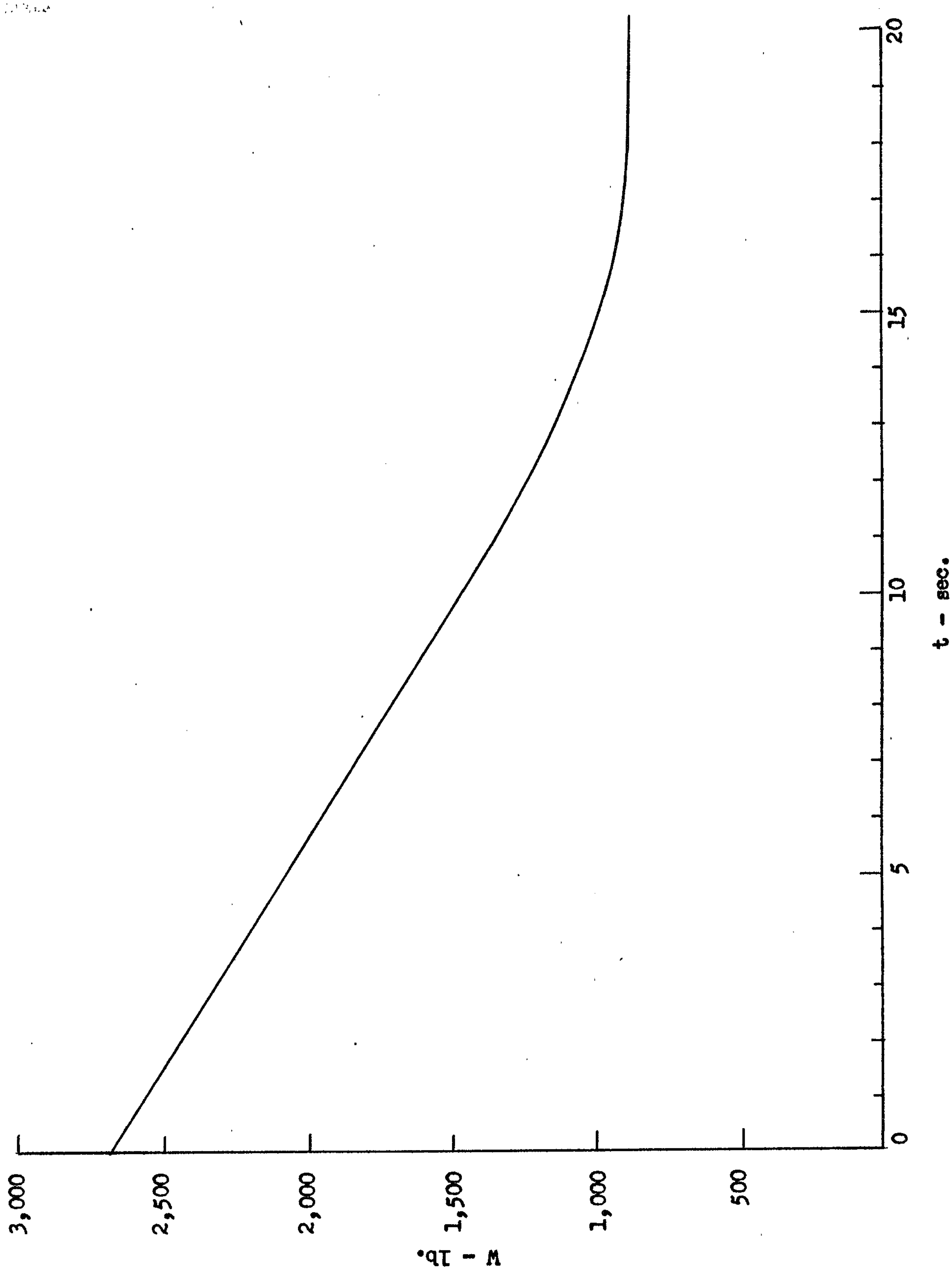
FIGURE 13 - Instrumentation for CC II 17 and 18 vehicles


ANGLE OF ATTACK INDICATOR STA. 2.50
MAGNETIC ASPECT SENSORS STA. 37.00
GYROS POS. STA. 61.64
COMMUTATORS
OSCILLATORS
BEACON ANT. STA. 89.37
X ACC. STA. 93.89
U.C.L. PROBE STA. 99.00
JOINT STA. 110.57
PRESSURE AMP.
MOTOR
TEL. ANT. STA. 107.55
BEACON
Y ACC. STA. 94.17
Z ACC. STA. 93.17
U.C.L. AMP.
TRANSMITTER STA. 78.42
POWER SUPPLY
GYRO ROLL RATE STA. 65.69
A_1
A_2
A_3
15°



