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DA18 – 001 – AMC-746(X)

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Canadian DDP Contract No.
MM 91 – 356, Serial 4MM4-34





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REPORT of the NOVEMBER 1965 TEST FIRING SERIES PROJECT HARP

SRI-R-20

Prepared by

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Work performed under
U.S. Army Contract No.
DA18-001-AMC-746(X)
and
Canadian DDP Contract No.
MM91-356, Serial 4MM4-34

TECHNICAL REPORTS SECTION
STINFO BRANCH
BLDG. 305

ABSTRACT

This report is a review and analysis of results of the fourteenth test firing series of Project HARP with the Barbados 16 inch gun.

The objectives of the series were:

i) Gathering of wind data in synoptic firings and their correlation with ionosonde drift data;

ii) Continuation of vehicle instrumentation and payload development tests, and in particular,

iii) Engineering tests of a self-destruct system for the Martlet 3B vehicle.

The series consisted of twenty-seven rounds, fired in the period from 10 to 23 November 1965. Fifteen rounds carried TMA release payloads for wind measurements in two night series. A further round had a Cesium payload with a point release for ionospheric studies. The remaining eleven rounds were for engineering development tests of a sea-impact payload (two rounds), the self-destruct system (three rounds), an ejection system with a parachute telemetry package (three rounds). Two rounds carried a telemetry package to measure time pulses and temperatures in the electronics section and to test a high gain differential amplifier, in one of these rounds in addition to the TMA payload in the synoptic series. Finally two test slugs were fired as engineering tests of the gun and another propellant whereby also a new method of loading, by inserting spacers between the propellant bags, was tried out.

The series was generally successful. The gun performance was satisfactory, and the new loading technique with spacers to achieve smoother burning of the propellant proved successful. All vehicles performed satisfactorily with the exception of three Martlet 2C (Mod 2) which were unsuccessful probably owing to pusher plate failure and resultant vehicle damage.

The sea impact payload tests were satisfactory, and so were the parachute ejection tests; in one of the three rounds, however, the parachute did not open. Not so successful were the Martlet 3B rounds since the destruct system was activated ahead of the planned time though not as a result of ground control.

The telemetry systems, carried in eight rounds, did not perform to complete satisfaction. In some rounds the telemetry and the GMD tracking worked properly; in some cases, however, the subcarrier oscillators failed whereas in others they functioned properly. Further studies are necessary to obtain fully reliable systems. The tests so far have shown, though, that the units can stand the high accelerations associated with gun launch.

The TMA release rounds, finally, have shown again the reliability of the Martlet 2C vehicles and their release system. With the exception of three rounds which were unsuccessful owing to pusher plate failure, all TMA rounds gave good trails in two synoptic series, and wind data were obtained for an altitude band from 91 to 138 km. One further round with point release of Cesium was also successful.

This series was the last in 1965. Since the first shots in January, 1963 170 rounds were fired from the 16 inch gun in Barbados, 86 of them in 1965.

ACKNOWLEDGEMENTS

The work described in this report was carried out as part of the continuing HARP program. As such it has been a joint effort between the staff of the Space Research Institute (SRI) of McGill University and the personnel of the Ballistic Research Laboratories (BRL) of the U.S. Army, Aberdeen Proving Ground.

The support from Space Instruments Research (SIR), Atlanta, Georgia, is also gratefully acknowledged.

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PART I

1.0 INTRODUCTION

The November 1965 test firing series is the fourteenth of Project HARP with the Barbados 16 inch gun*). In this series twenty-seven shots, Nos. 153 to 179, were fired in the period November 10 to 23, 1965. Table I lists the firings in chronological order.

The purpose of the test series was three-fold, viz.:

(i) Scientific data gathering, specifically wind shear data in synoptic firings and the correlation of the results with ionosonde drift data;

(ii) The engineering test of a self-destruct system for the Martlet 3B series.

(iii) Engineering development tests of ejection systems and payloads, including telemetry.

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*) A list of former test firing series is given in Appendix A-1.

TABLE I

CHRONOLOGICAL LIST OF FIRINGS

Shot No.	Name	Date Nov. 65	Time AST	Vehicle Martlet	Payload	Purpose
153	TS 1	10	1525	Slug	----	Engineering test.
154	FOAM	15	1200	3B	Telemetry, destruct system	Test of destruct system
155	GOOSE	15	1603	3B	Telemetry, destruct system	Test of destruct system
156	ZENMAC	16	1318	2C Mod. 2	SOFAR Bomb	Test of sea impact payload
157	YORKSHIRE	16	1815	2C Mod. 3	CESIUM (12 lb)	Ionospheric studies
158	HAHA	17	1431	3B	Telemetry, destruct system	Test of destruct system
159	BRIDGETOWN	17	1616	2C Mod. 3	Chaff, telemetry parachute	Test of Telemetry pack, wind temperature measurement
160	CHRISTCHURCH	17	1815	2C Mod. 2	5.5 LB TMA	Synoptic series for wind shear and ionosonde data
161	DOVER	17	1934	2C Mod. 2		
162	ENTERPRISE	17	2038	2C Mod. 2		
163	FOULBAY	17	2315	2C Mod. 2		
164	GUNHILL	18	0045	2C Mod. 2		
165	HASTINGS	18	0158	2C Mod. 2		