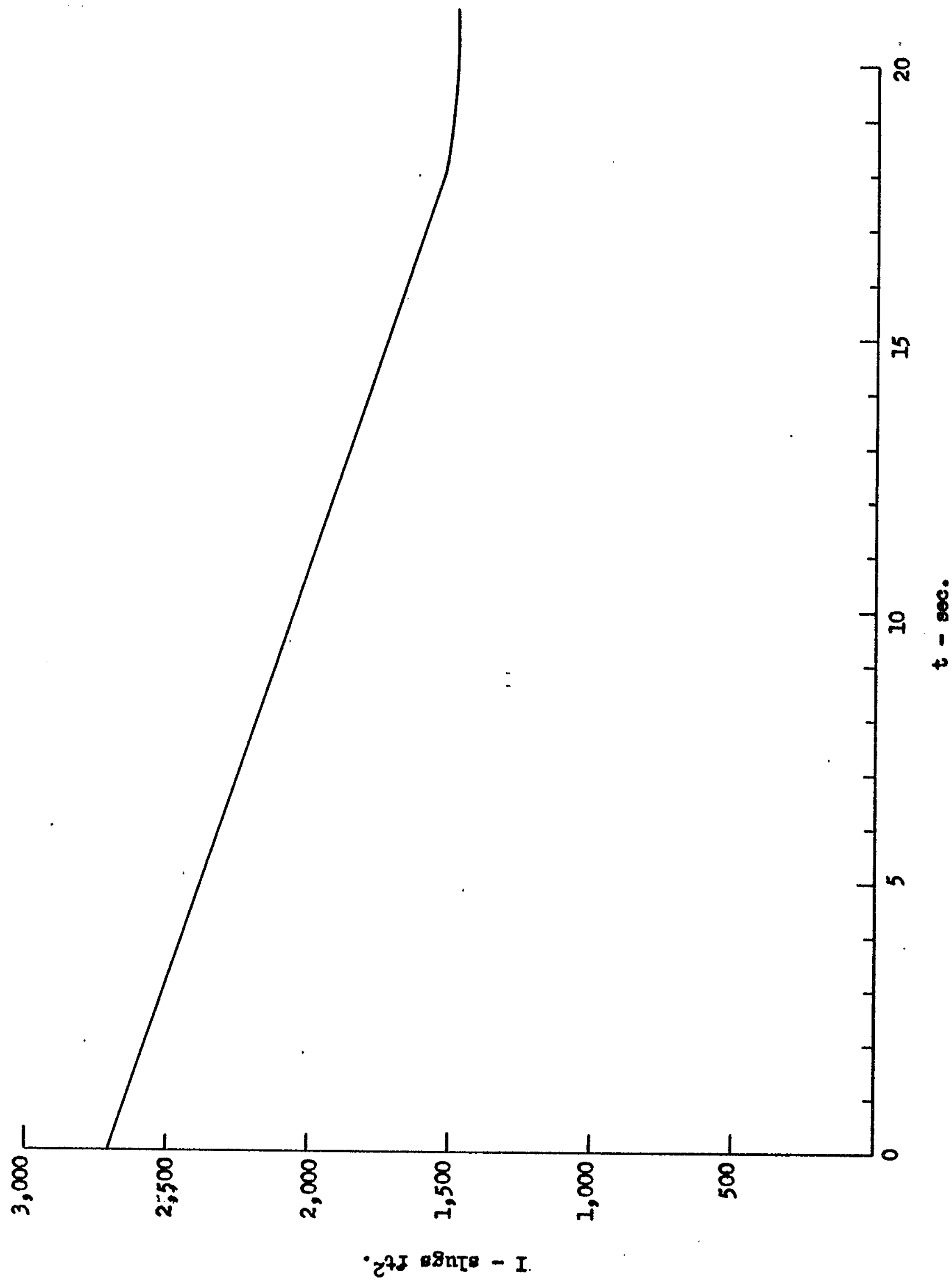
Thrust versus time

FIGURE 15



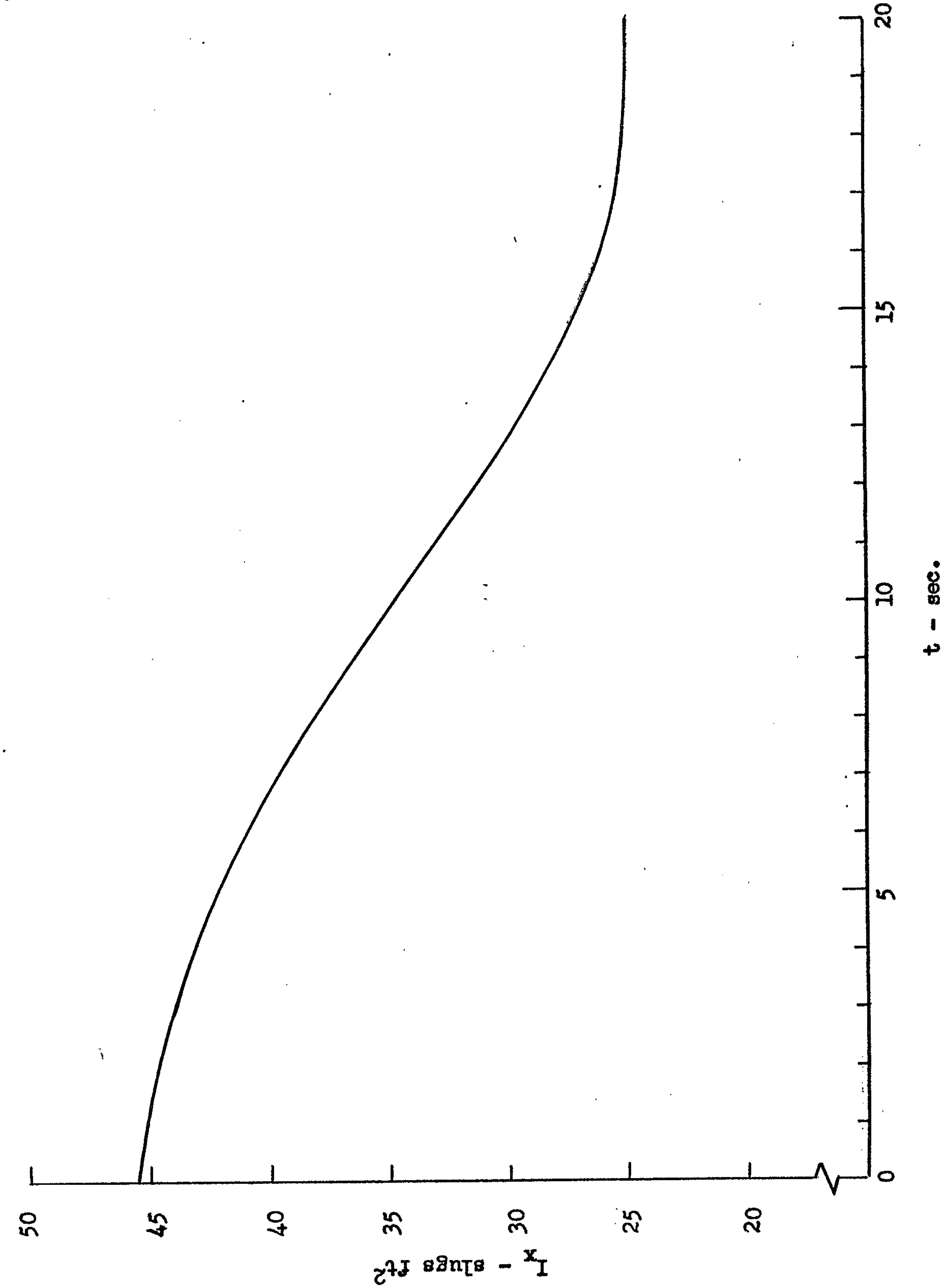
Weight versus time

FIGURE 16



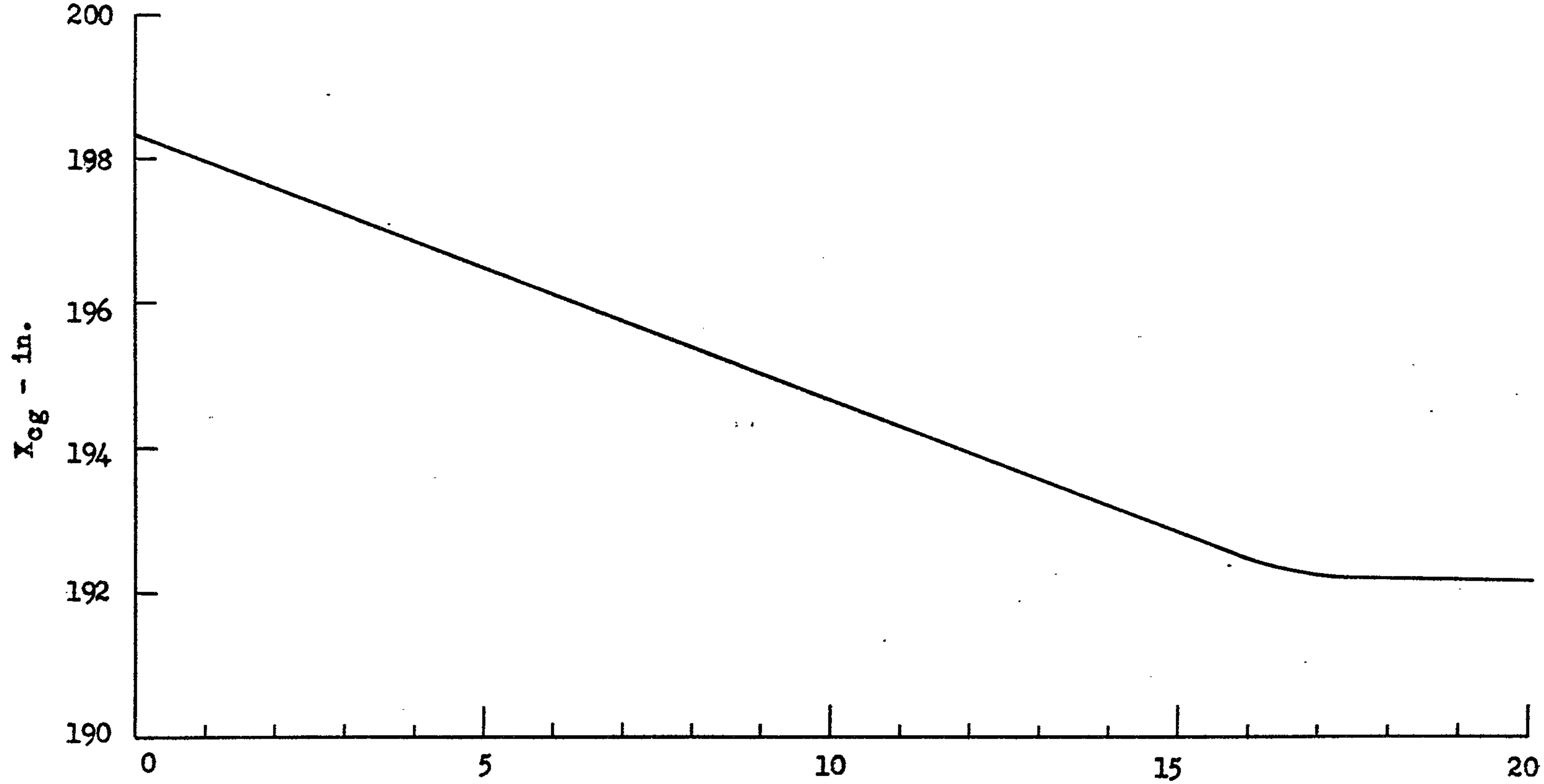
Pitch moment of inertia versus time

FIGURE 17



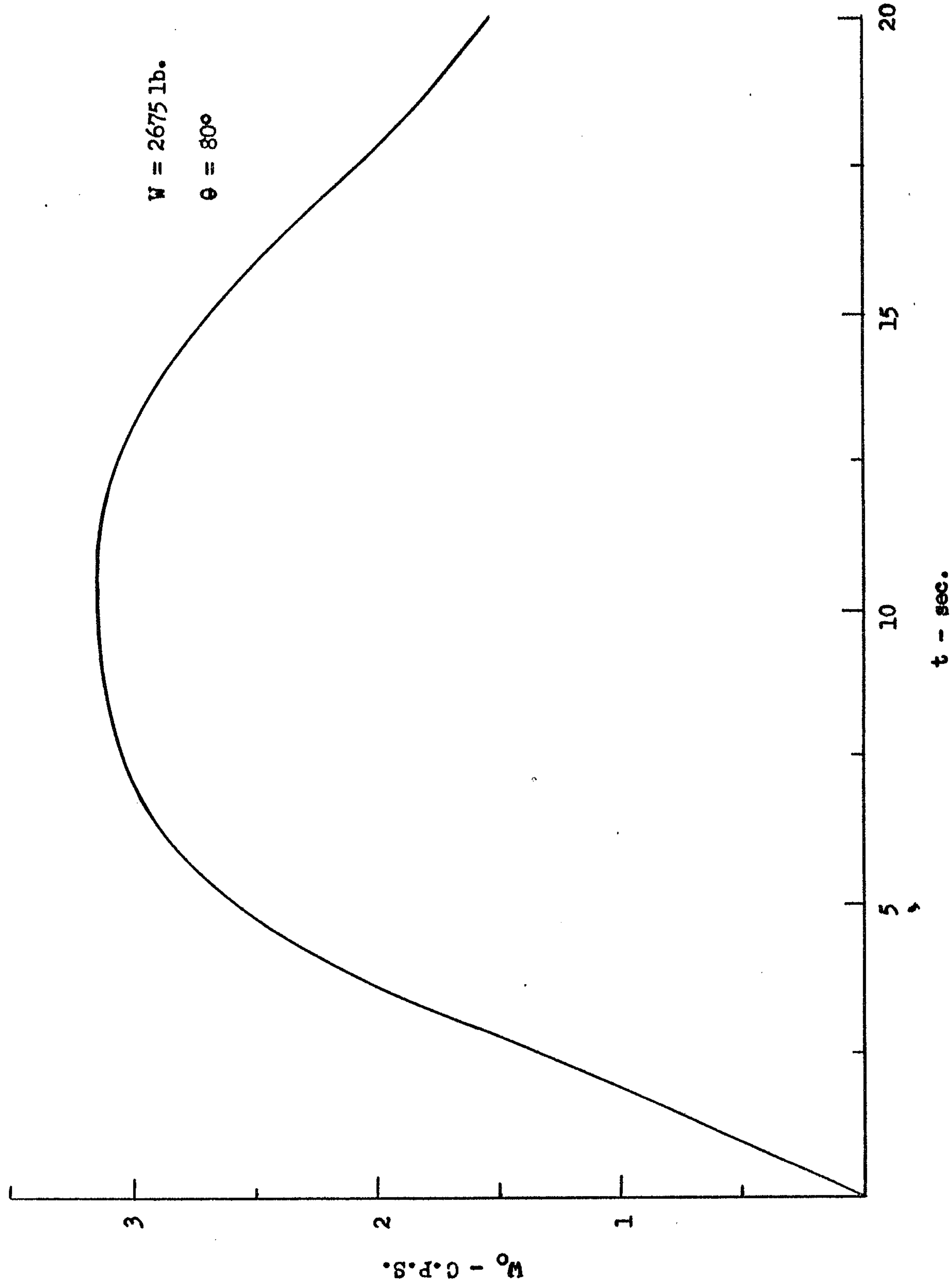
Roll moment of inertia versus time

FIGURE 18



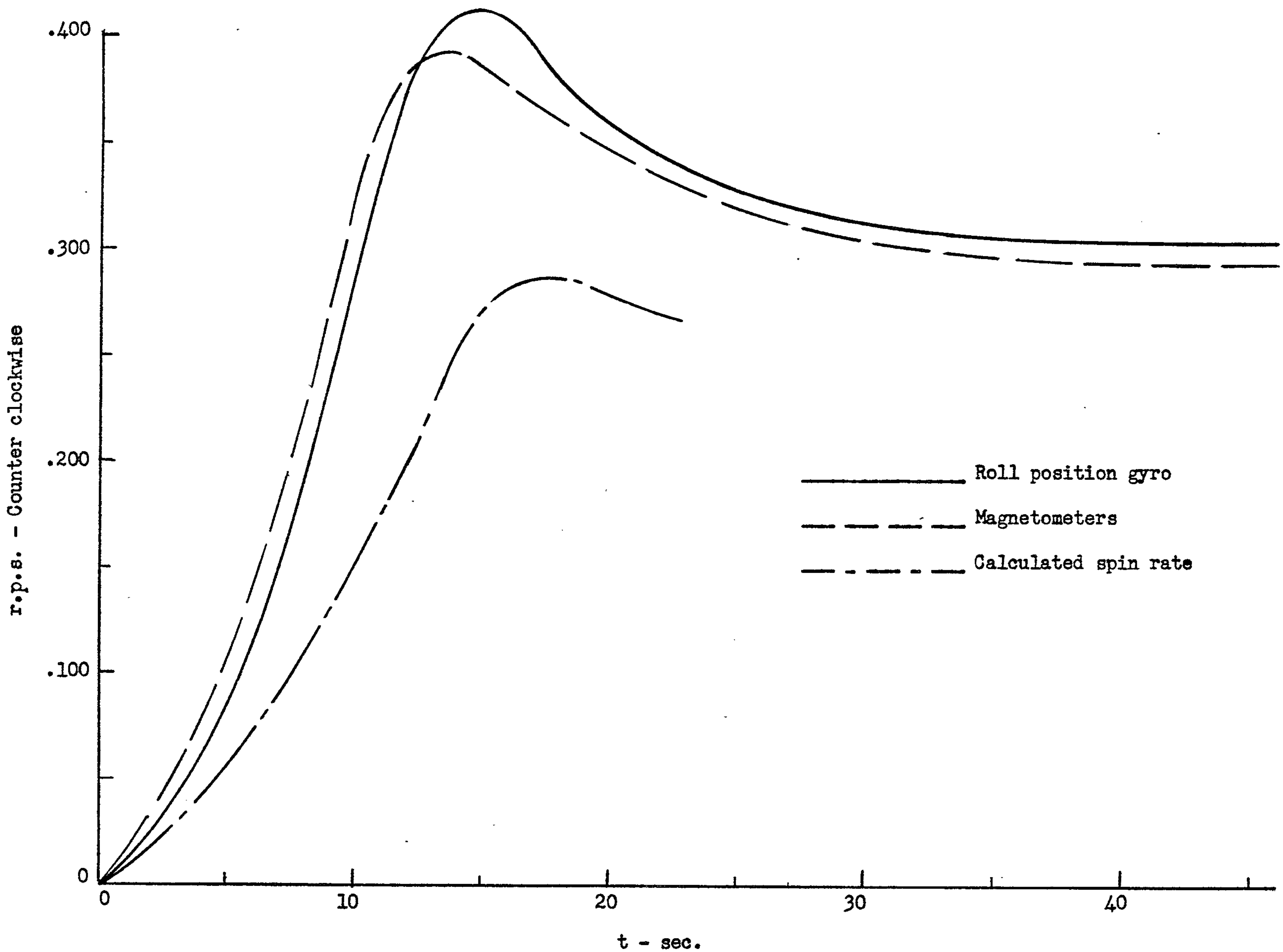
Center of gravity versus time

FIGURE 19



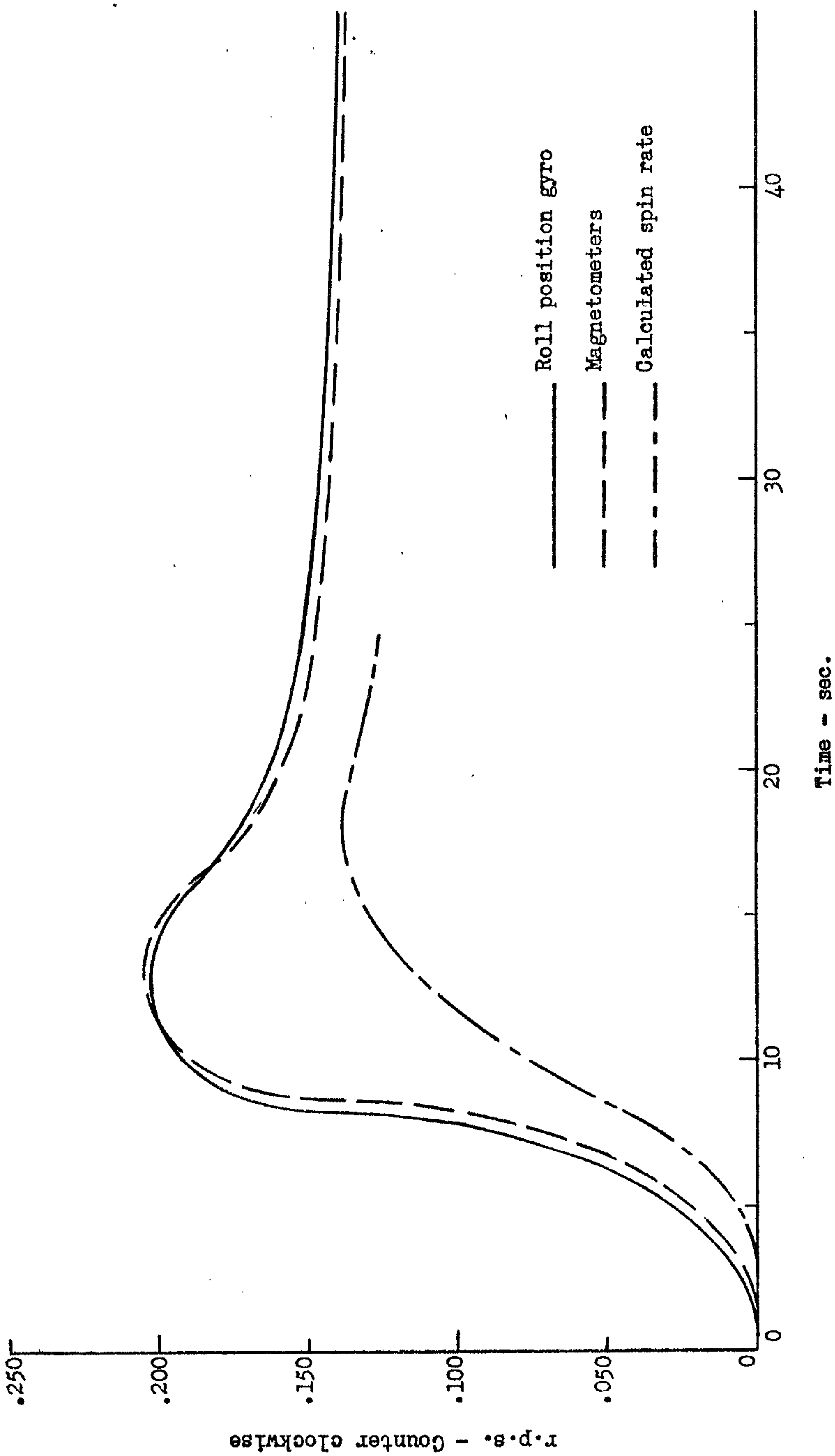
Undamped pitching frequency versus time

FIGURE 20



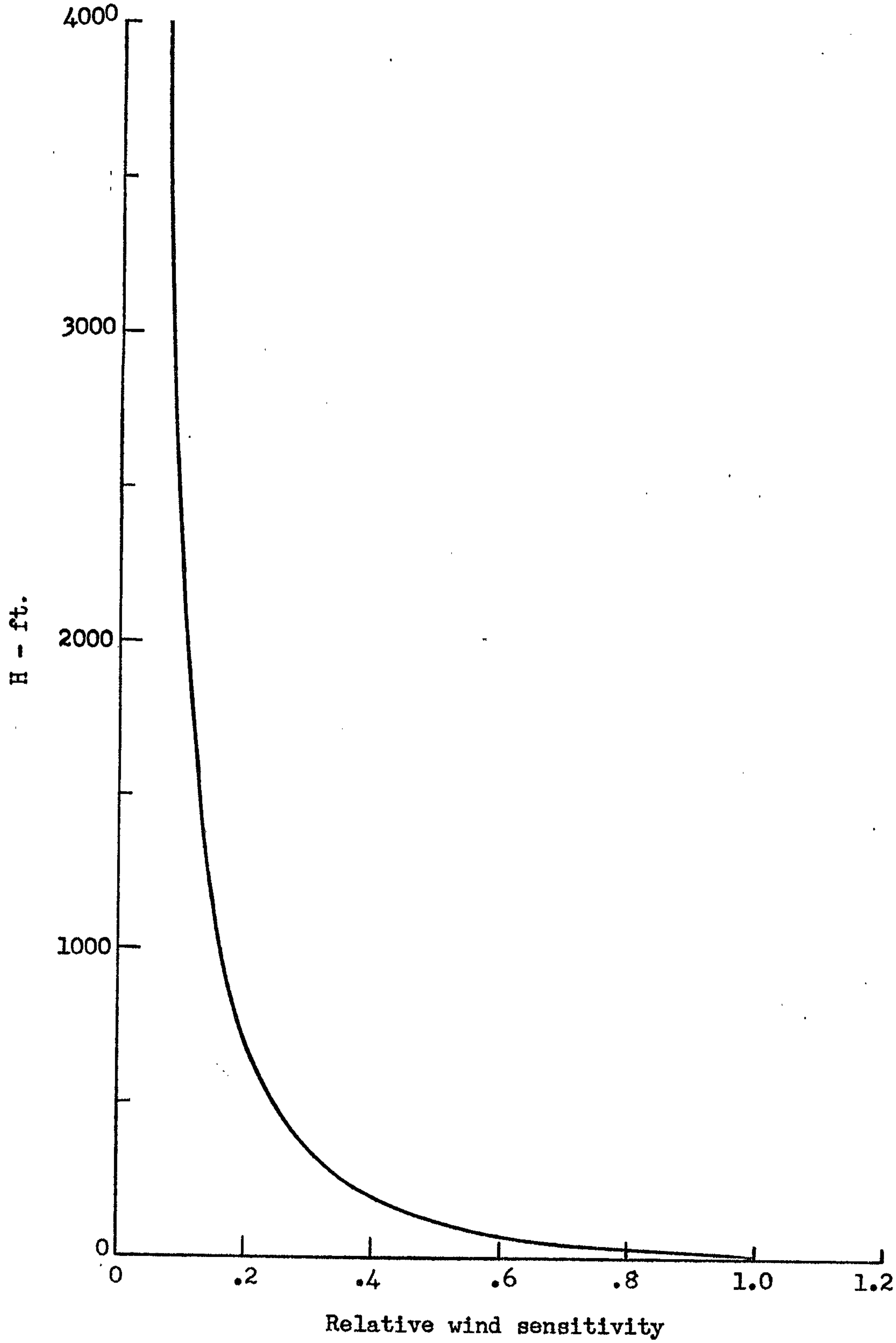
Roll rate history for CC II-17 vehicle.

FIGURE 21



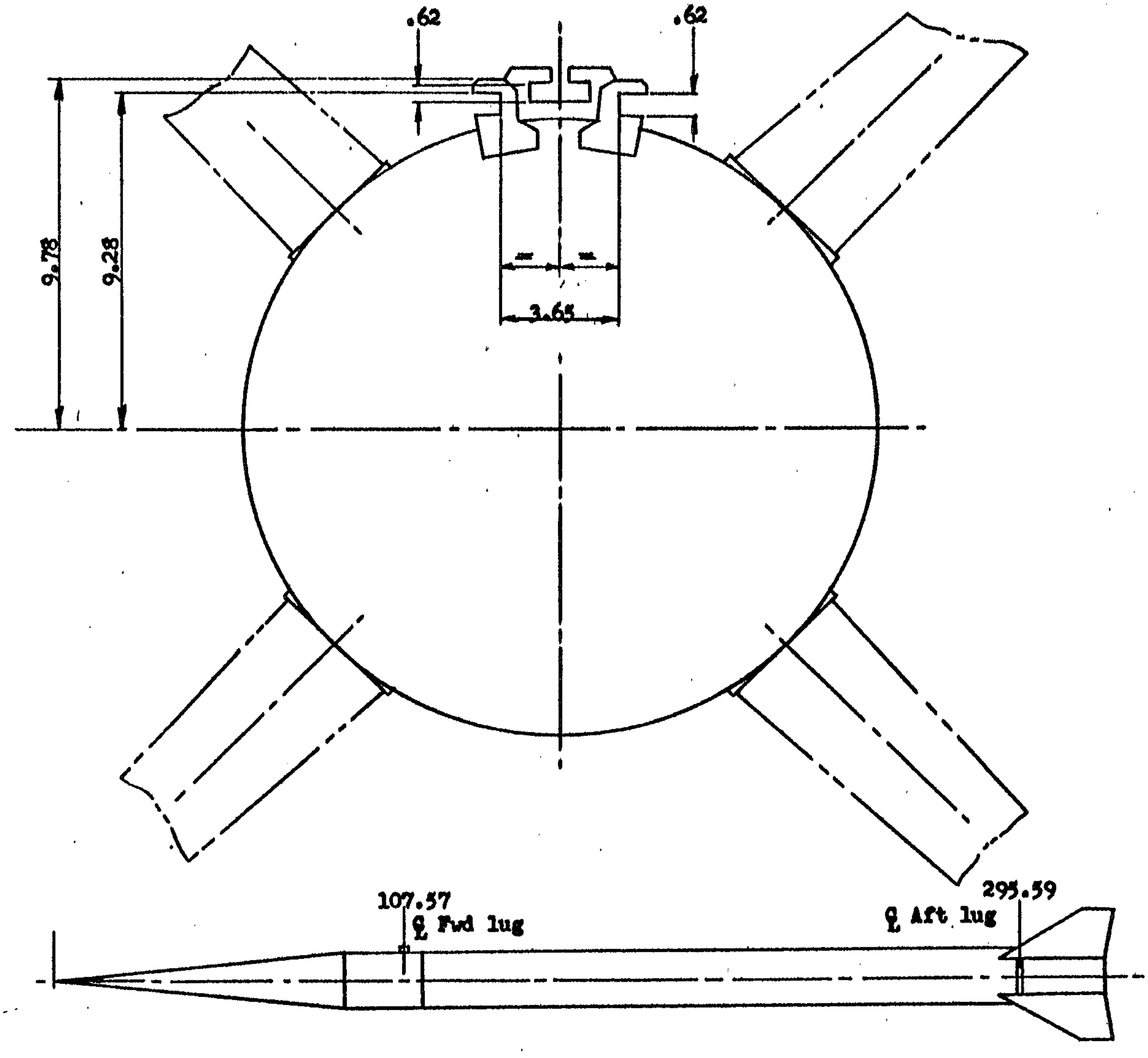
Roll rate history for CC II-18 vehicle.

FIGURE 22



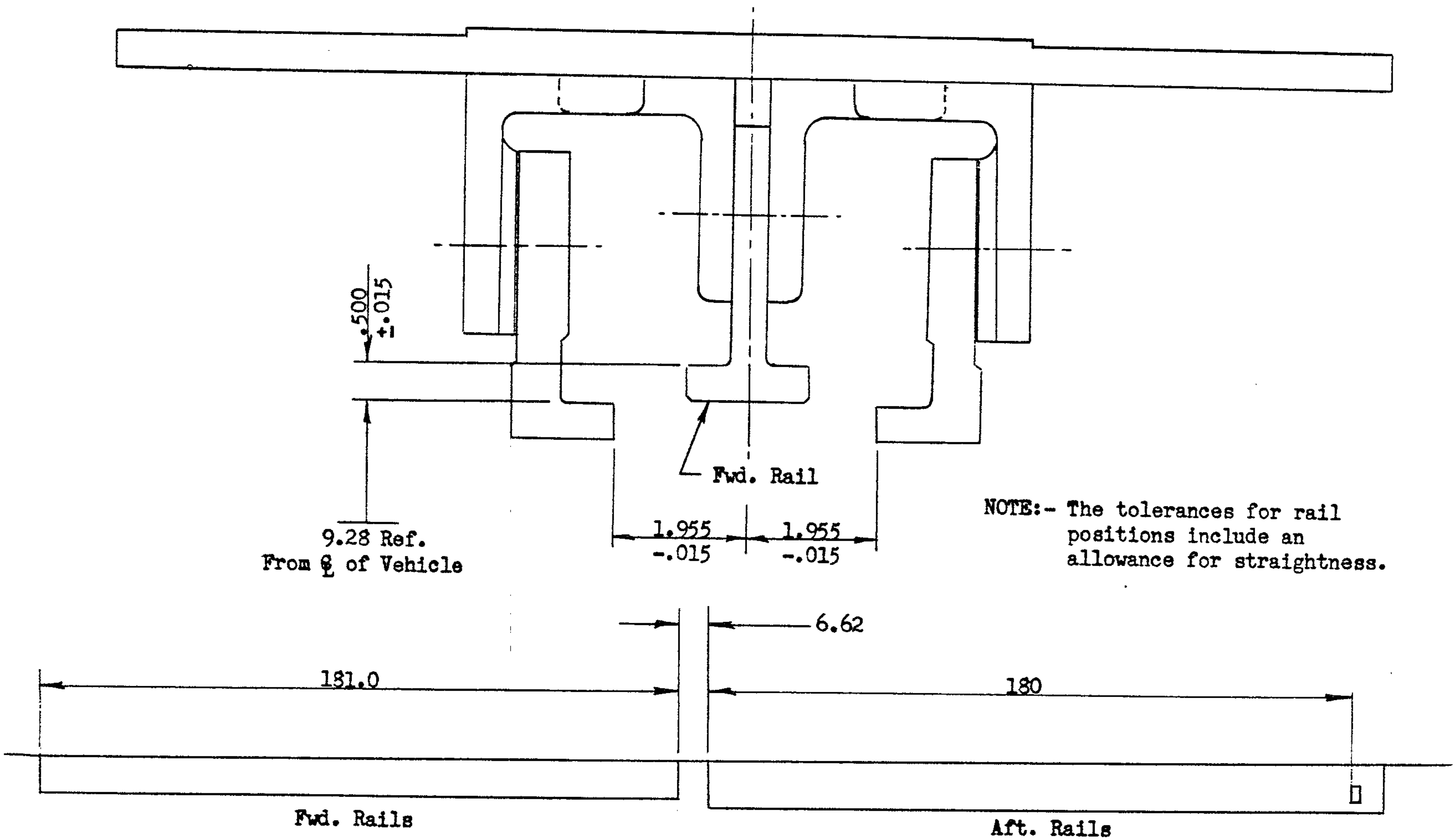
Vehicle relative wind sensitivity versus altitude

FIGURE 23



Layout of launcher lugs

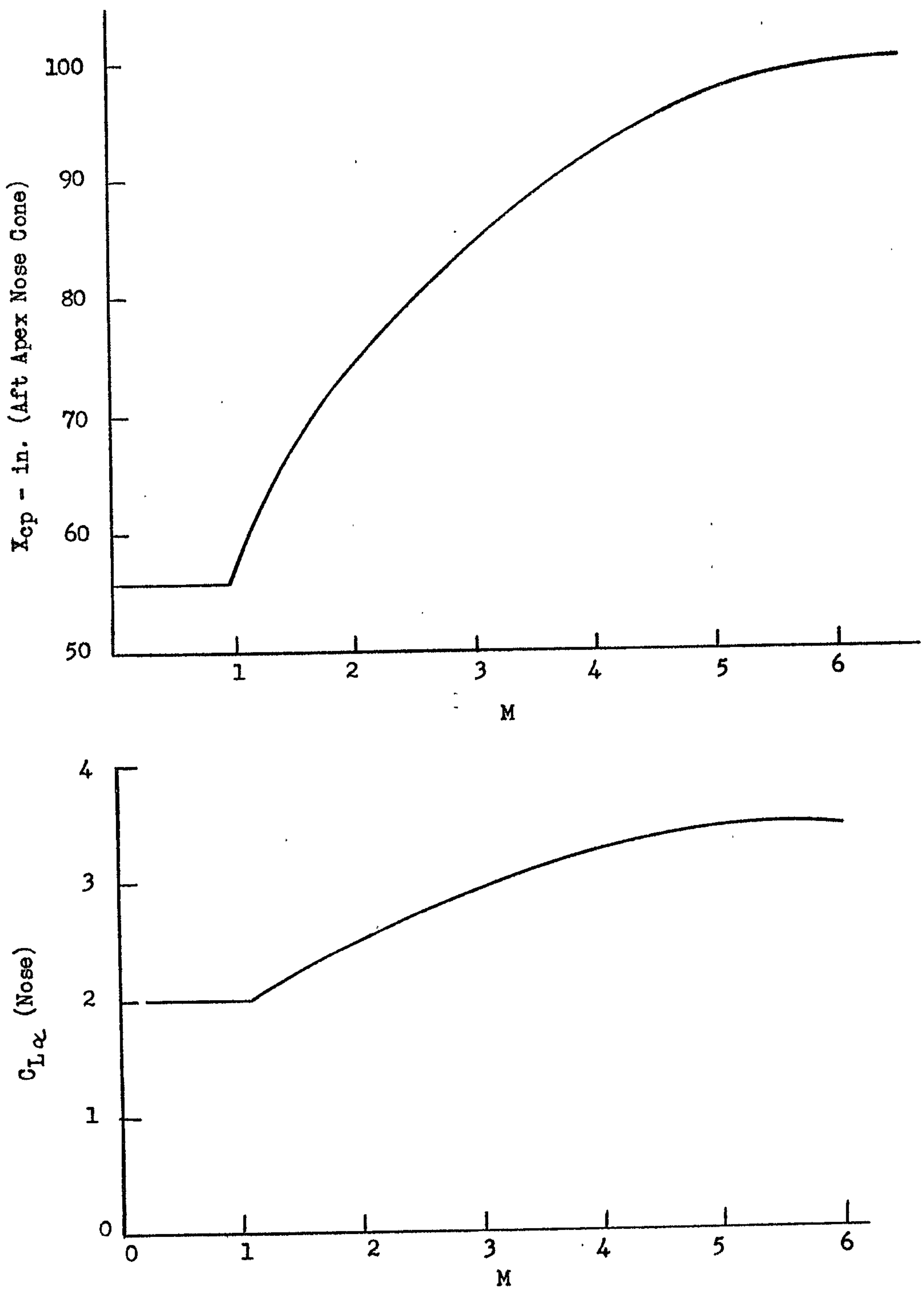
FIGURE 24



Rail positions for zero tip-off

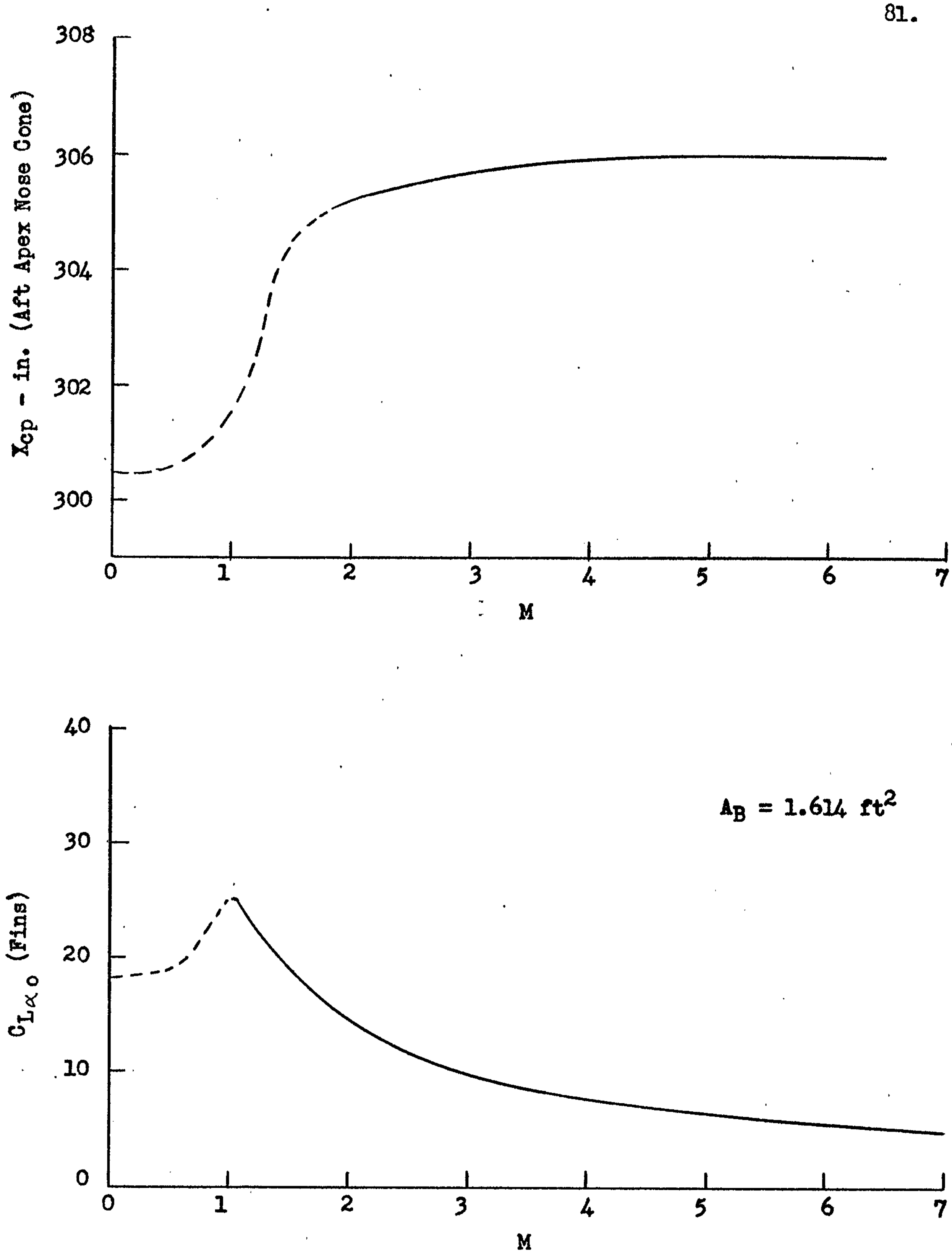
Launcher rails layout and alignment

FIGURE 25



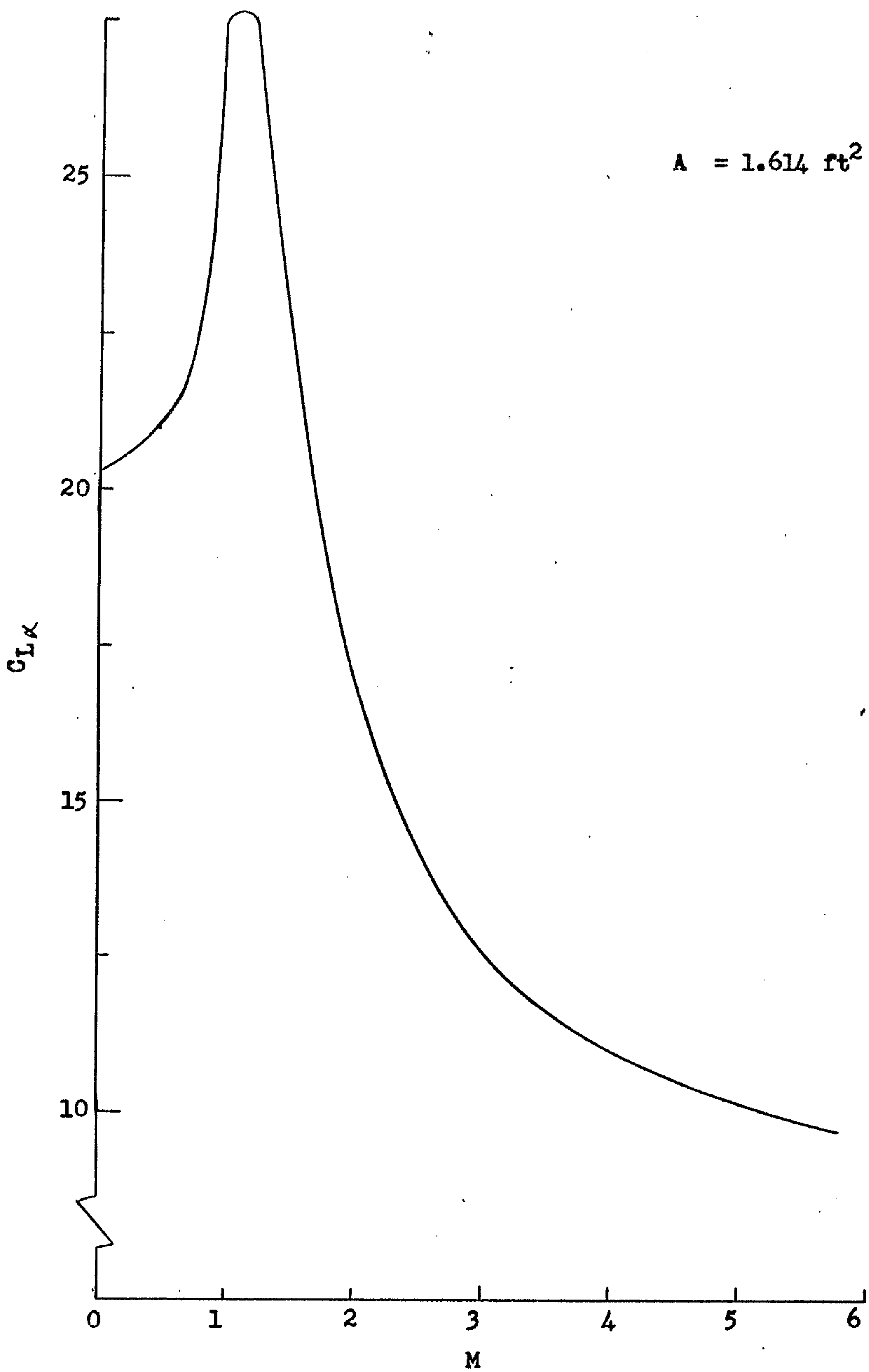
Nose and body zero lift curve slope and center of pressure versus Mach No.

FIGURE 26



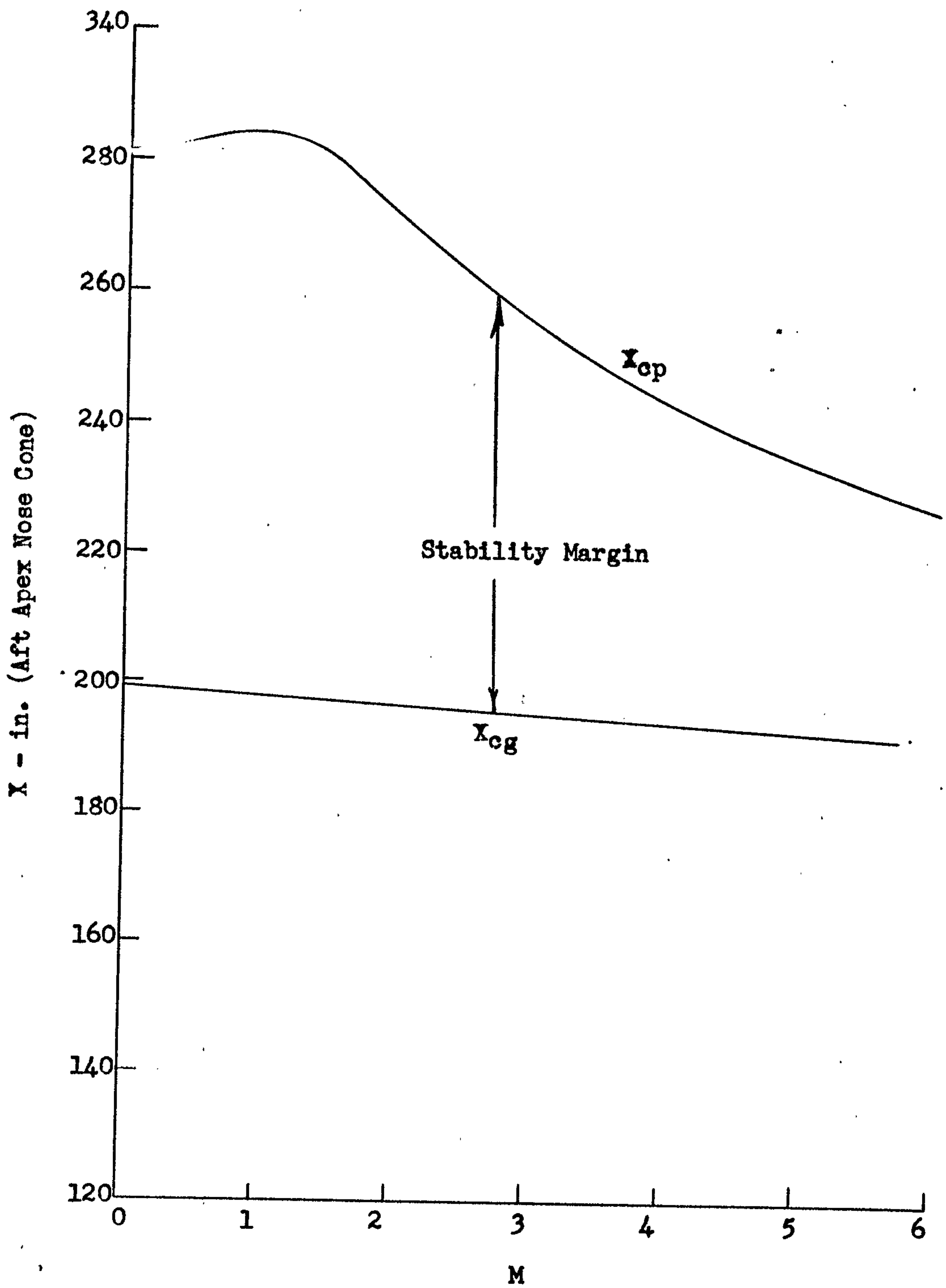
Fins zero lift curve slope and center of pressure versus Mach No.

FIGURE 27



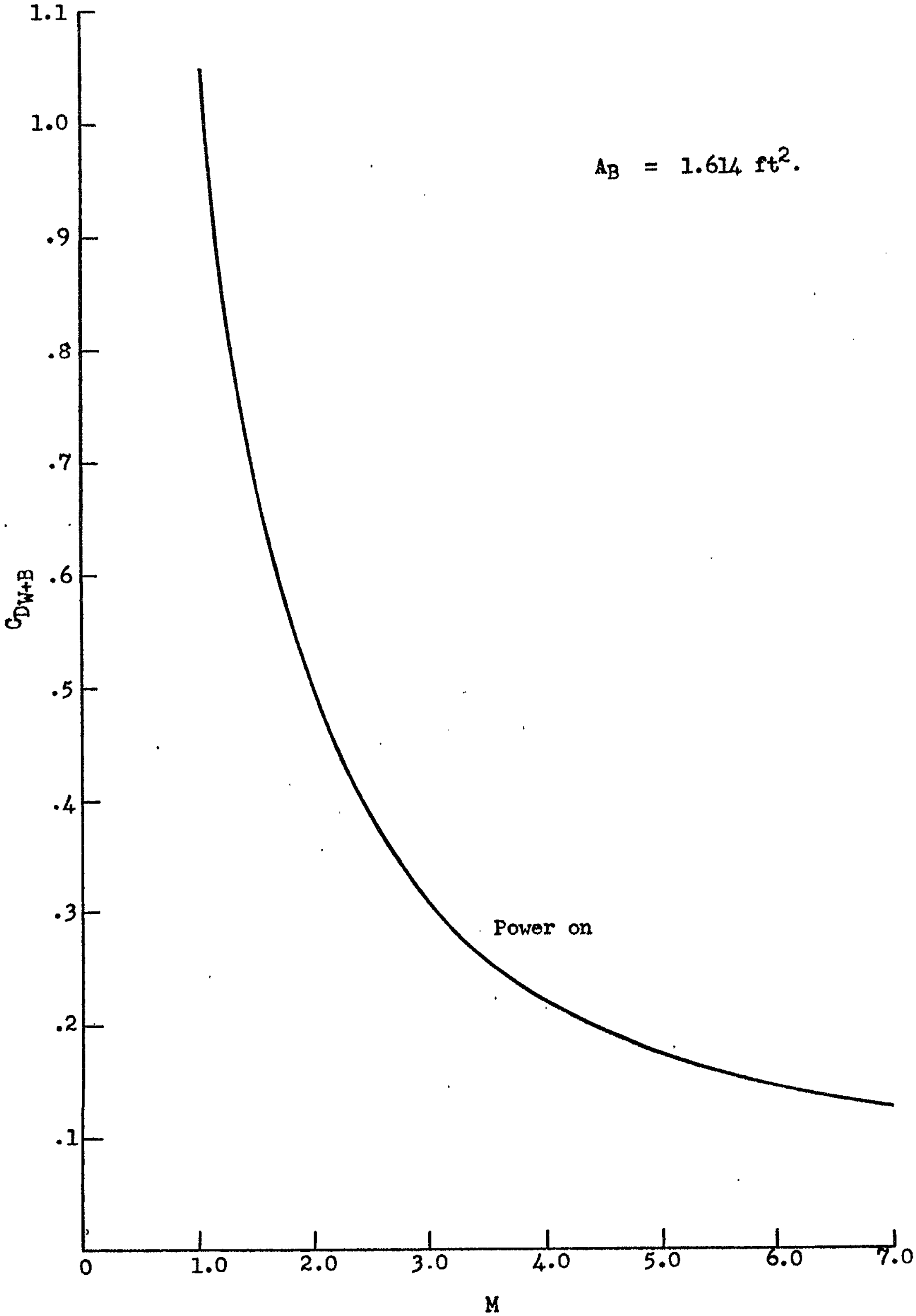
Zero lift curve slope for the complete vehicle versus Mach No.

FIGURE 28



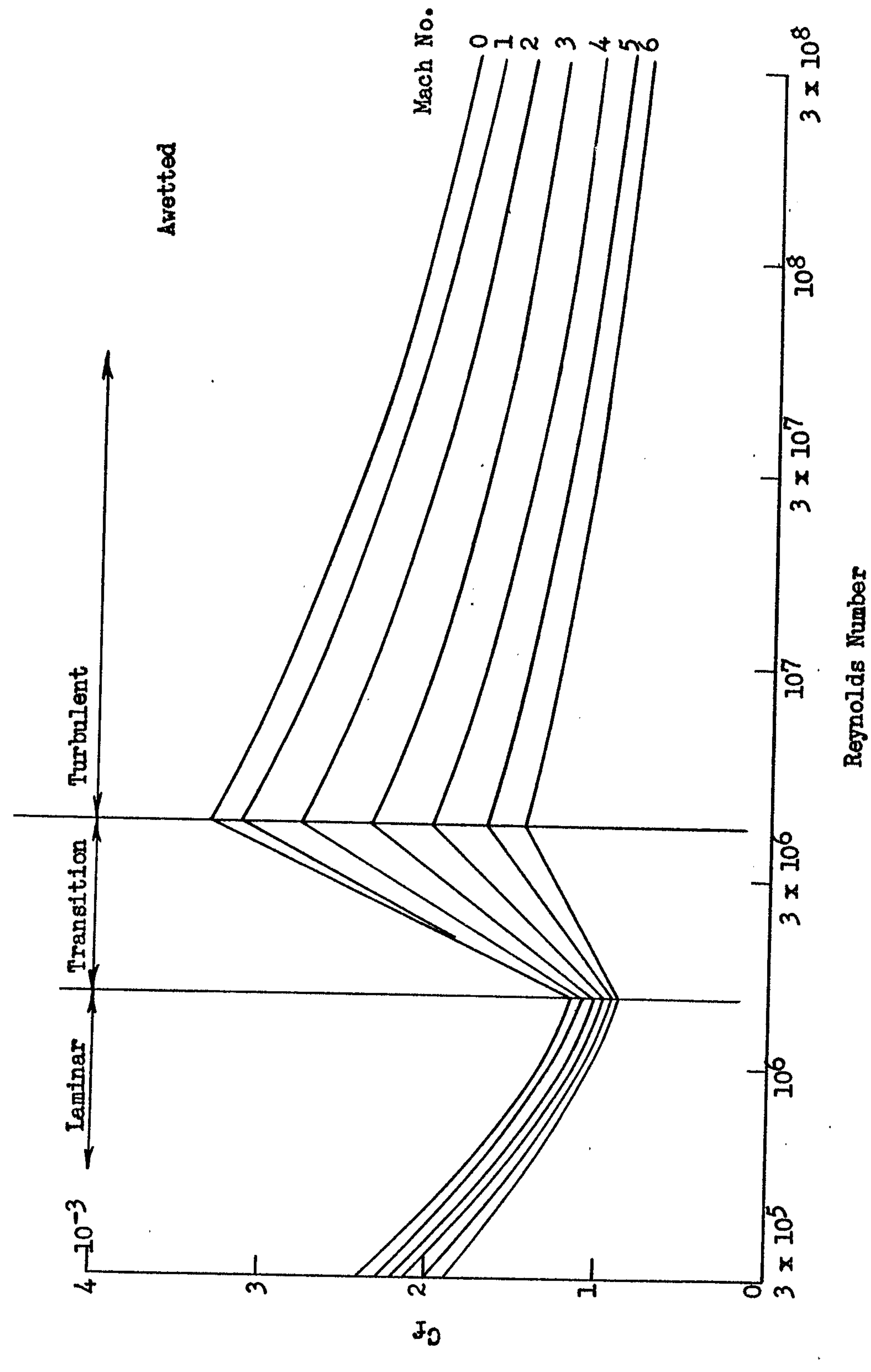
Static stability margin versus Mach No.