TABLE I (cont'd)

CHRONOLOGICAL LIST OF FIRINGS

Shot No.	Name	Date Nov. 65	Time AST	Vehicle Martlet	Payload	Purpose
166	INDIAN GROUND	18	0330	2C Mod. 2	5.5 LB TMA	Synoptic series for wind shear and ionosonde data
167	JAMESTOWN	18	0508	2C Mod. 2		
168	KENDALL	19	1330	2C Mod. 3	Chaff, telemetry parachute	Test of telemetry pack, wind temperature measurement
169	TS/2	19	1550	Slug	----	Propellant test
170	WORTHING	20	1200	2C Mod. 2	SOFAR Bomb	Test of sea impact payload
171	LANCASTER	20	1647	2C Mod. 3	Chaff, telemetry parachute	Test of telemetry pack, wind temperature measurement
172	VAUXHALL	21	1210	2C Mod. 2	Telemetry pack	Test of telemetry pack
173	MAXWELL	22	1809	2C Mod. 2	5.5 LB TMA	Synoptic series for wind shear and ionosonde data
174	NEEDHAM'S POINT	22	1930	2C Mod. 2		
175	OLDBURY	22	2055	2C Mod. 2		
176	PARAGON	22	2259	2C Mod. 2		
177	QUEEN'S FORT	23	0131	2C Mod. 2		
178	ROCKLEY	23	0328	2C Mod. 2		
179	SEAWELL	23	0516	2C Mod. 2		

2.0 GUN AND PROPELLANT

In the preceding series (Ref. 3) a few rounds were fired from an evacuated gun, in order to increase the muzzle velocity. This technique was continued, and in 12 out of the 27 November rounds the bore was evacuated to an average vacuum of 28 inches of Mercury.

The propellants used in this series were M8M.22 and WMM.225 for which the performance had already been established in previous series. In the second part of the present series an M8M propellant with a larger web (0.270") was used. This propellant has a slower burning rate than the one with .22" web, and lower breech pressures at the same charge weights.

A new method of loading the charge was also introduced in this series. Two wooden spacers were inserted between the propellant bags so that the propellant was more evenly spaced within the chamber and therefore could burn more evenly. In this way the chamber could also be completely filled. The method resulted in very smooth pressure-time plots at the breech.

3.0 FIRING PROGRAMS

The twenty-seven shots of the series were grouped as follows:

(1) Two test slug firings for gun and propellant engineering tests;

(2) Three Martlet 3B firings to test the self-destruct system;

(3) Three Martlet 2C (Mod 2) firings, two to check a sea-impact test payload (SOFAR bomb), and one to test a telemetry pack;

(4) Four Martlet 2C (Mod 3) firings for tests of the ejection system, and the telemetry pack, in addition to ionospheric studies; and

(5) Fifteen Martlet 2C (Mod 2) firings for synoptic wind measurements in two night series.

Detailed flight performance data of each round are given in Part II.

3.1 Test Slug Rounds

The two aluminum test slugs (Rounds No. 153 and 169) had a shot weight of approximately 400 lbs, and both were fired as engineering tests; the first to check the gun, the second to test a slower burning propellant, i.e. the M8M with a larger web size of .270", instead of the previously used M8M.22. Furthermore, a new method of loading the charge was introduced in the second round, by inserting two wooden spacers between the charge bags. In this way the propellant was more evenly spaced within the chamber and also filled the chamber completely. The purpose was to achieve a more uniform burning of the propellant and thus a smoother breech pressure time curve.

Both rounds were successful; in particular the second slug firing showed the usefulness of the spacing method. Summarized flight results of the two rounds are given in Table II.

TABLE II

NOVEMBER 1965 TEST PROGRAM - TEST SLUG FIRINGS

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
153 TEST SLUG 1 10 November 1965 1525 AST QE 80 deg	Aluminum test slug Engineering test to check the gun	W_V: 403 W_S: 403 C: 735 (WMM.225)	RD: 192 in RL: 30 tons ChV: 40,800 in^3 Rec: 36.3 in BE: None	St: - Mll: 41,300 Mk6: 41,100	EP: - - -	R: -	Successful
169 TEST SLUG 2 19 November 1965 1550 AST QE 80 deg	Aluminum Test slug Engineering test of slower burning propellant M8M.27	W_V: 397.5 W_S: 397.5 C: 750 (M8M.270)	RD: 197 in RL: 12 tons ChV: 41,860 in^3 Rec: 34 in BE: None	St: 23,300 Mll: 21,900 Mk6: 26,600	EP: - 4780 -	R: 13,000 (4)	Successful Very smooth pressure - time curve obtained.

W_V: Vehicle Weight
W_S: Shot Weight
C: Charge Weight

RD: Ram Distance
RL: Ram Load
ChV: Chamber Volume
Rec: Recoil
BE: Bore Evacuation

St: Strain Gauge
Mll: } Crusher Gauges
Mk6: }

EP: Electric Muzzle Vel. Probe (left, right, average)
R: Radar

3.2 Martlet 3B Rounds

The three Martlet 3B's fired in this series were Round 154 - FOAM, 155 - GOOSE and 158 - HAHA. The launch elevation was 75 degrees, and WMM.225 propellant was used.

The vehicle configuration as shown in the schematic drawing Fig. 1.1 was similar to those flown in the March and May/June 1965 series. (Refs. 1 and 2). The purpose of the rounds of the present series was to test the self-destruct system. For these tests no rocket grain was incorporated in the motor chamber but an aluminum ballast system was used as "dummy grain", weighing 59 lbs. The ballast was so designed as to be self-supporting through to the pusher plate during the launch phase. To provide stability, flip-out fins similar to those flown on the Martlet 3B steel vehicle in the March 1965 series (Ref. 1) were used.

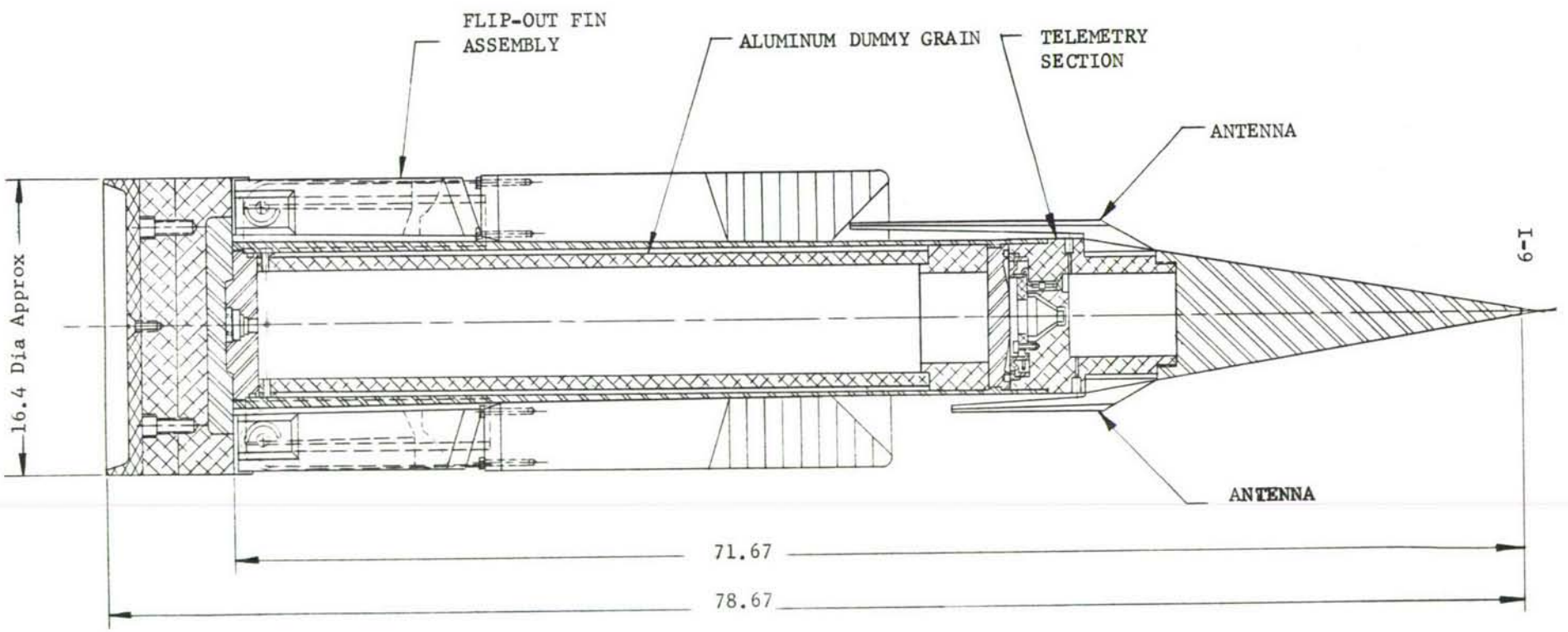
The payload was a Command System including an HDL 250 MHz telemetry package and a destruct module containing about one half pound of Pentolite. The Command System was provided not only to test the operation of the self-destruct system as a range safety device, but also to permit command of functions which could not be conveniently preprogrammed into the test vehicle. The system used a combination of tones which frequency modulated the transmitter. A circularly polarized antenna with a relatively broad beam width was used in conjunction with a 100 watt transmitter oriented to cover the trajectory. A receiver was located in the vehicle, and demodulators were to translate the tones into a switching action; they were appropriately combined by gates to initiate the desired action.

The tone generators could be actuated either manually or automatically if desired, from panels located in the launch control. The range safety officer's panel contained the keyed ON/OFF switch for all tones, an ARM switch, and a DESTRUCT switch. For a destruct command both the ARM and DESTRUCT switches had to be actuated. The unit in the vehicle had two separate arming actions; immediately before loading by the removal of a shorting screw, and upon firing by the opening of a g-switch which functioned at 1000 g.