FIGURE 29



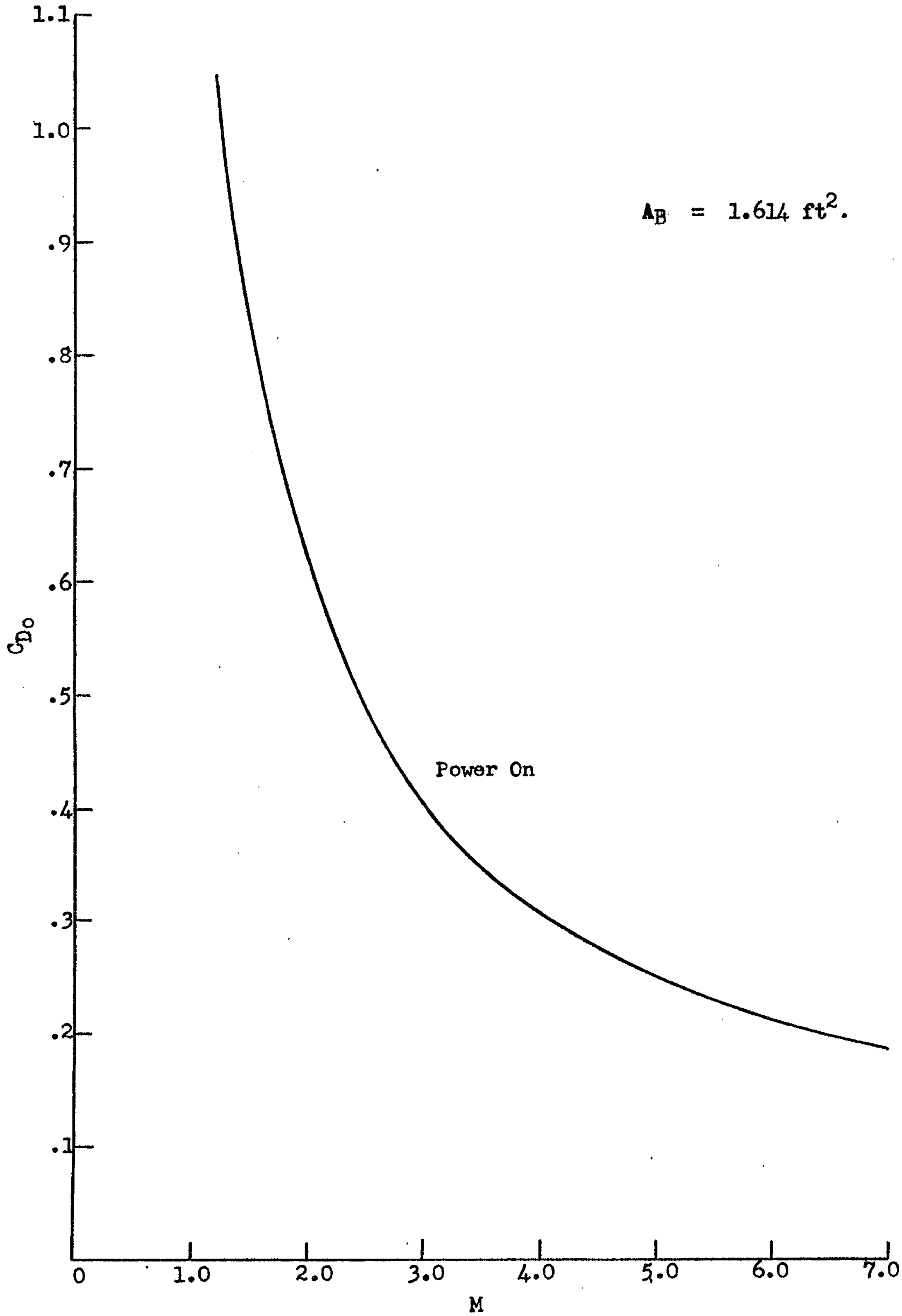
Wave and base drag coefficient versus Mach No.

FIGURE 30



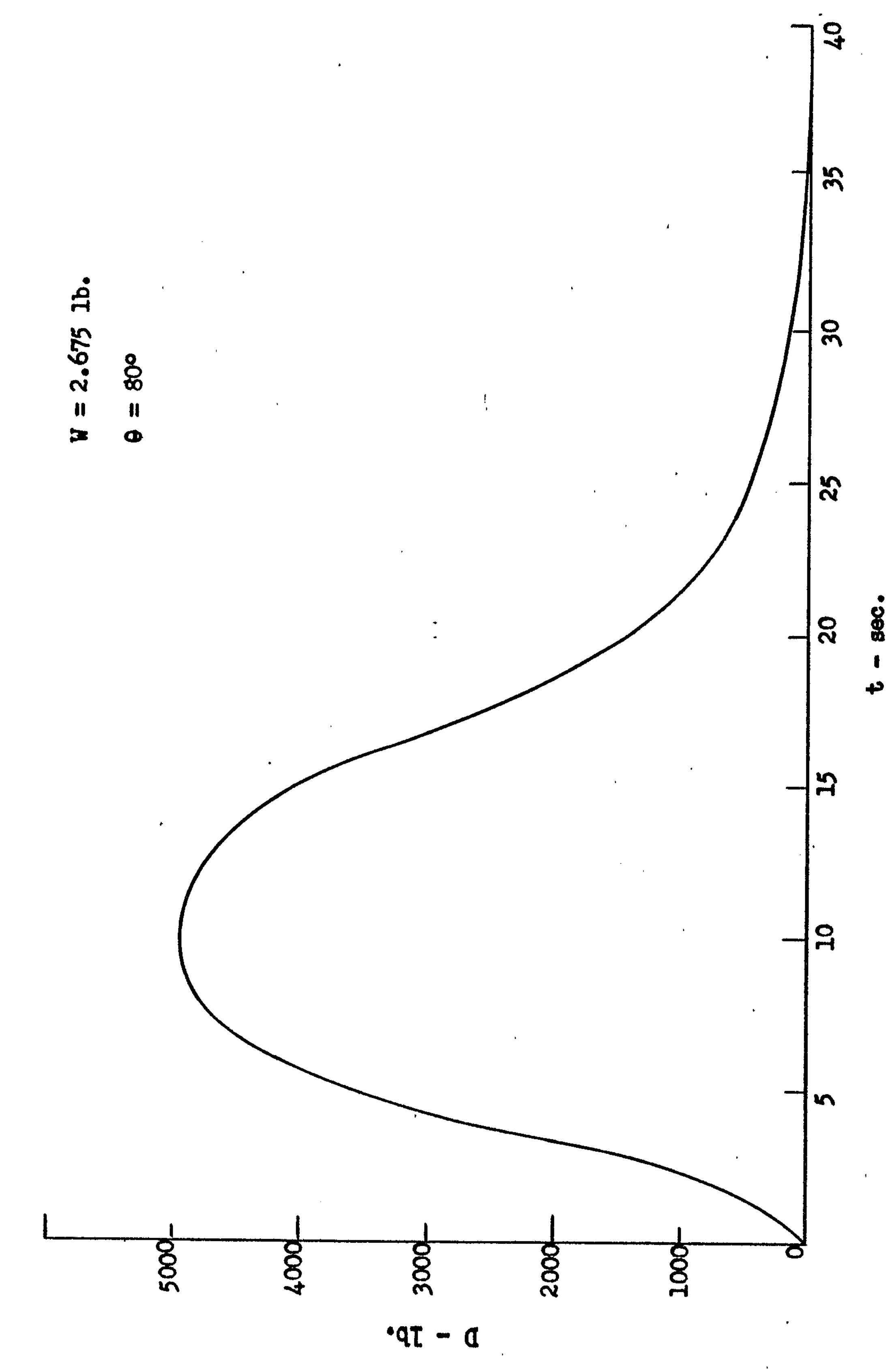
Skin friction coefficient as a function of Reynolds No. and Mach No.

FIGURE 31



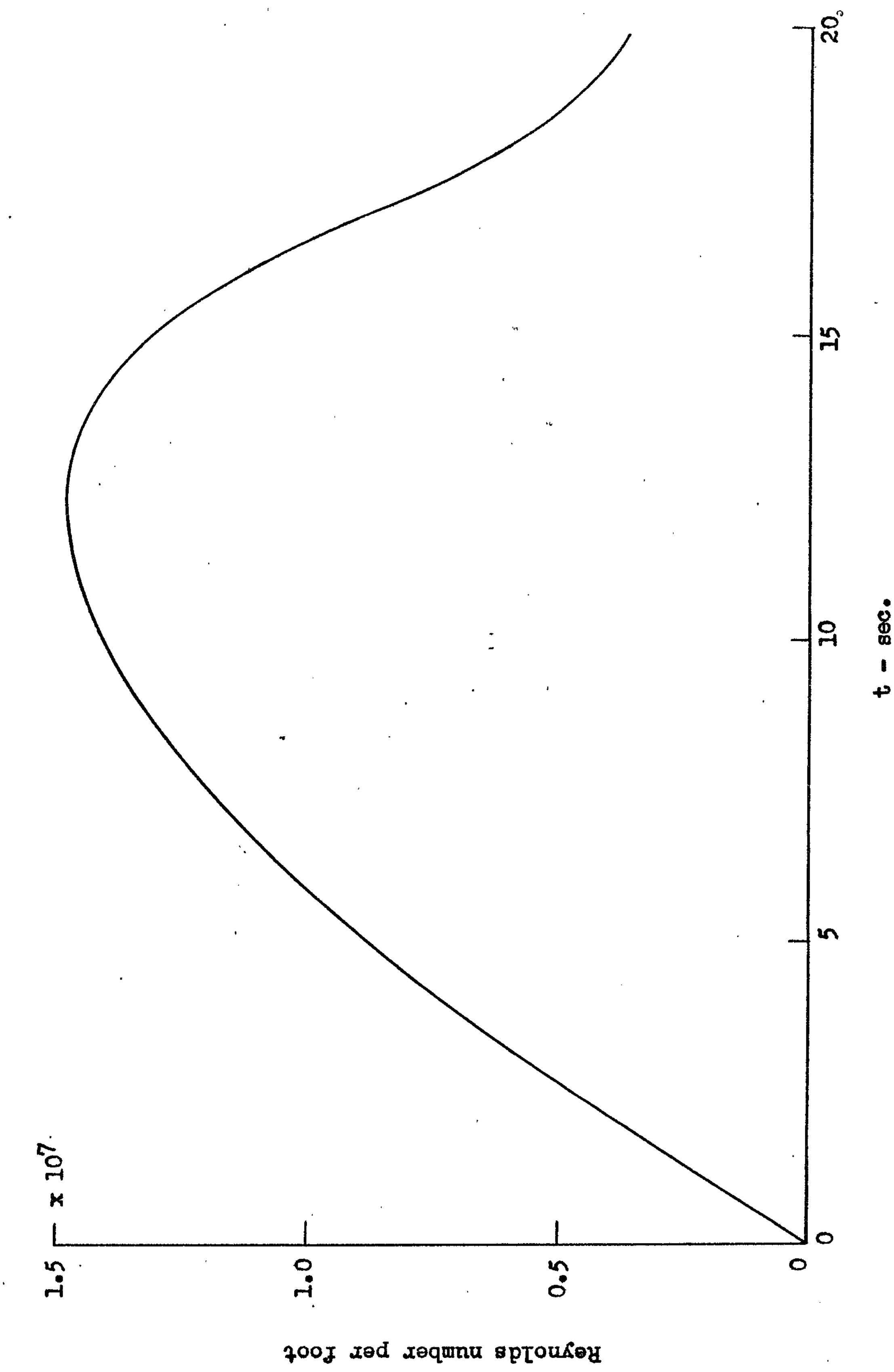
Zero lift drag coefficient versus Mach No.

FIGURE 32



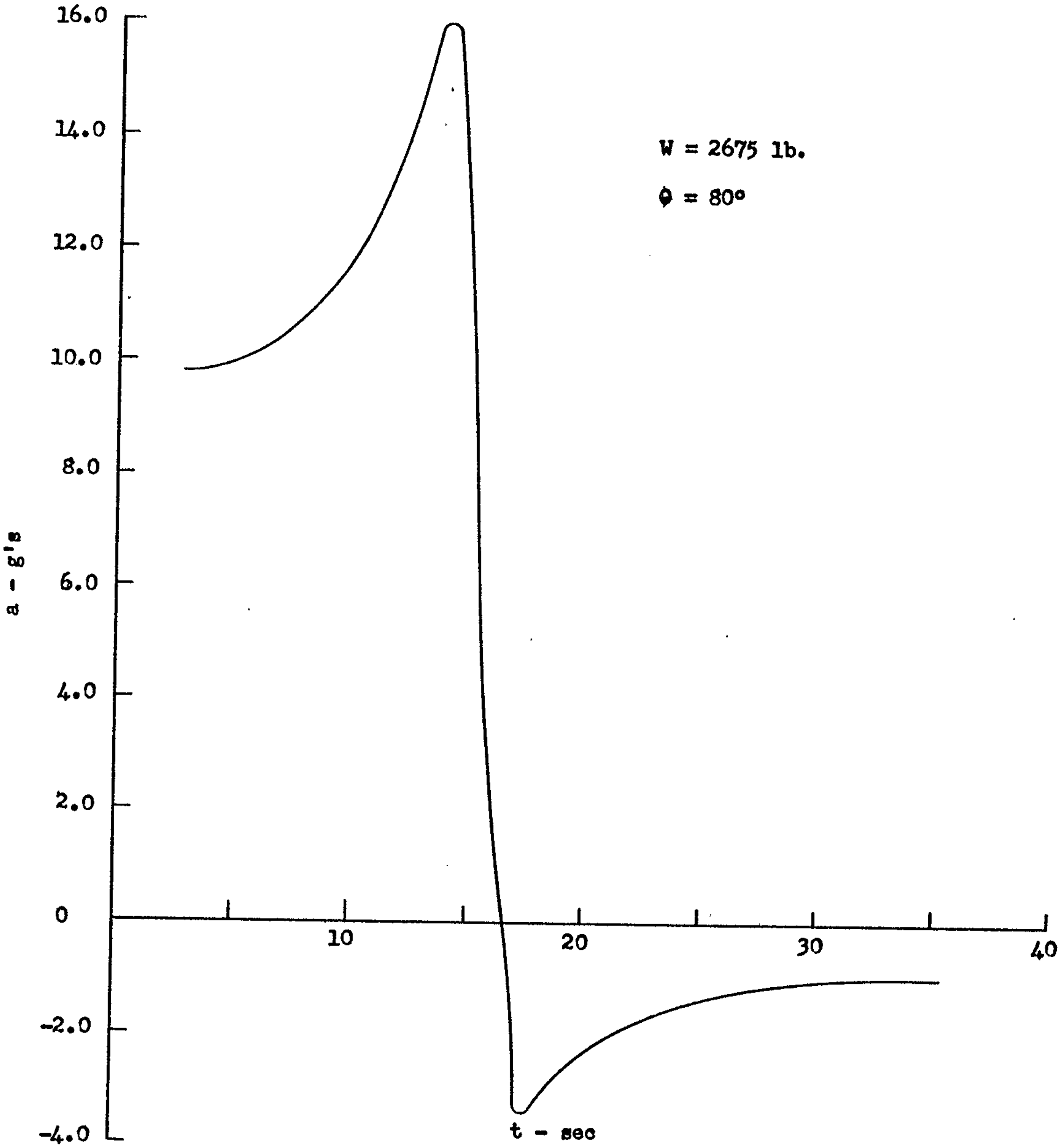
Drag versus time

FIGURE 33



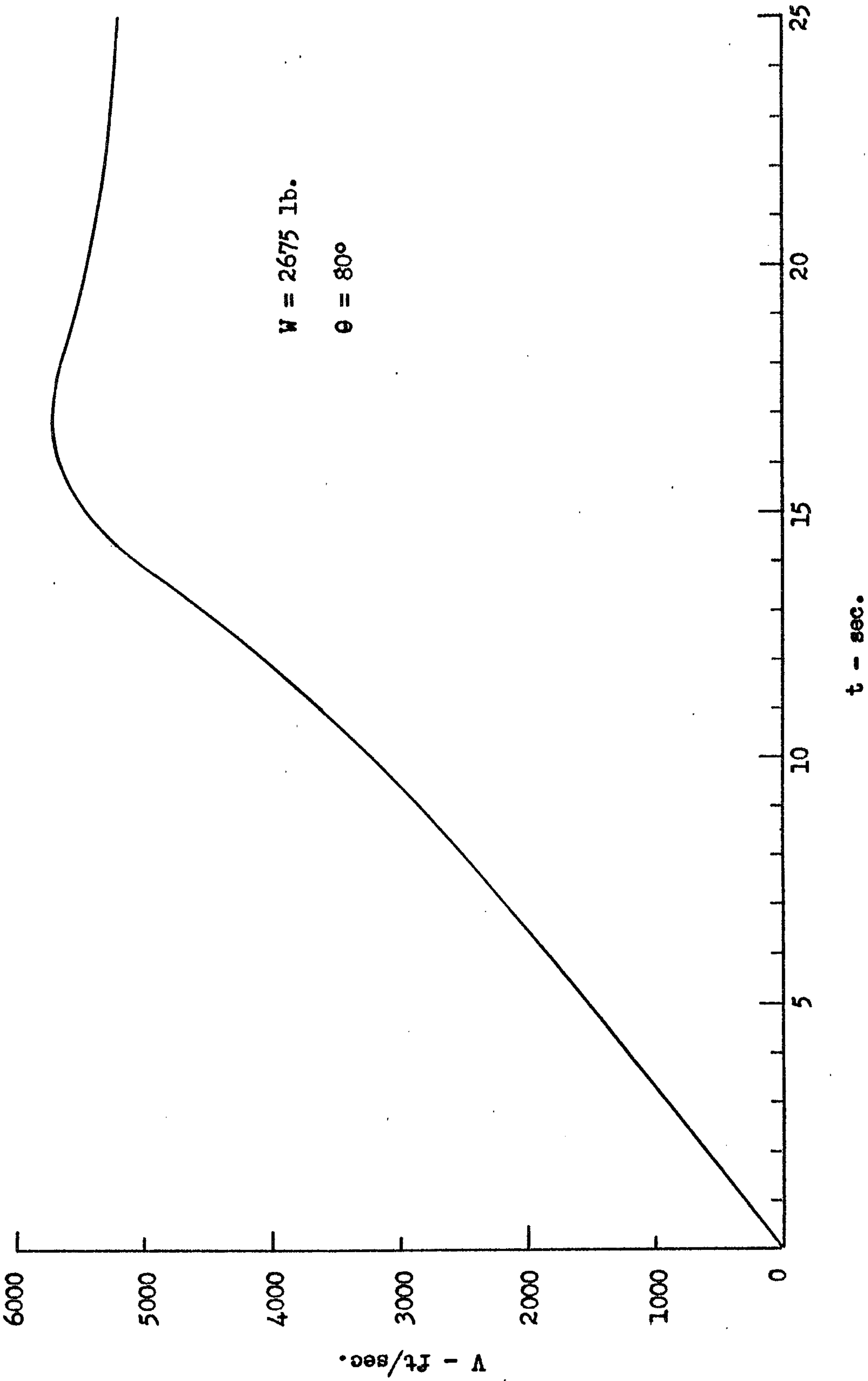
Reynolds No. per foot versus time.