The basic command system was based on the IRIG standard tone and FM carrier. The receiver/decoder used was a miniature high-g crystal controlled unit operating on 415 MHz.

The tests were not fully successful. In the first round, FOAM, the destruct system probably fired at 8 seconds after launch, though not through ground control. The vehicle was considerably decelerated between T + 8 sec and T + 9 sec, but was evidently not damaged. In the second round, GOOSE, the telemetry did not work at all, and the photographic records indicated damage to the antenna and the fins. The destruct system may have been activated when the vehicle was still in the barrel although the barrel was not damaged. In the third round, HAHA, the telemetry worked but not the receiver of the command destruct system. In this round the Pentolite charge was not carried.

Summarized flight results of the three rounds are given in Table III.



PUSHER PLATE DIA: 16.4"
DIAMETER OF BODY: 8.50" to 9.27"

FIG. 1.1 MARTLET 3B VEHICLE FOR DESTRUCT SYSTEM TESTS

TABLE III

NOVEMBER 1965 TEST PROGRAM - MARTLET 3B FIRINGS

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
154 FOAM 15 November 1965 1200 AST QE 75 deg	Martlet 3B with "flip out" fins, carrying an HDL 250 MHz telemetry package and a pentolite charge (0.5 lb) for destruct system	W_v: 298.5 W_s: 570.5 C: 550 (WMM.225)	RD: 187 in RL: 55 tons ChV: 39,750 in^3 Rec: 31.5 in BE: None	St: 25,400 M11: 25,100 Mk6: 24,900	EP: 4,500 4,540 4,520	R: 36,000 (11)	Vehicle and telemetry performance good at launch. Destruct system not satisfactory
155 GOOSE 15 November 1965 1603 AST QE 75 deg	Martlet 3B with "flip out" fins, carrying HDL 250 MHz telemetry package and pentolite charge (0.5 lb) for the destruct system	W_v: 297.5 W_s: 568.5 C: 590 (WMM.225)	RD: 186.5 in RL: 36 tons ChV: 39,630 in^3 Rec: 32 in BE: None	St: 28,100 M11: 27,900 Mk6: 24,300*) *) Note: Mk6 pressure may not be correct as 10 tons pre-compression used.	EP: 4,630 4,530 4,580	R: -	Round not successful regarding telemetry and destruct system performance.
158 HAHA 17 November 1965 1431 AST QE 75 deg	Martlet 3B with "flip-out" fins, carrying HDL 250 MHz telemetry package but no pentolite charge	W_v: 296.0 W_s: 567.0 C: 540 (WMM.225)	RD: 188 in RL: 26 tons ChV: 39,950 in^3 Rec: 29.5 in BE: None	St: 19,400 M11: 19,300 Mk6: -	EP: 4040 4120 4080 EF: 4430 WF: 3950	R: 38,600 (12)	Successful round regarding vehicle and ballistics. Payload performance not satisfactory since receiver did not work.

W_v: Vehicle Weight
W_s: Shot Weight
C: Charge Weight

RD: Ram Distance
RL: Ram Load
ChV: Chamber Volume
Rec: Recoil
BE: Bore evacuation

St: Strain Gauge
EP: Electrical Probe (left, right, average)
R: Radar
EF: East Fastax
WF: West Fastax

3.3 Martlet 2C (Mod 2) Synoptic Test Rounds

The main part of the present series was devoted to synoptic firings for wind shear measurement. Martlet 2C (Mod 2) vehicles, shown in Fig. 1.2, were used for these tests in two night series. Eight vehicles were fired at an elevation of 85 deg in the night of 17/18 November from sunset to sunrise (Rounds No. 160 to 167). The propellant used was M8M.22 as in previous series. Six of these rounds were successful, and good trails were obtained from which wind shear data were obtained in the 100 km altitude region. Rounds No. 162 - ENTERPRISE and No. 165 - HASTINGS were not successful. In both cases the vehicles appeared to tumble and did not reach the expected apogees so that no TMA trails were obtained. The behaviour of the vehicles in these two rounds indicated some vehicle damage probably caused by a sabot failure. This led to a change in sabot design, and a strengthened aluminum sabot of lower weight was used in later firings; the pusher plate was changed correspondingly. These design changes reduced the shot weight by about thirty pounds on the average.

The second synoptic series took place during the night 22/23 November; seven vehicles were fired (Rounds No. 173 to 179), with an M8M.27 propellant, and using spacers for the propellant. For all these shots the strengthened aluminum sabots were used. Six rounds of the series were successful producing good TMA trails and resulting in wind shear data around the 100 km altitude level. Round No. 175 - OLDBURY failed in this respect, since an apogee of only approximately 100,000 ft - 30 km was obtained. It became apparent from sabot parts recovered on the Seawell runway that the supports placed in the sabot shells to prevent buckling had failed causing subsequent vehicle damage.

One round (No. 174 - NEEDHAM'S POINT) in the second night series carried, in addition to the TMA payload, a telemetry package in the nose cone consisting of a 231 MHz transmitter with two subcarrier oscillators. Although pre-test data had indicated good performance for both the transmitter and the two subcarrier oscillators, the telemetry failed in flight, and a failure of either the power supply or the transmitter must be assumed.

A summary of the flight results of all TMA rounds is given in Table IV. A discussion of the resulting wind data is presented in Section 4.3.

3.4 Martlet 2C (Mod 2) SOFAR Bomb and Telemetry Test Rounds

The two rounds with a sea impact payload were No. 156 - ZENMAC and No. 170 - WORTHING. A cross-sectional drawing of these vehicles is shown in Fig. 1.3. Both were fired with a launch elevation of 80 degrees and with approximately the same muzzle velocity. In both firings vehicle impact was observed about 300 seconds after launch at a range of approximately 250,000 ft. There was no evidence of the SOFAR bomb at the first firing but in the second round the bomb was successful 41 seconds after impact.

Another Martlet 2C (Mod 2) round, 172 - VAUXHALL, carried telemetry with two subcarrier oscillators at 40 and 70 KHz, and a flush mounted quadraloop antenna. The purpose was to measure temperature in the electronics section, and to determine the feasibility of utilizing a high gain differential amplifier for measurements of low-level signals. The RF signal was received at launch at the predicted frequencies for four seconds, and the 70 KHz subcarrier oscillator worked as predicted but no information was available on the 40 KHz subcarrier. The quadraloop antenna appeared to have been broken, and no temperature data were obtained.

MATERIALS

BODY: AISI 4340
H.T. Rc 43/46
NOSE CONE: AISI 1045
NOSE TIP: AISI 1045
TAILFINS: ALUM. 75ST6
PISTON: ALUM. 24ST4
FIN NUT: AISI 4340
PUSHER PLATE SKIRT: ALUM. 7075T6
PUSHER PLATE CROWN: AISI 4340
H.T. Rc 43/45
PUSHER PLATE INSERT: PLYWOOD OBTURATOR SEAL