FIGURE 34



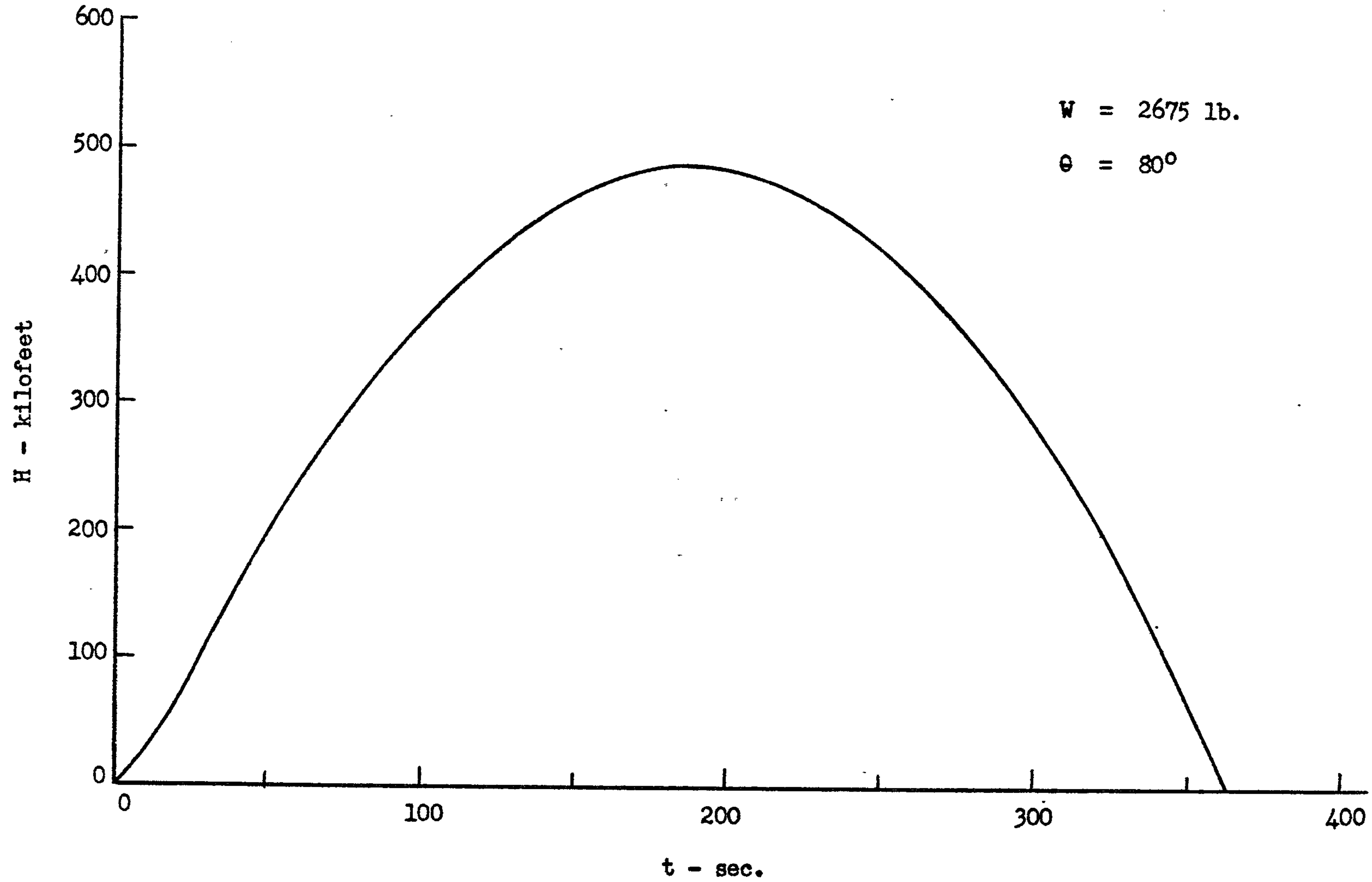
Calculated acceleration versus time

FIGURE 35



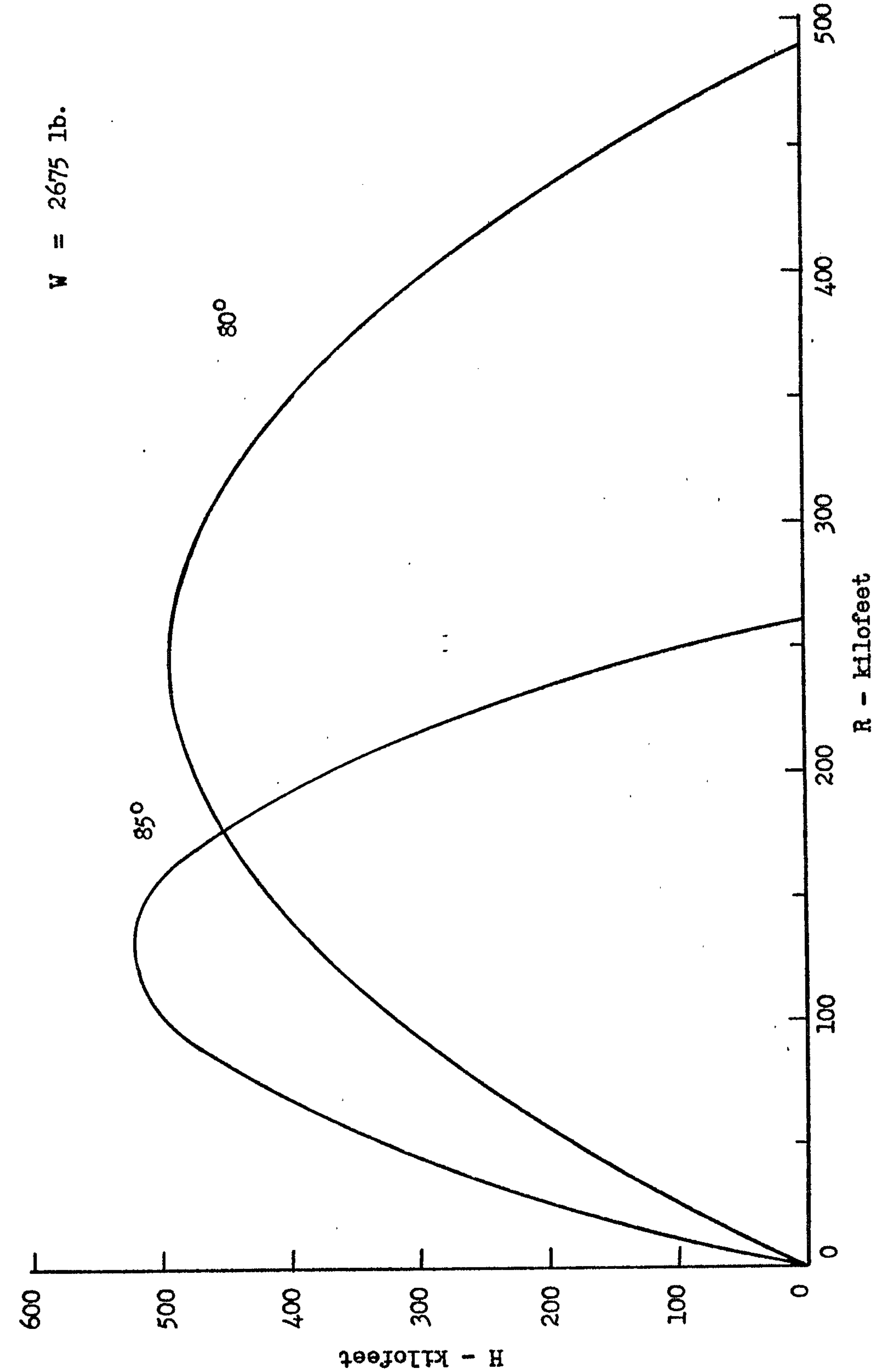
Calculated velocity versus time

FIGURE 36



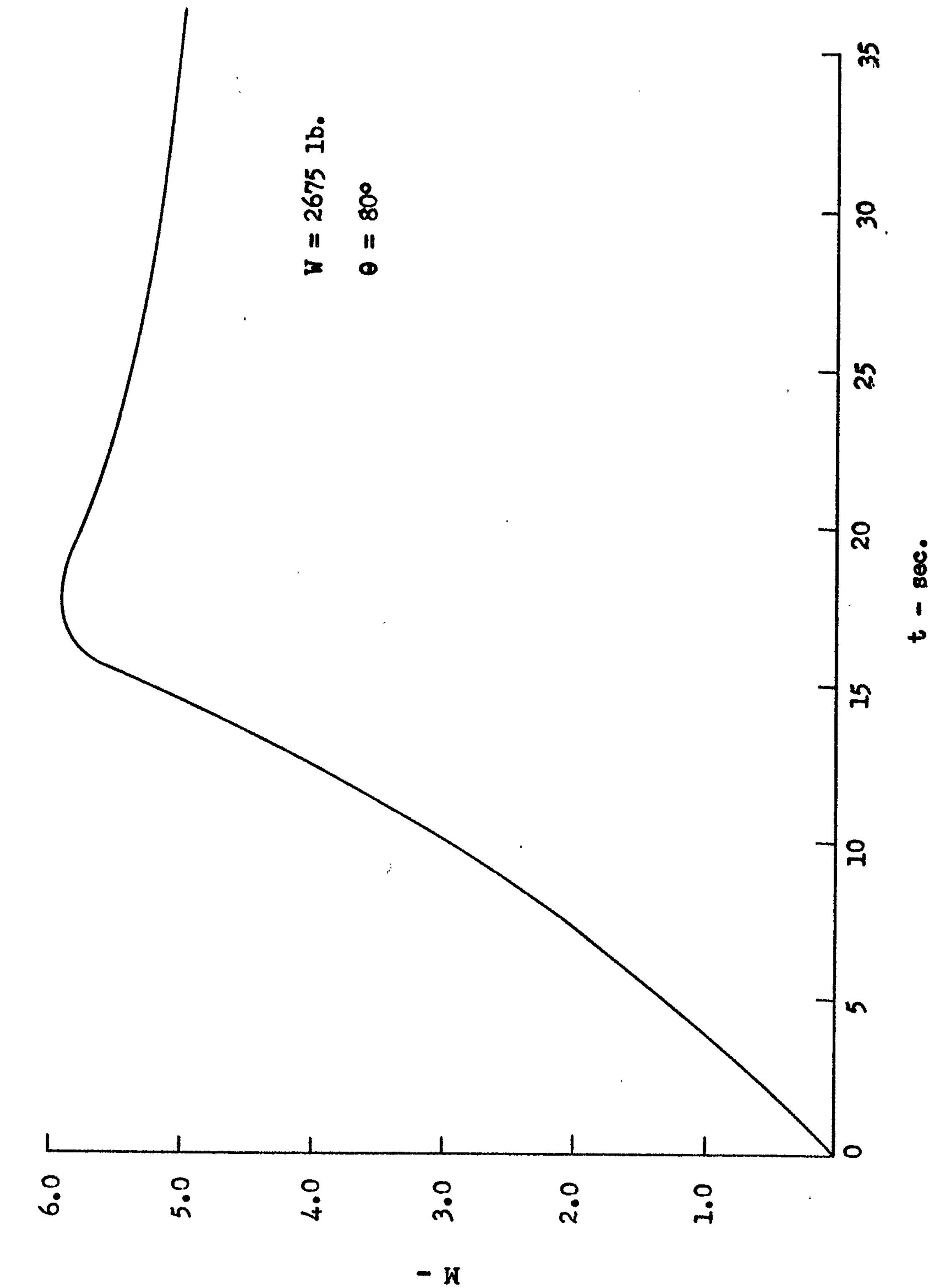
Calculated altitude versus time

FIGURE 37



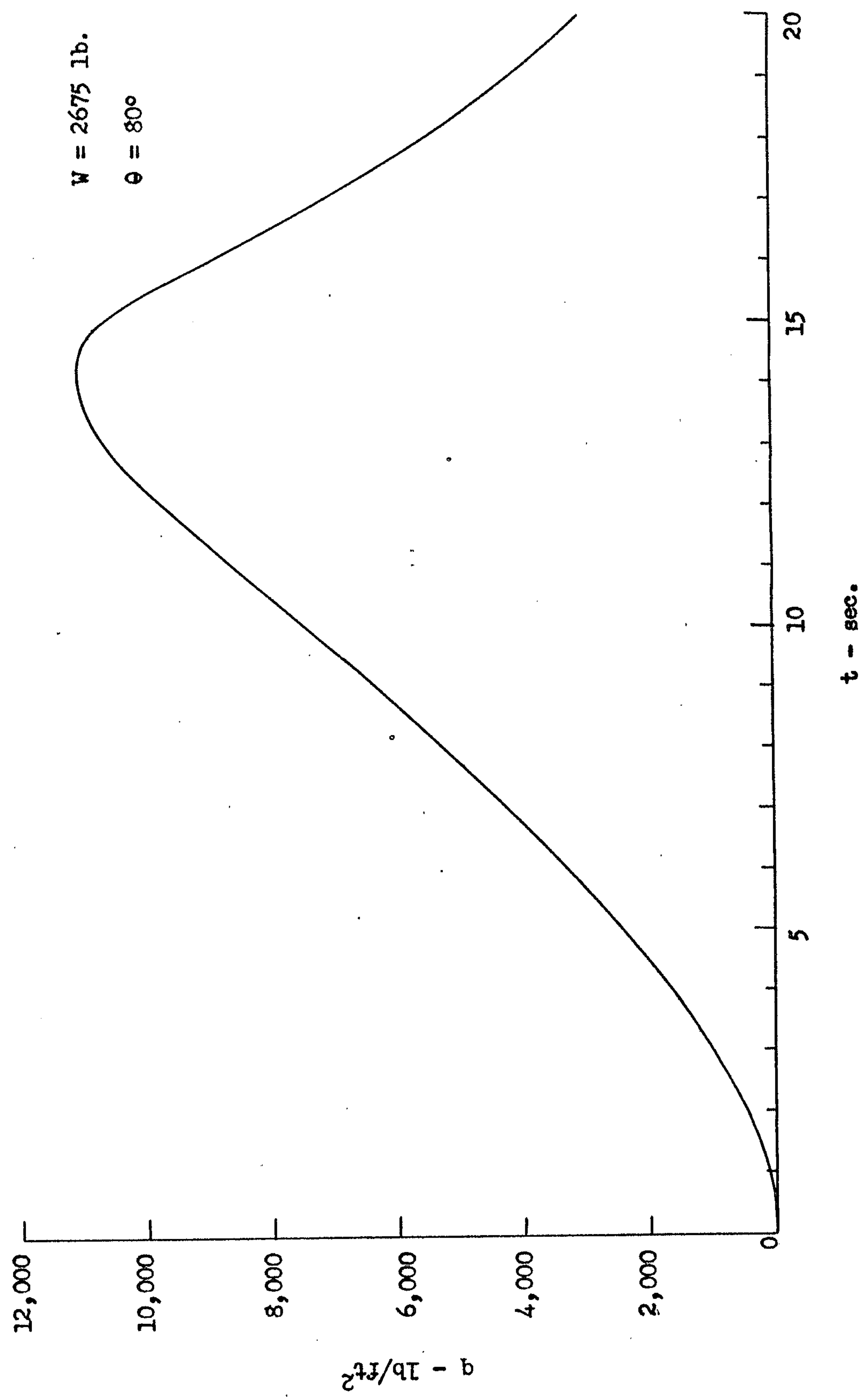
Calculated altitude versus range

FIGURE 38



Calculated Mach No. versus time

FIGURE 39



Dynamic pressure versus time

FIGURE 40

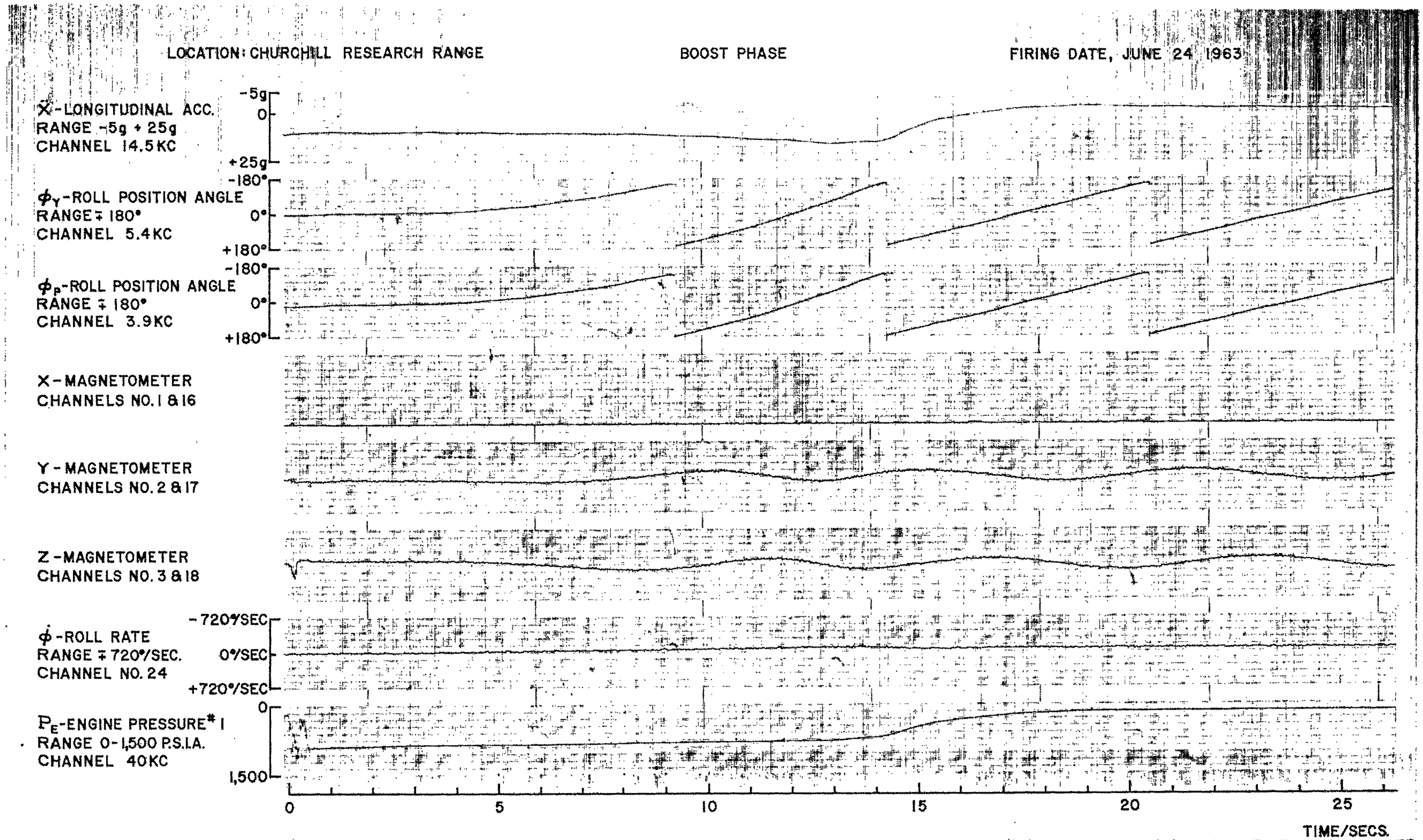


FIGURE 41 - Telemetry flight-test records for CC II-18 boost phase

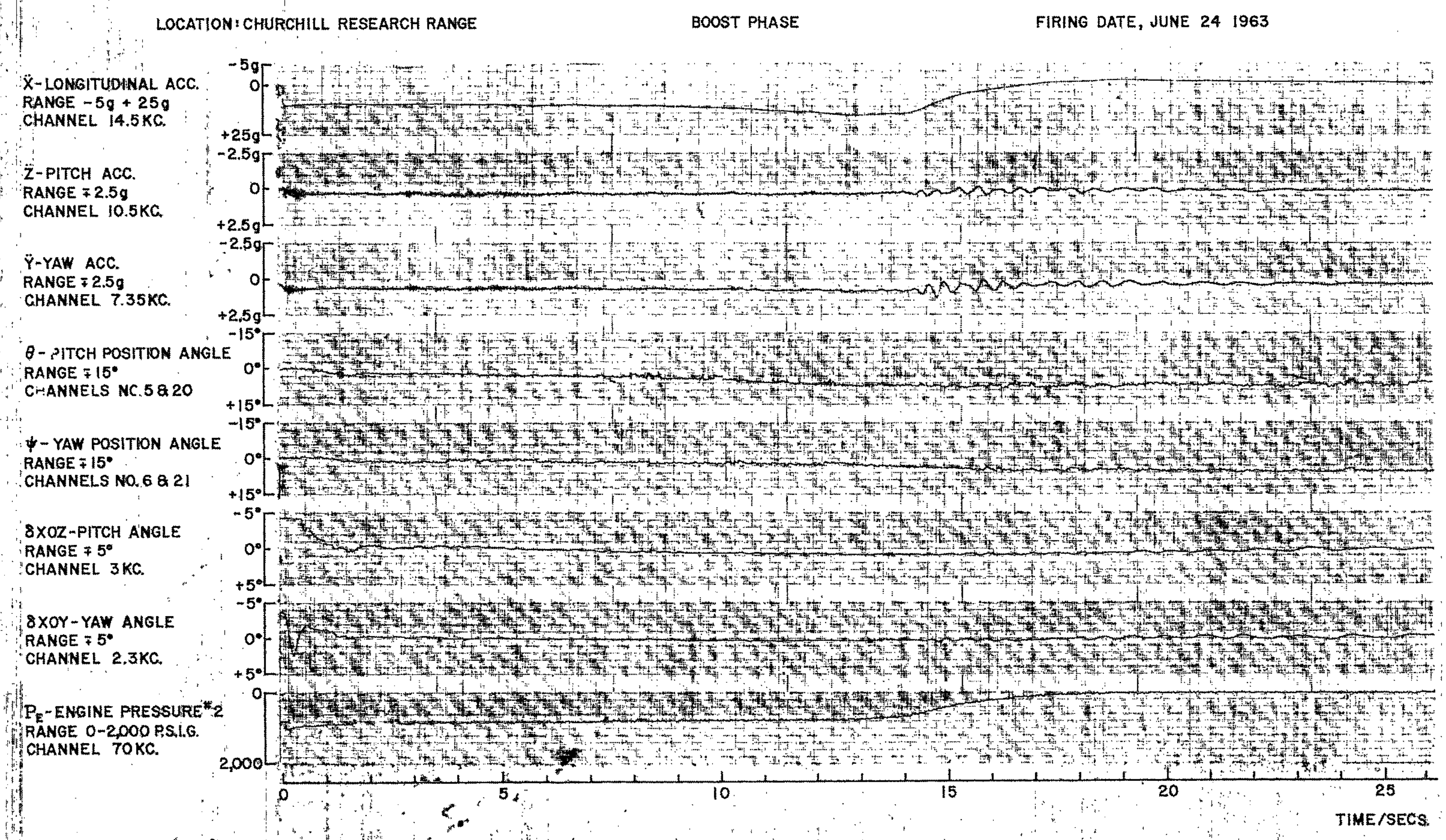


FIGURE 42 - Telemetry flight-test records for CC II-18 boost phase

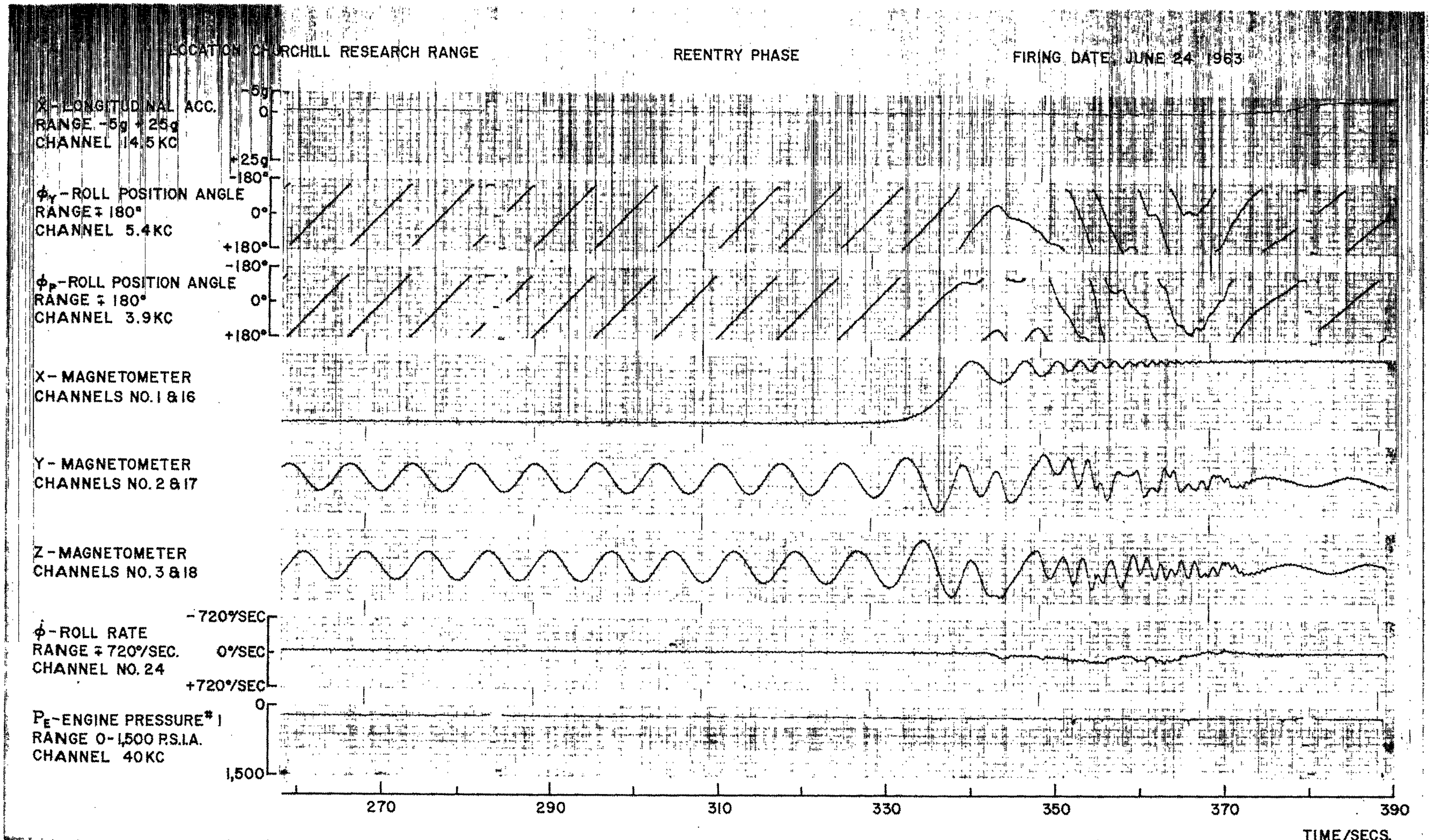


FIGURE 43 - Telemetry Flight-test records for CC II-18 reentry phase

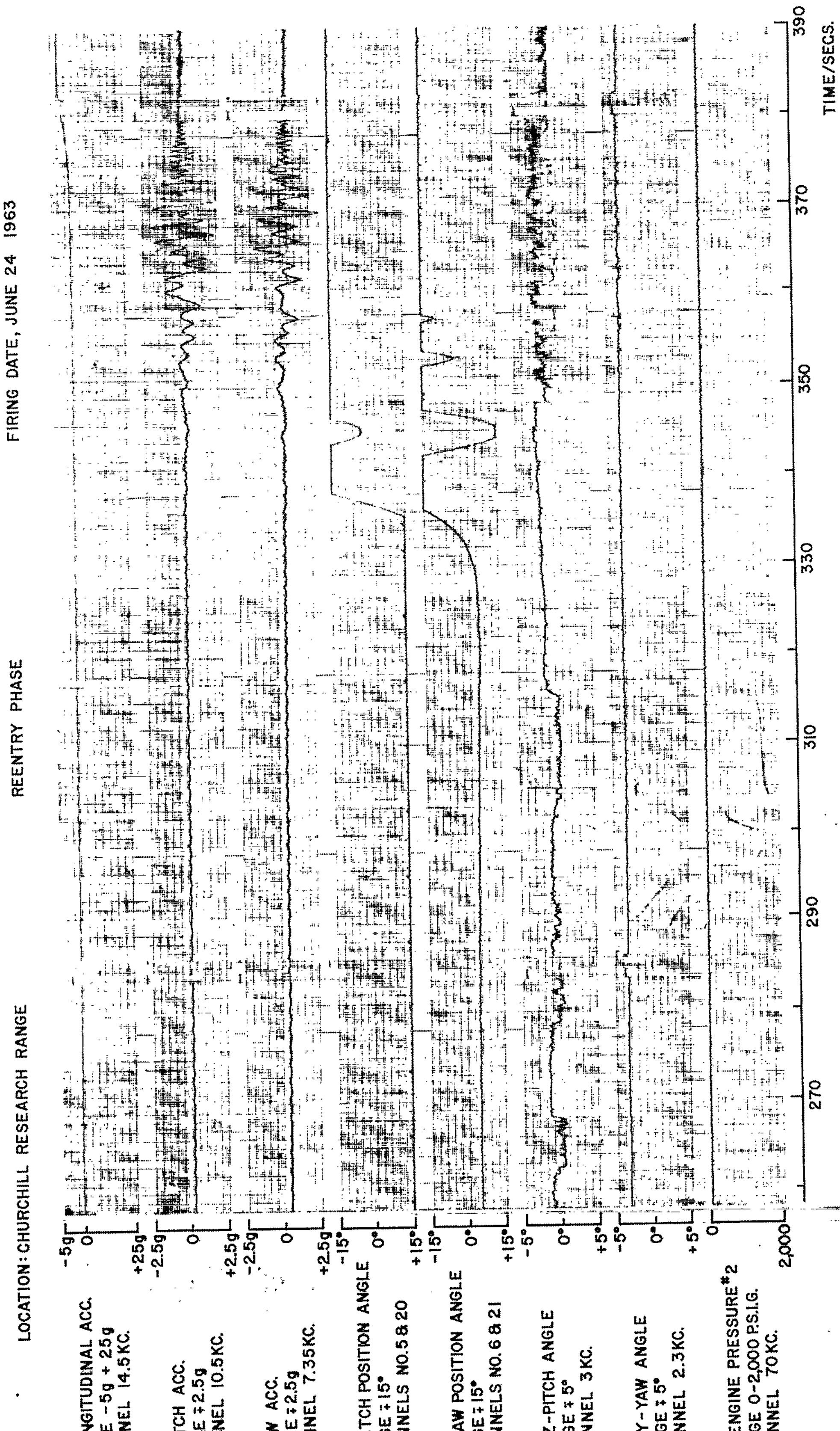
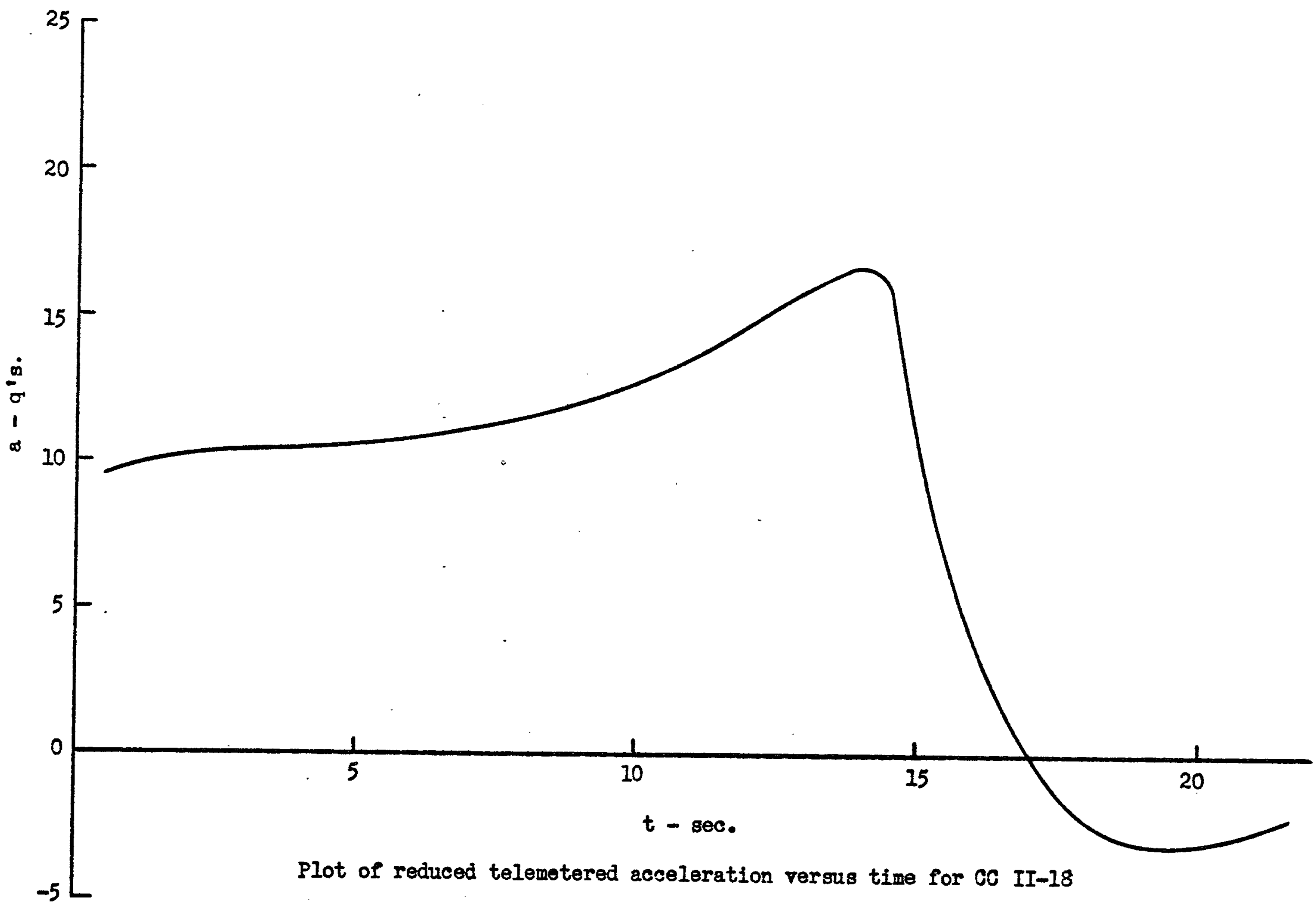
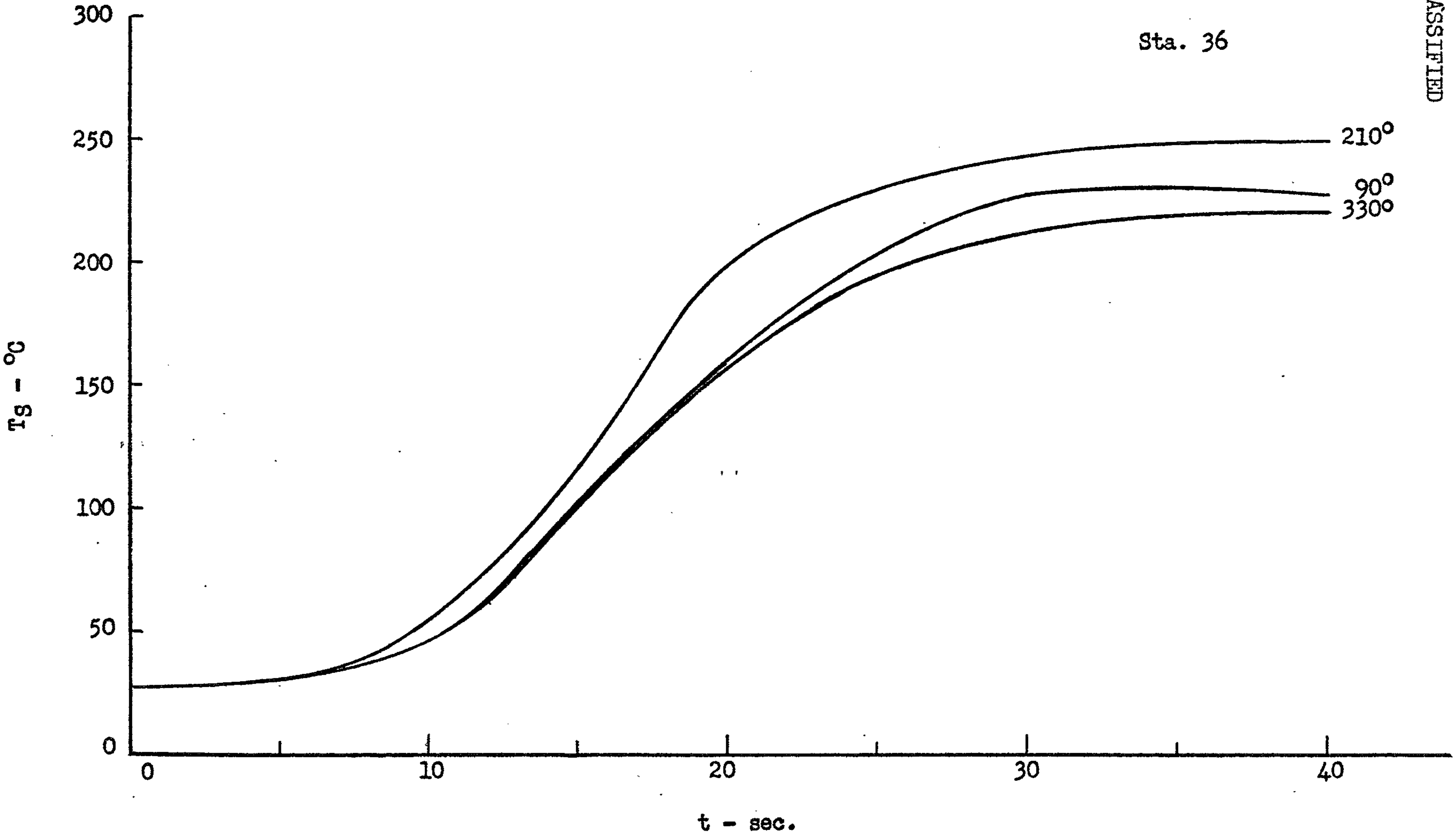


FIGURE 44 - Telemetry flight-test records for CC II-18 reentry phase



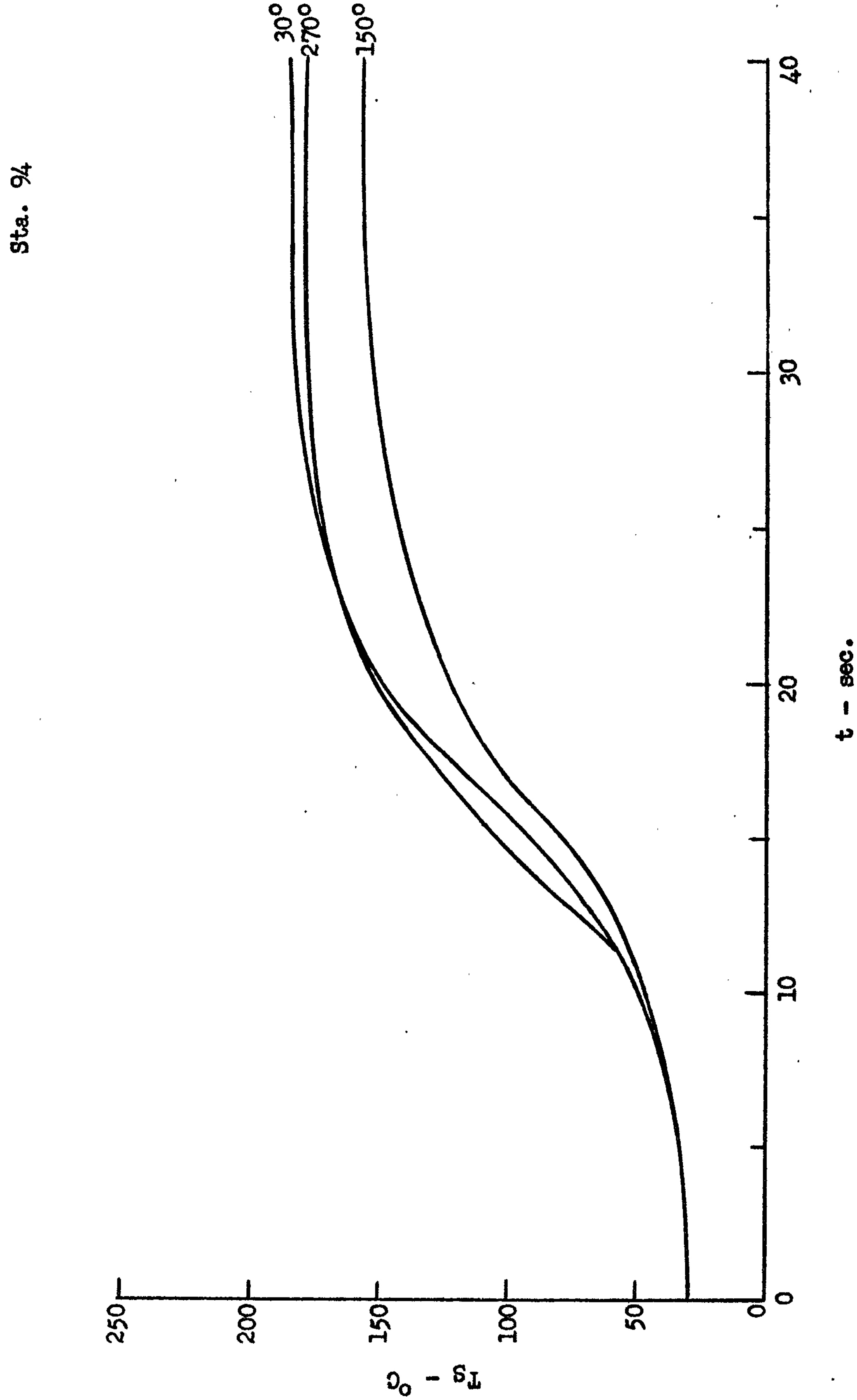
Plot of reduced telemetered acceleration versus time for CC II-18

FIGURE 45



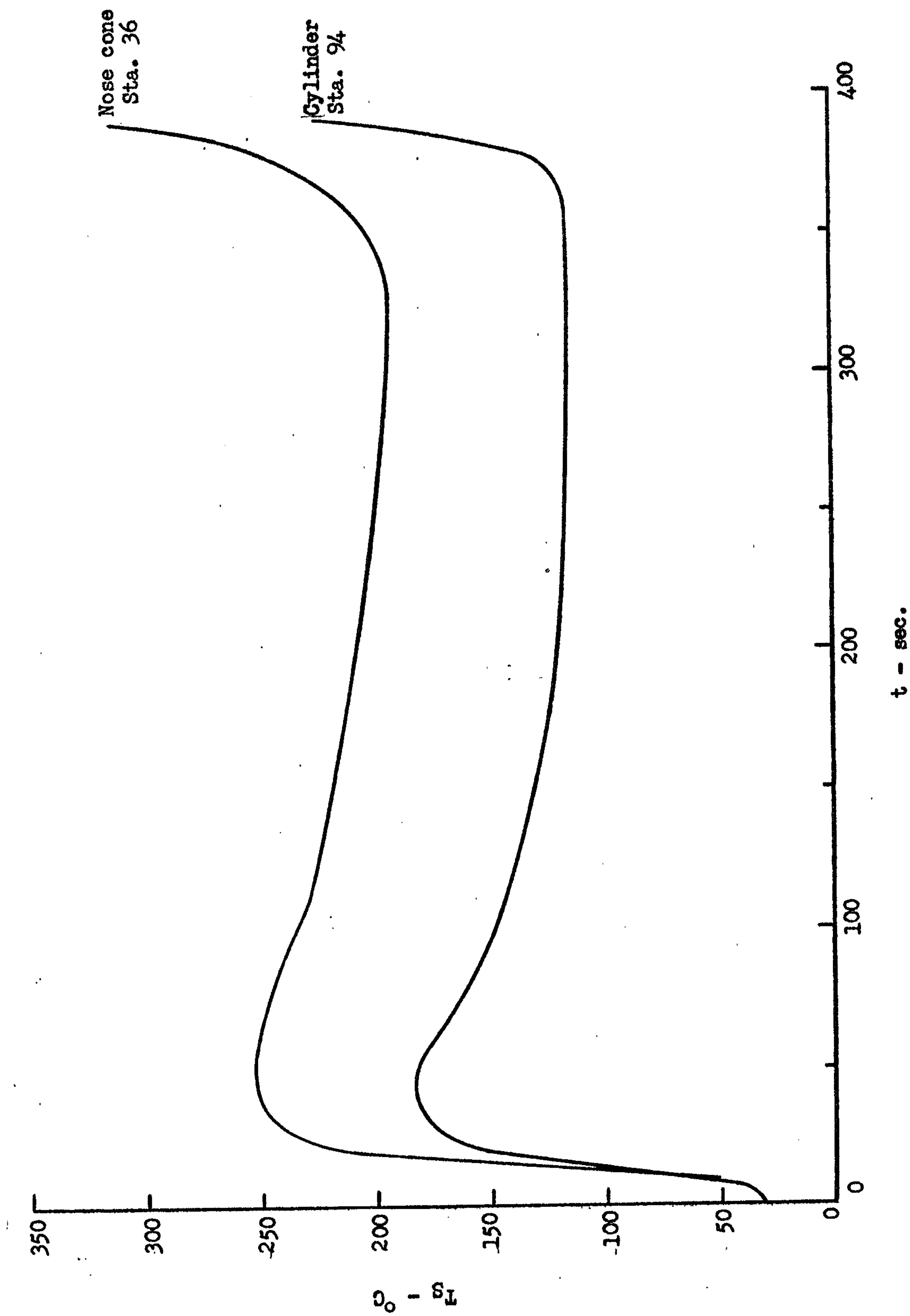
Plots of measured cone temperatures versus time for CC II-18.