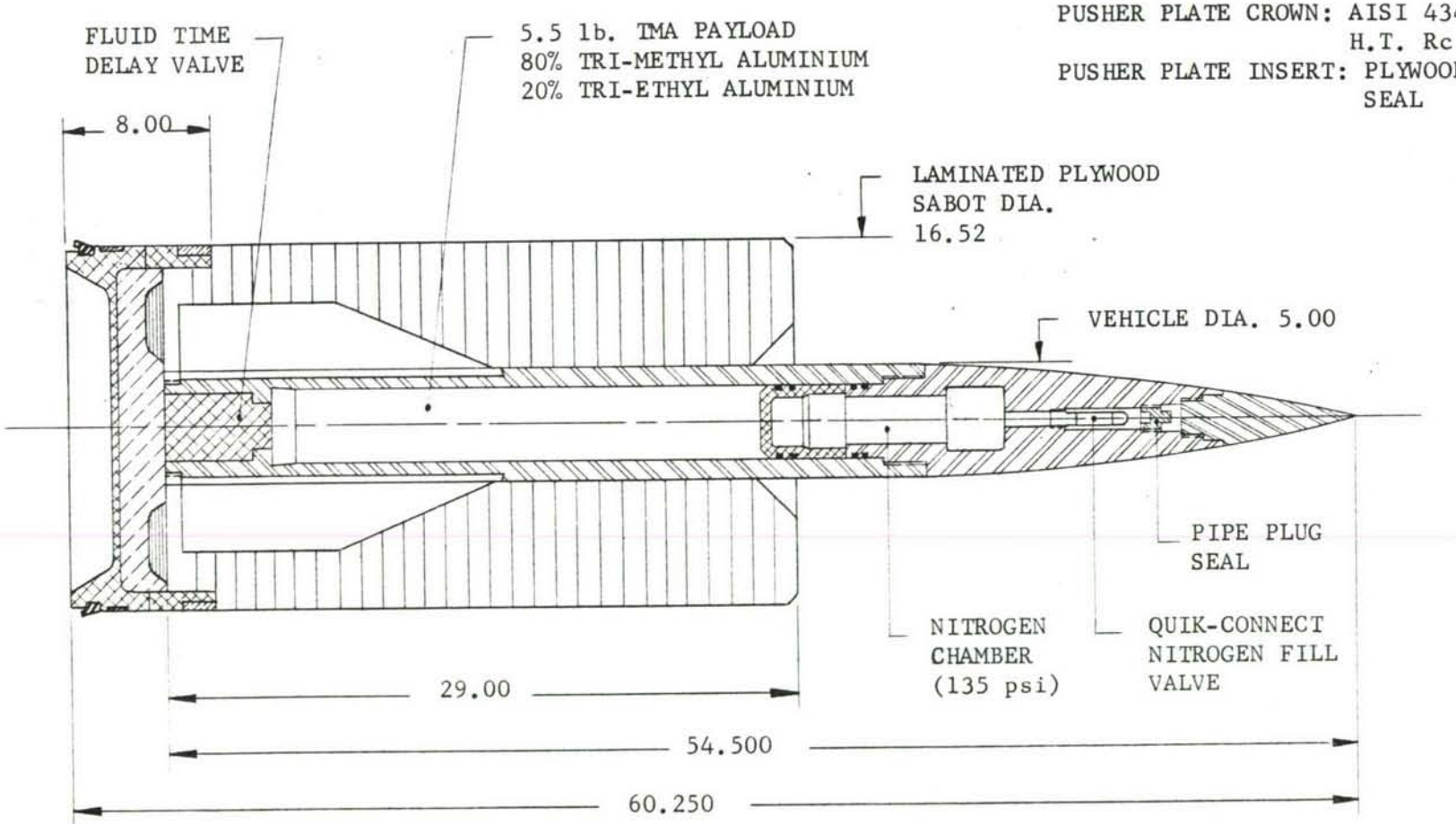


FIG. 1.2 MARTLET 2C MOD. 2 - TMA PAYLOAD

TABLE IV

NOVEMBER 1965 TEST PROGRAM - MARTLET 2C (MOD. 2) FIRINGS- SYNOPTIC TEST ROUNDS

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
160 CHRISTCHURCH 17 November 1965 1815 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 182 W_s: 415 C: 750 (M8M.22)	RD: 192 in RL: 15 tons ChV: 40,800 in^3 Rec: 37.5 in BE: 28 inches of mercury	St: 40,700 M11: 40,900 Mk6: -	EP: 5990 6030 6010	R: 392,000 (120)	Successful round
161 DOVER 17 November 1965 1934 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 183.5 W_s: 415.3 C: 750 (M8M.22)	RD: 195 in RL: 9 tons ChV: 41,300 in^3 Rec: 38 in BE: None	St: 37,900 M11: 37,900 Mk6: -	EP: 5730 5780 5760	R: 400,000 (122)	Successful round
162 ENTERPRISE 17 November 1965 2038 AST	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 185 W_s: 418 C: 770 (M8M.22)	RD: 196 in RL: 12 tons ChV: 41,640 in^3 Rec: 39 in BE: 27 inches of mercury	St: 40,000 M11: 40,000 Mk6: -	EP: 5980 6000 5990	R: 231,000 (71)	Unsuccessful probably due to a sabot failure and resultant vehicle damage

TABLE IV (continued)

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
163 FOUL BAY 17 November 1965 2315 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb pay- load of TMA with delay release mech- anism	W_v: 183.8 W_s: 415.3 C: 770 (M8M.22)	RD: 196 in RL: 15 tons ChV: 41,640 in^3 Rec: 39 in BE: 28 inches of mercury	St: 41,400 M11: 41,150 Mk6: -	EP: 6130 6100 6120	R: 416,000 (127)	Successful round
164 GUN HILL 18 November 1965 0045 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb pay- load of TMA with delay release mech- anism	W_v: 183.5 W_s: 415.5 C: 770 (M8M.22)	RD: 196 in RL: 19 tons ChV: 41,640 in^3 Rec: 39 in BE: 28 inches of mercury	St: 41,400 M11: 41,500 Mk6: -	EP: 6010 5930 5970	R: 413,000 (126)	Successful round
165 HASTINGS 18 November 1965 0155 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb pay- load of TMA with delay release mech- anism	W_v: 184 W_s: 417.5 C: 790 (M8M.22)	RD: 196 in RL: 18 tons ChV: 41,640 in^3 Rec: 41.5 in BE: 28 inches of mercury	St: 43,000 M11: 53,300 Mk6: -	EP: - - -	R: 104,000 (32)	Unsuccessful probably due to a sabot failure and resultant vehicle damage

TABLE IV (continued)

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
166 INDIAN GROUND 18 November 1965 0330 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 184 W_s: 418 C: 750 (M8M.22)	RD: 196 in RL; 16 tons ChV: 41,640 in^3 Rec: 38.5 in BE: 27 inches of mercury	St: 43,600 M11: 42,200 Mk6: -	EP: 5950 6000 5980	R: 400,000 (122)	Successful round
167 JAMESTOWN 18 November 1965 0548 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 184 W_s: 415 C: 750 (M8M.22)	RD: 195 in RL: 18 tons ChV: 41,640 in^3 Rec: 39 in BE: None	St: 38,200 M11: 37,900 Mk6: -	EP: 5670 - -	R: 391,000 (119)	Successful round
173 MAXWELL 22 November 1965 1809 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 181 W_s: 380.8 C: 915 (M8M.27)	RD: 185 in RL: 100 tons ChV: 39,300 in^3 Rec: 41.5 in BE: None	St: 49,200 M11: 49,500 Mk6: -	EP: - - - (R = 6300)	R: 466,500 (142)	Successful round Note: A strengthened sabot was used from this round on.