FIGURE 46



Plots of measured cylinder temperatures versus time. for CC II-18

FIGURE 47



Plots of measured skin-temperatures versus total flight time for GG II-18.

FIGURE 48

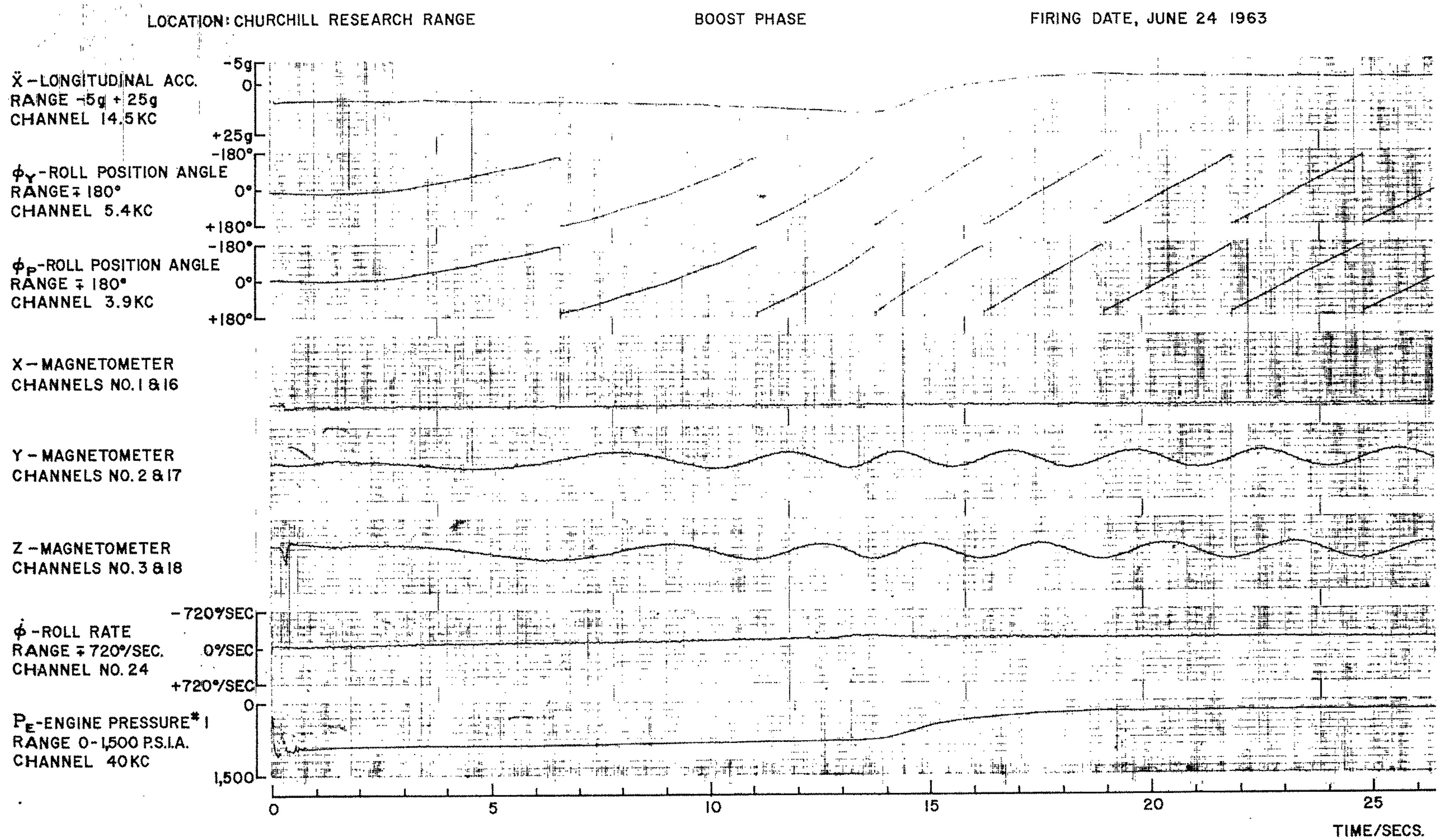


FIGURE 49 - Telemetry flight-test records for CC II-17 boost phase

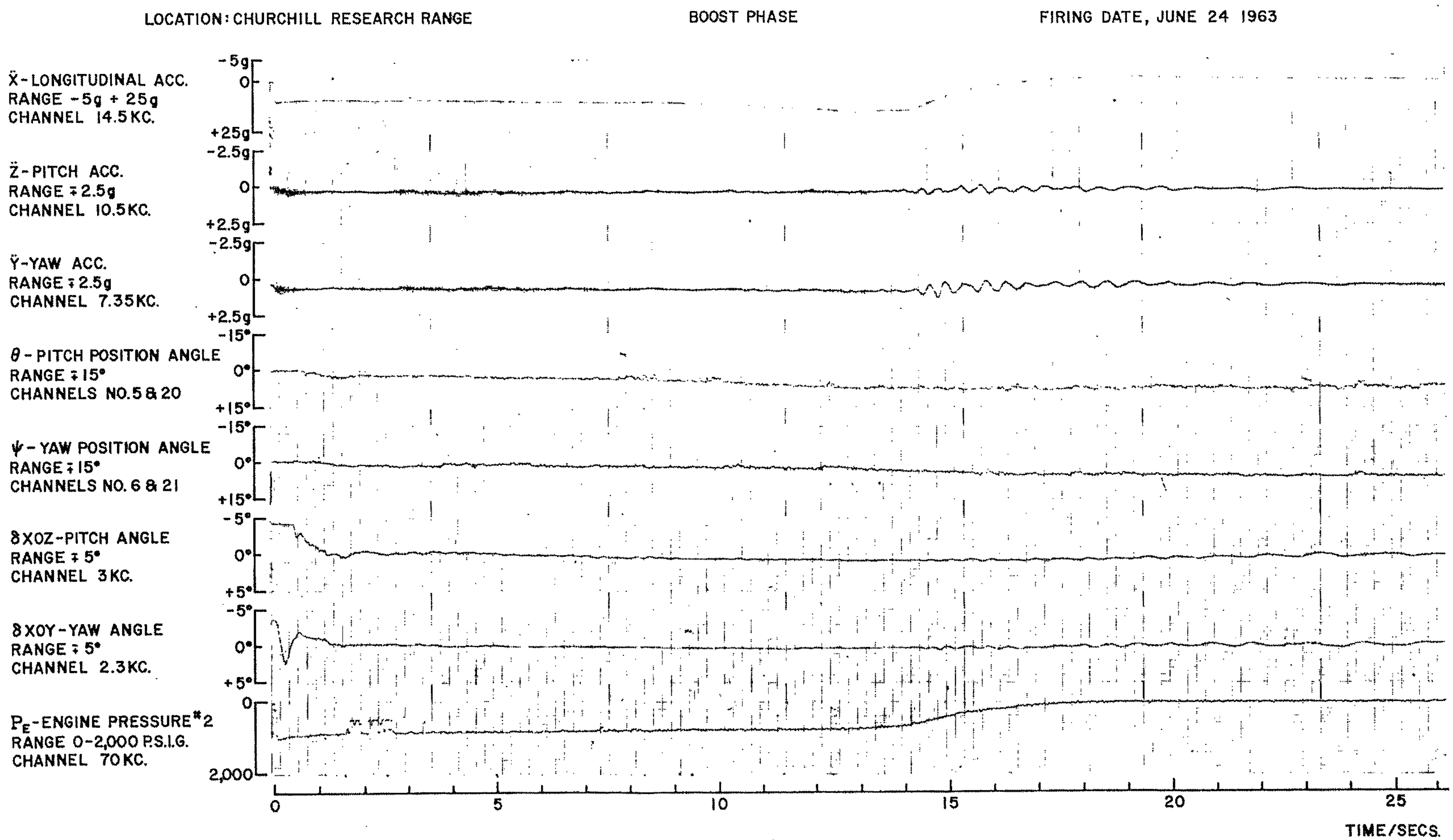


FIGURE 50 - Telemetry flight-test records for CC II-17 boost phase

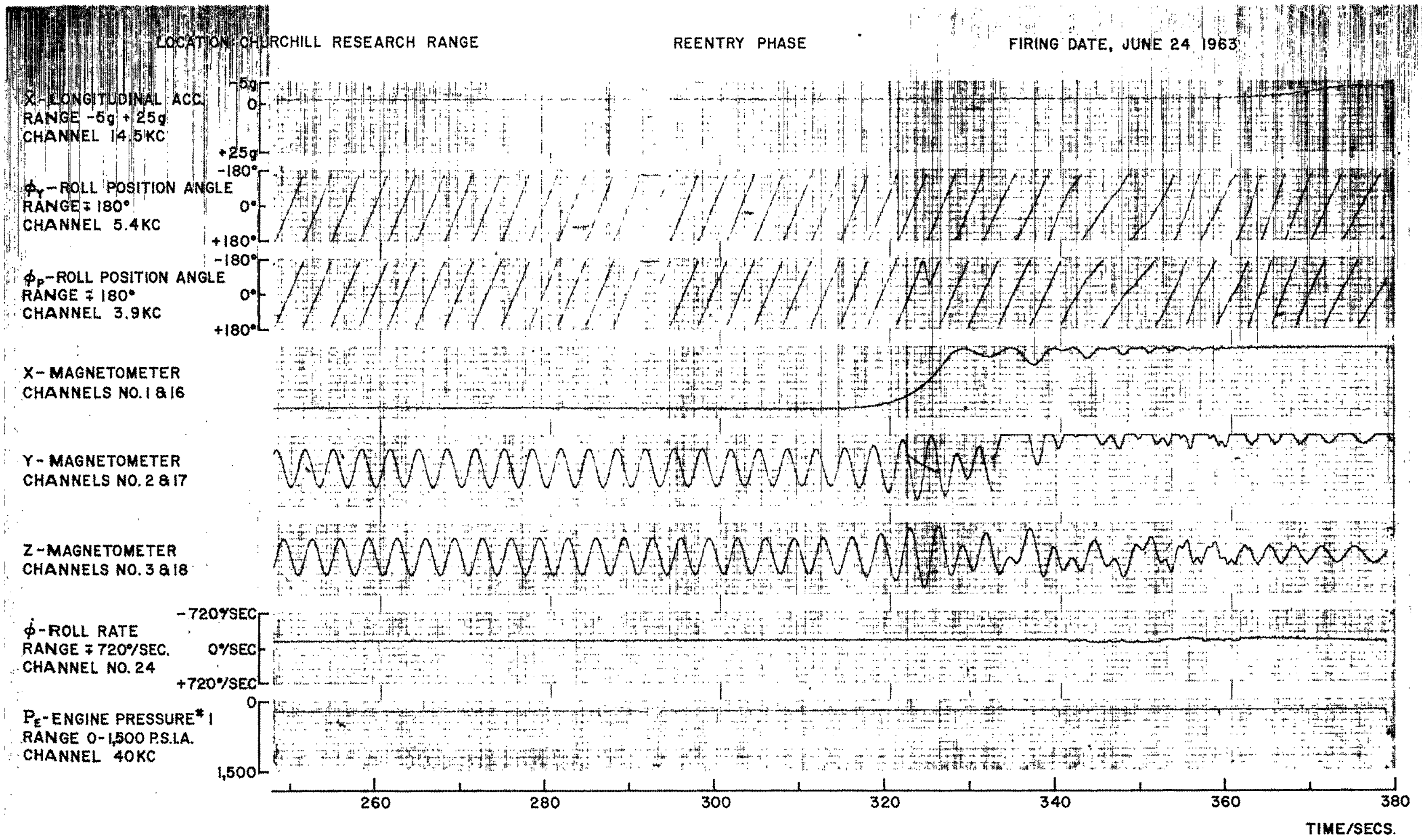


FIGURE 51 - Telemetry flight-test records for CC II-17 re-entry phase

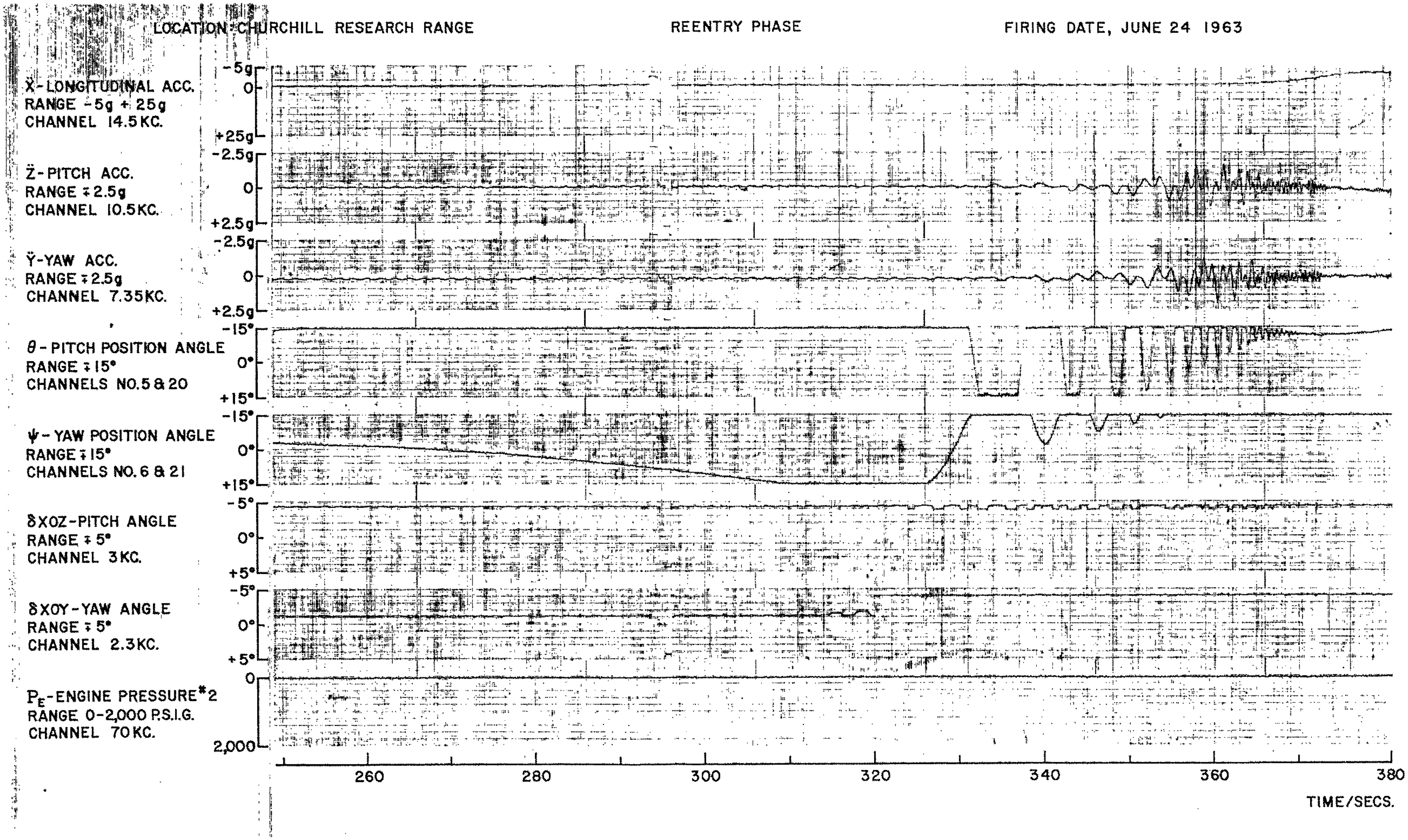
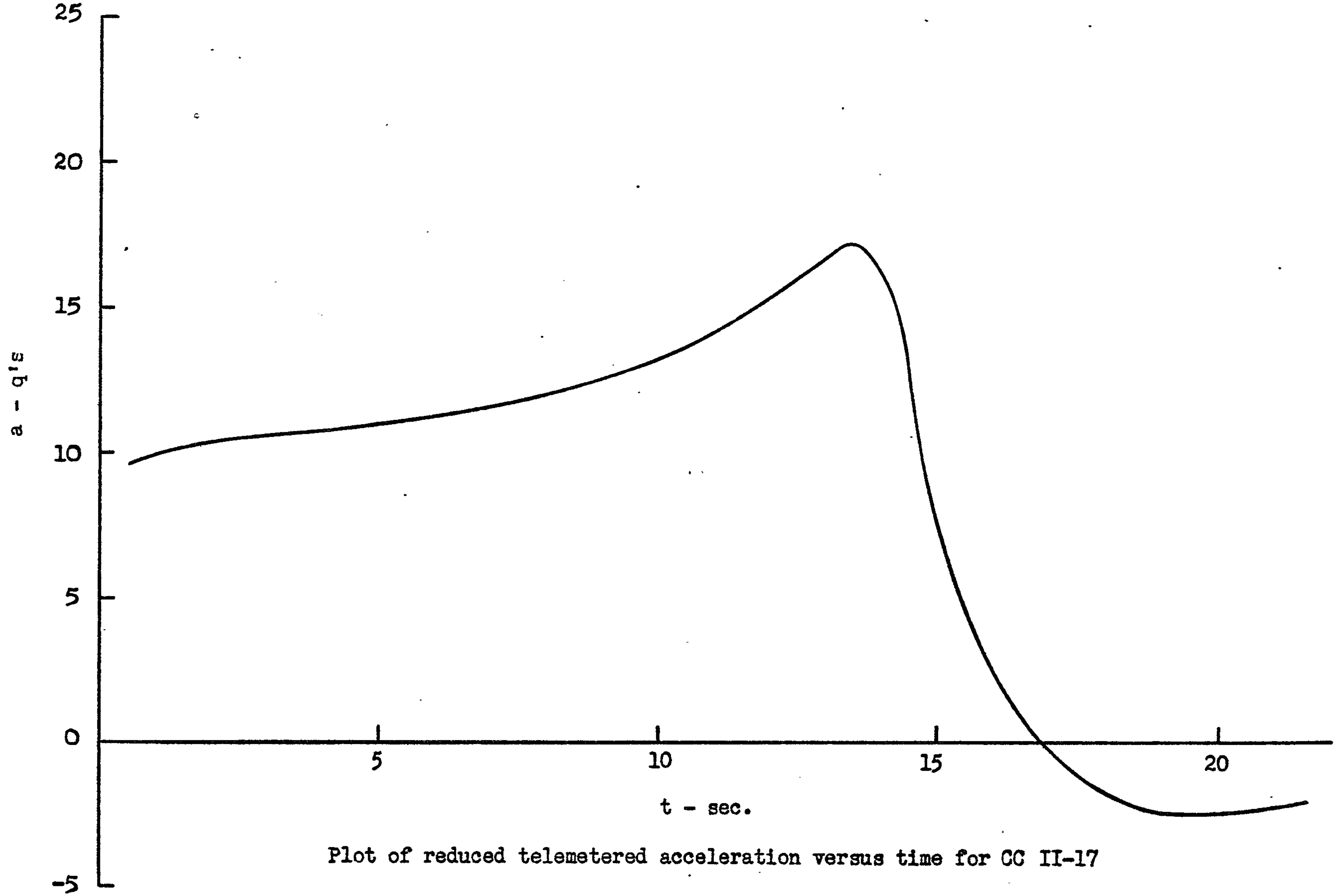
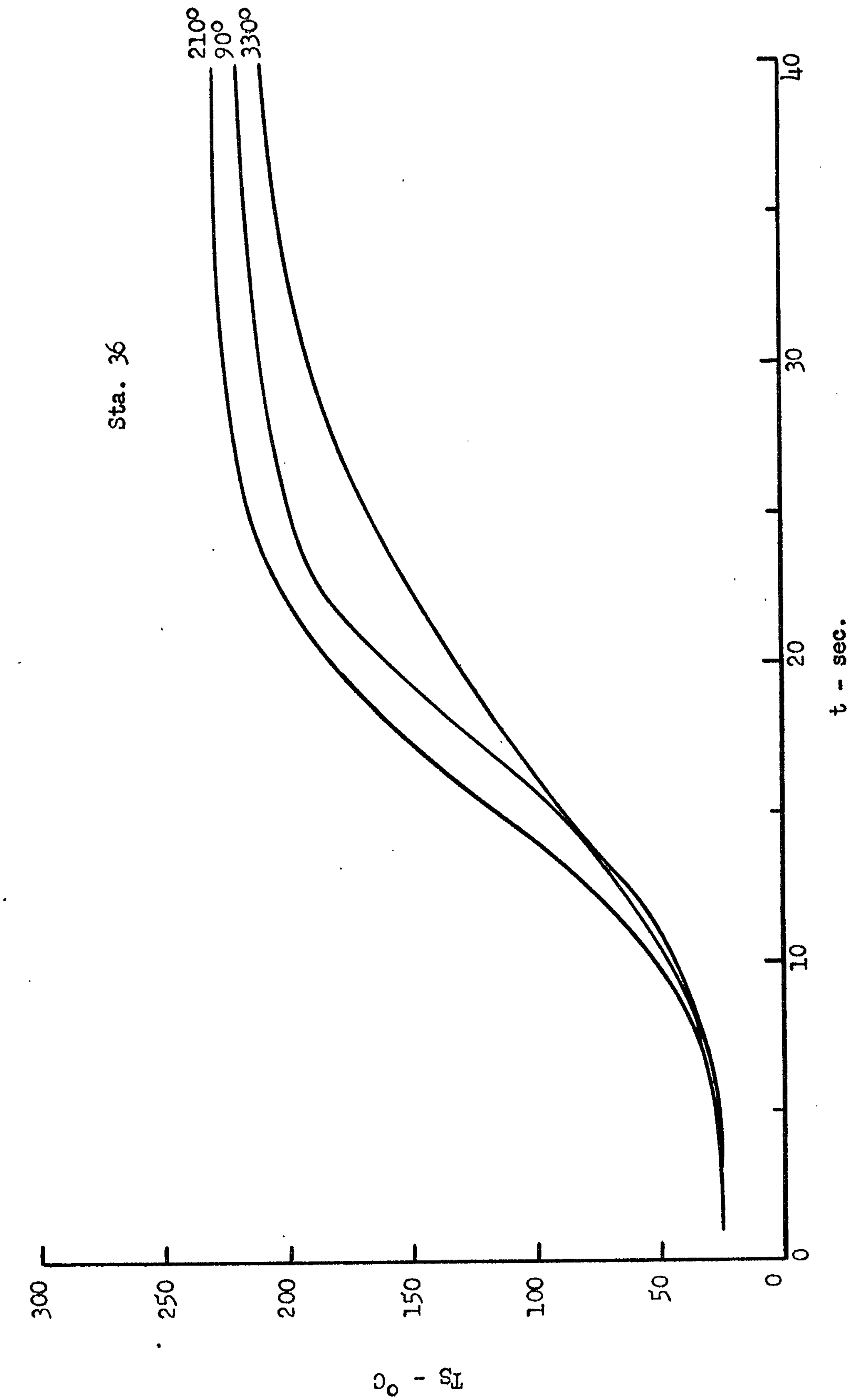


FIGURE 52 - Telemetry flight-test records for CC II-17 re-entry phase



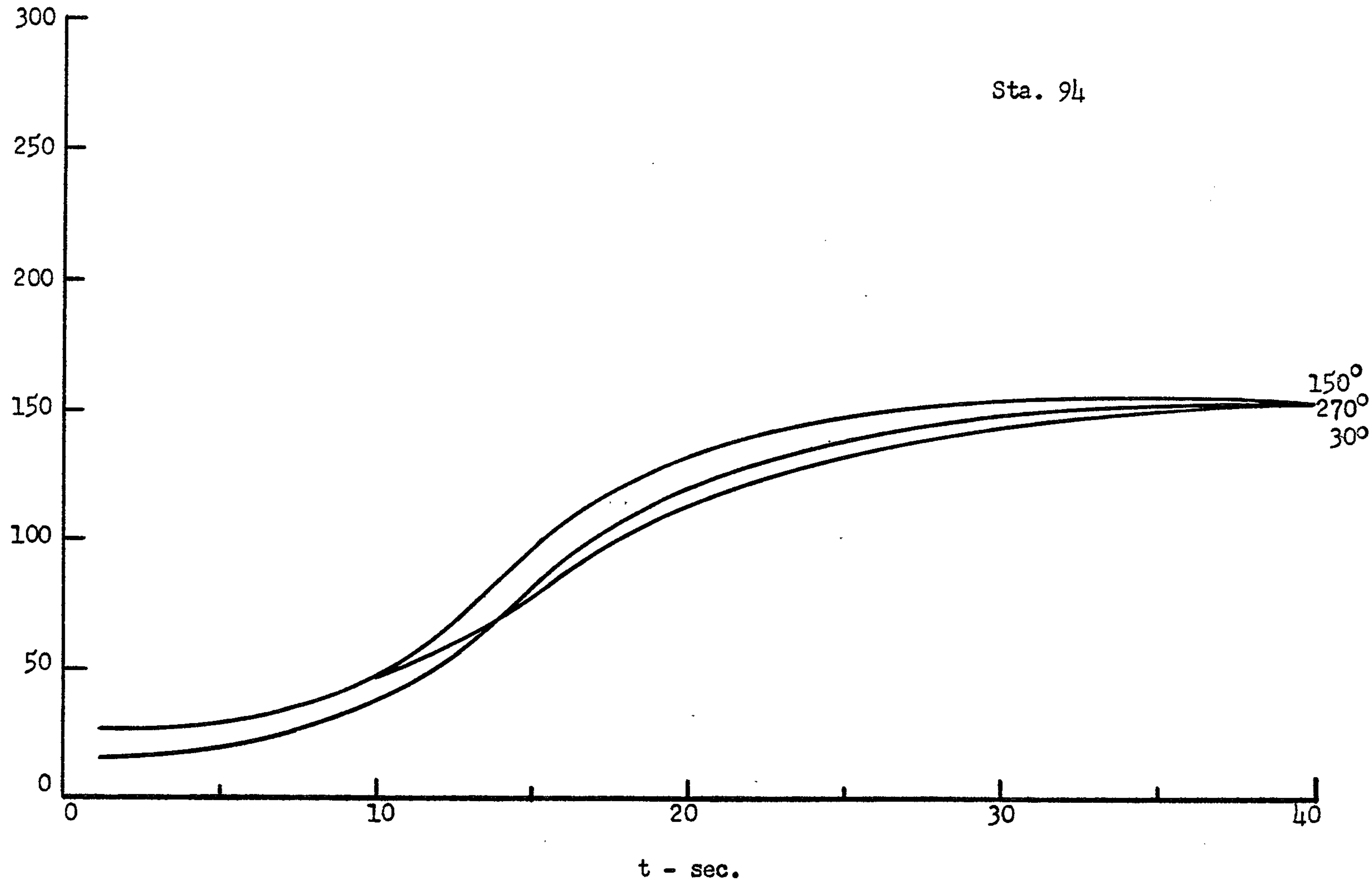
Plot of reduced telemetered acceleration versus time for CC II-17

FIGURE 53



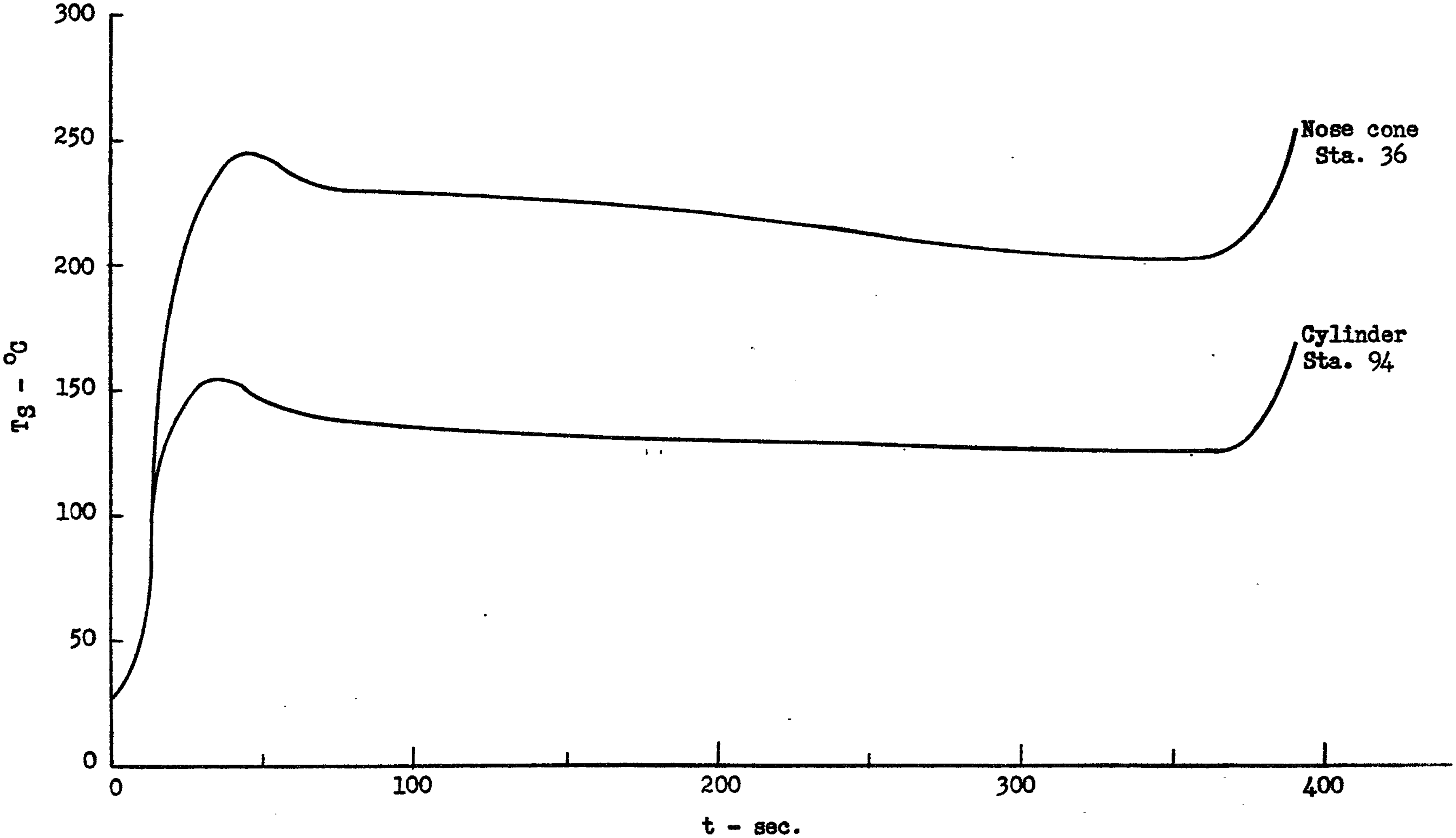
Plots of measured cone temperatures versus time for GC II-17.

FIGURE 54



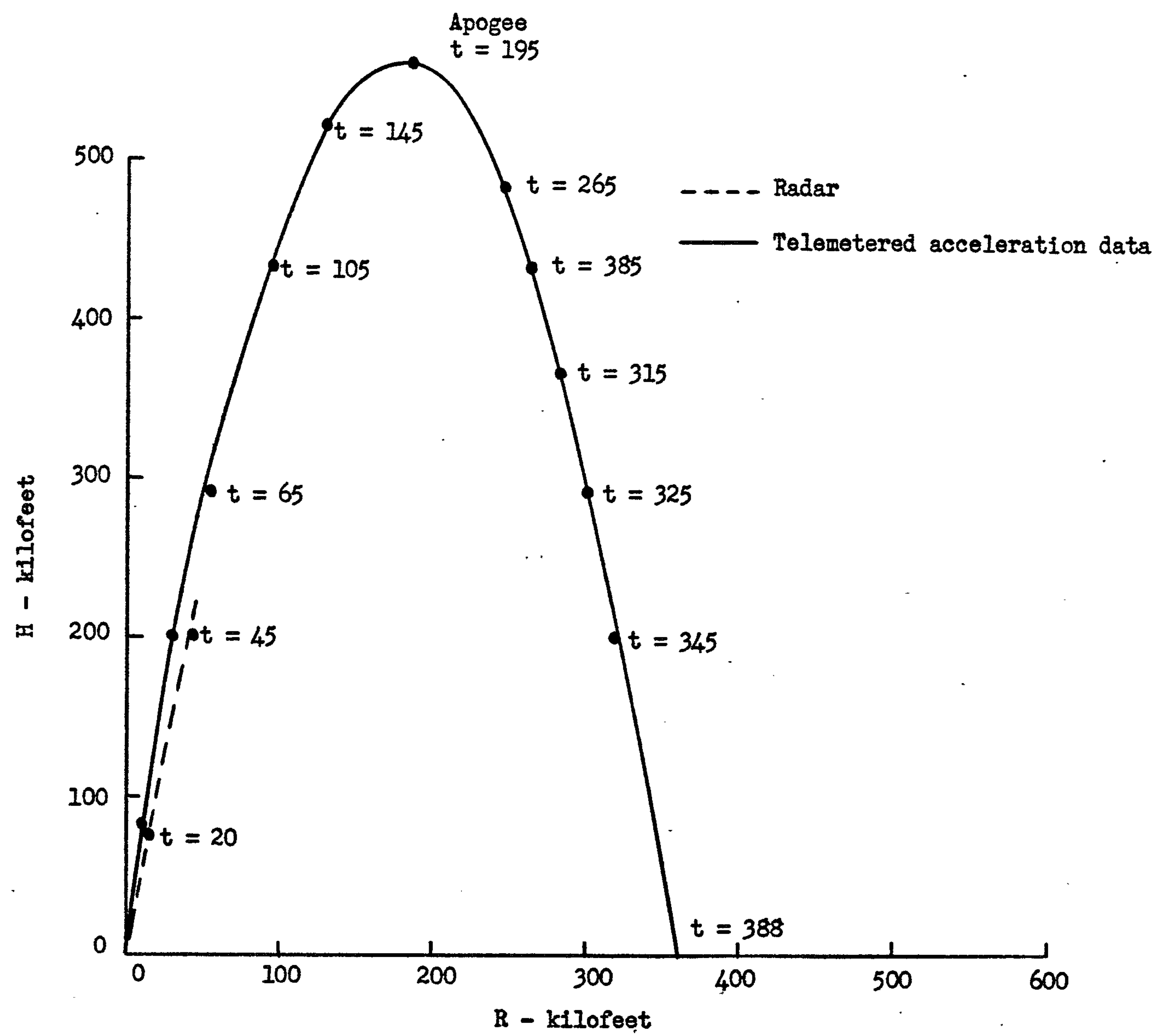
Plots of measured cylinder temperatures versus time for CC II-17.

FIGURE 55



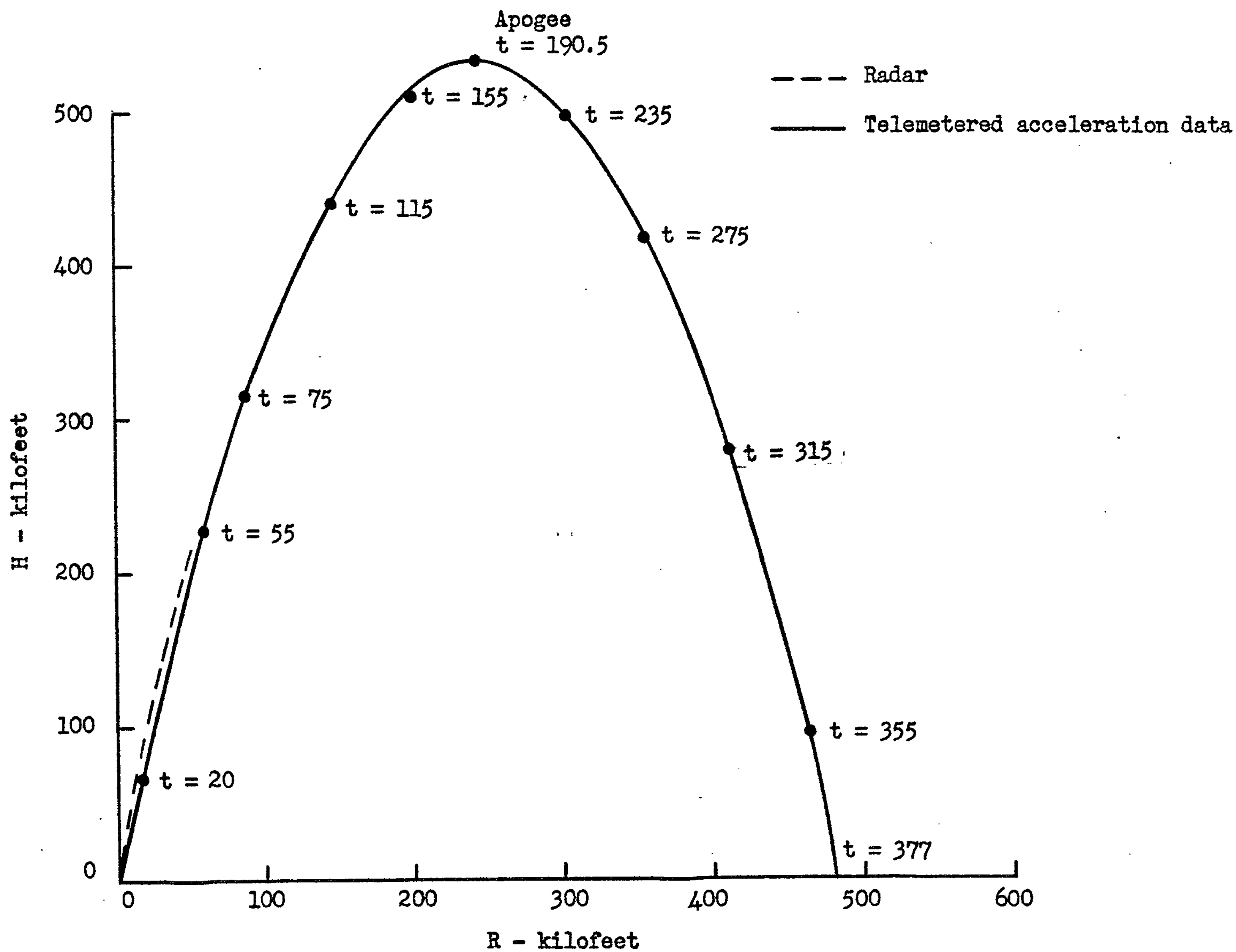
Plots of measured skin temperatures versus total flight time for CC II-17

FIGURE 56



Trajectory for CC II-18 vehicle

FIGURE 57.



Trajectory for CC II-17 vehicle

FIGURE 58

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Copy # 2: Ref. File
3: CARDE
4: DRTE
5,6: DWER
7: DRNL
8: COMMANSEC
9: SAG
10: SES
11: PARL
12: DIR

(youe)

Circ.: UKLO; DSS; DG (A); DPhys.R.