TABLE IV (continued)

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
174 NEEDHAM'S POINT 22 November 1965 1930 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism, consisting of a 231 MHz transmitter	W_v: 183.5 W_s: 387.5 C: 930 (M8M.27)	RD: 196 in RL: 17 tons ChV: 41,640 in^3 Rec: 41.5 in BE: 29 inches of mercury	St: 42,200 M11: 42,800 Mk6: -	EP: 6,090 6,080 6,090	R: 435,000 (133)	Successful round
175 OLDBURY 22 November 1965 2055 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 185.5 W_s: 391 C: 975 (M8M.27)	RD: 196 in RL: 12 tons ChV: 41,640 in^3 Rec: 41.8 in BE: 29 inches of mercury	St: 47,400 M11: 49,100 Mk6: -	EP: - 6420 -	R: 102,000 (31)	Unsuccessful probably due to a sabot failure and subsequent vehicle damage
176 PARAGON 22 November 1965 2259 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 185.5 W_s: 391 C: 930 (M8M.27)	RD: 200 in RL: 10 tons ChV: 42,500 in^3 Rec: 39.5 in BE: 24 inches of mercury	St: 43,900 M11: 45,100 Mk6: -	EP: 6240 6240 6240	R: 442,000 (135)	Successful round

TABLE IV (continued)

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
177 QUEEN'S FORT 23 November 1965 0131 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 184 W_s: 388 C: 930 (M8M.27)	RD: 200 in RL: 10 tons ChV: 42,500 in^3 Rec: - BE: None	St: 42,300 M11: 42,400 Mk6: -	EP: 6090 6090 6090	R: 436,000 (133)	Successful round
178 ROCKLEY 23 November 1965 0328 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism, strengthened aluminum sabot was used.	W_v: 184.3 W_s: 381.1 C: 950 (M8M.27)	RD: 200 in RL: 10 tons ChV: 42,500 in^3 Rec: 41.5 in BE: 21 inches of mercury	St: 43,800 M11: 45,000 Mk6: -	EP: 6200 6220 6210	R: 470,000 (143)	Successful round
179 SEAWELL 23 November 1965 0516 AST QE 85 deg	Martlet 2C (Mod. 2) carrying a 5.5 lb payload of TMA with delay release mechanism	W_v: 183 W_s: 388.5 C: 975 (M8M.27)	RD: 203 in RL: 10 tons ChV: 43,100 in^3 Rec: 42 in BE: None	St: 46,000 M11: 46,200 Mk6: -	EP: 6220 6240 6230	R: 464,000 (141)	Successful round

W_v: Vehicle Weight
W_s: Shot Weight
C: Charge Weight

RD: Ram Distance
RL: Ram Load
ChV: Chamber Volume
Rec: Recoil
BE: Bore evacuation

St: Strain Gauge
EP: Electrical Probe (left, right, average)
R: Radar

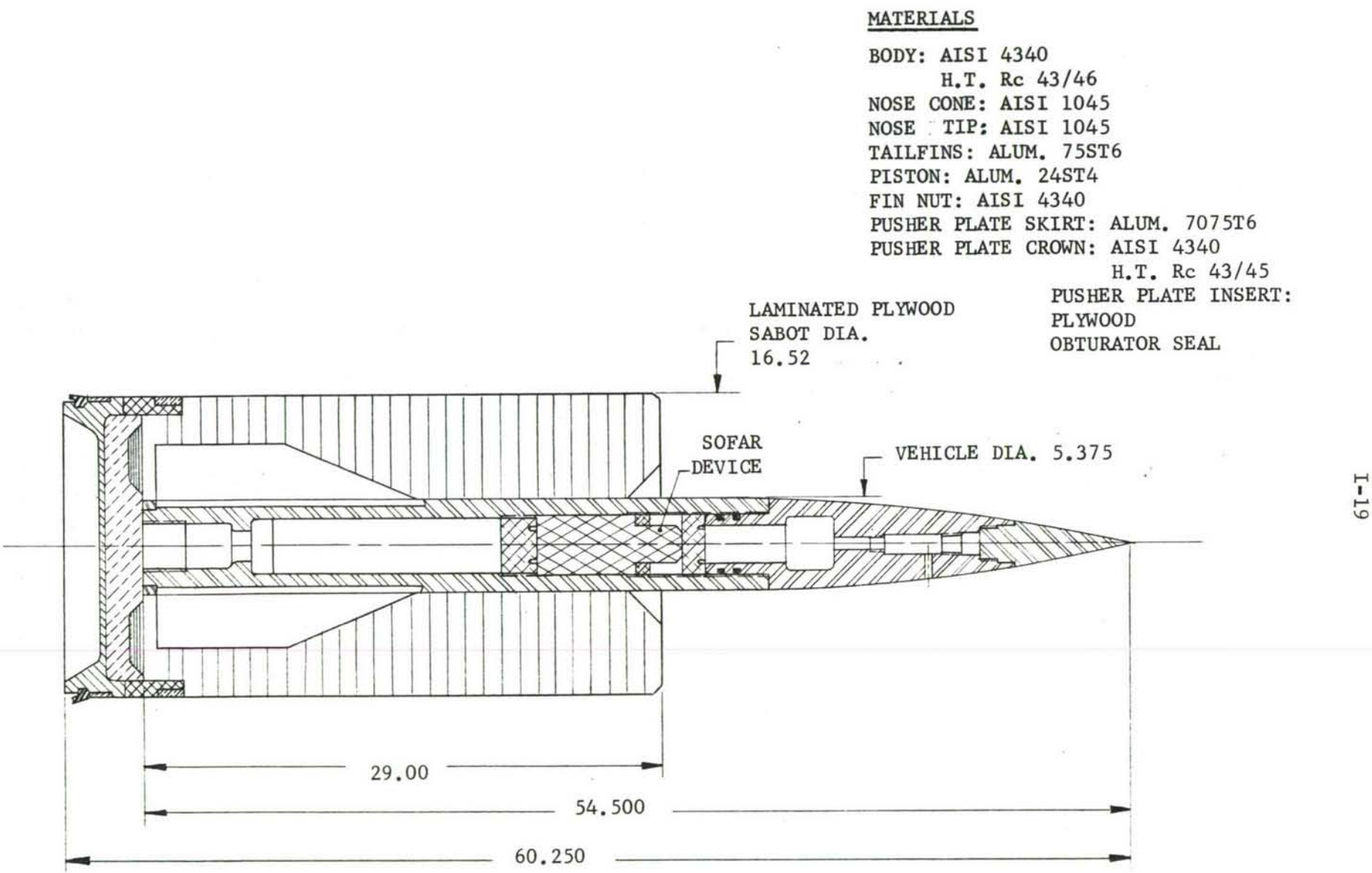


FIG. 1.3 MARTLET 2C (MOD 2) WITH SOFAR DEVICE

A summary of the flight results of the three rounds is given in Table V.

3.5 Martlet 2C (Mod 3) Rounds

This modification of the Martlet 2C (Fig. 1.4) uses the same material as the Mod 2 and differs only slightly in the external configuration and the interior profile. Four of these vehicles were fired in the series.

One vehicle (No. 157 - YORKSHIRE) carried a 12 lb ejection payload of Cesium to generate electrons for ionospheric studies and to obtain wind data. The round was successful, and wind data for the ejection altitude could be obtained. Details of the results are discussed in Section 4.3.

The other three rounds, 159 - BRIDGETOWN, 168 - KENDALL, and 171 - LANCASTER carried a payload consisting of S-band chaff and a parachute with a telemetry package and thermistors. The metallized silk parachutes had a 14 ft^2 area and 18 ft long shroud lines. The 1750 MHz telemetry unit was a SOLISTRON production model; it was attached to the parachute. A combined slot-loop or "sloop" antenna was used which protruded out of the end of the projectile to provide tracking and telemetry data from launch through ejection to impact. Because of this antenna a spacer had to be added to the pusher plate. Four bead thermistors were attached to the shroud lines. The purpose of these rounds were to test the performance of the telemetry transmitter, a seven-segment subcarrier oscillator, a nickel-cadmium battery pack and the sloop antenna, particularly at low temperatures; furthermore to check the parachute ejection system which had a tethered ejection slug to prevent parachute damage, and to check the performance of the thermistors

TABLE V

NOVEMBER 1965 TEST PROGRAM - MARTLET 2C (MOD. 2) SOFAR AND TELEMETRY TEST FIRINGS

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
156 ZENMAC 16 November 1965 1318 AST QE 80 deg	Martlet 2C (Mod. 2) carrying a sofar impact test payload	W_v: 176 W_s: 416 C: 725 (M8M.22)	RD: 194 in RL: 10 tons ChV: 41,200 in^3 Rec: 35.5 in BE: None	St: 33,400 M11: 32,700 Mk6: 33,900	EP: - 5640 - EF: 5940 WF: 5520	R: 360,000 (110)	Successful launch and trajectory. No evidence of SOFAR bomb.
170 WORTHING 20 November 1965 1200 AST QE 80 deg	Martlet 2C (Mod. 2) carrying a SOFAR impact test payload	W_v: 180 W_s: 380 C: 850 (M8M.27)	RD: 196 in RL: 20 tons ChV: 41,640 in^3 Rec: 38 in BE: 28 inches of mercury	St: 32,900 M11: 31,400 Mk6: 31,100	EP: 5600 5640 5620	R: 340,000 (104)	Successful round
172 VAUXHALL 21 November 1965 1210 AST QE 80 deg	Martlet 2C (Mod. 2) carrying tele- metry with two subcarrier osc- illators at 40 and 70 KHz	W_v: 183 W_s: 383 C: 780 (M8M.22)	RD: 196 in RL: 18 tons ChV: 41,640 in^3 Rec: 37.5 in BE: 28 inches of mercury	St: 39,000 M11: 39,800 Mk6: -	EP: 6130 6140 6140	R: 418,000 (128)	Successful launch and trajectory. Telemetry performance not completely satisfactory.

W_v: Vehicle Weight
W_s: Shot Weight
C: Charge Weight

RD: Ram Distance
RL: Ram Load
ChV: Chamber Volume
Rec: Recoil
BE: Bore evacuation

St: Strain Gauge
EP: Electrical Probe (left, right, average)
R: Radar
EF: East Fastax
WF: West Fastax

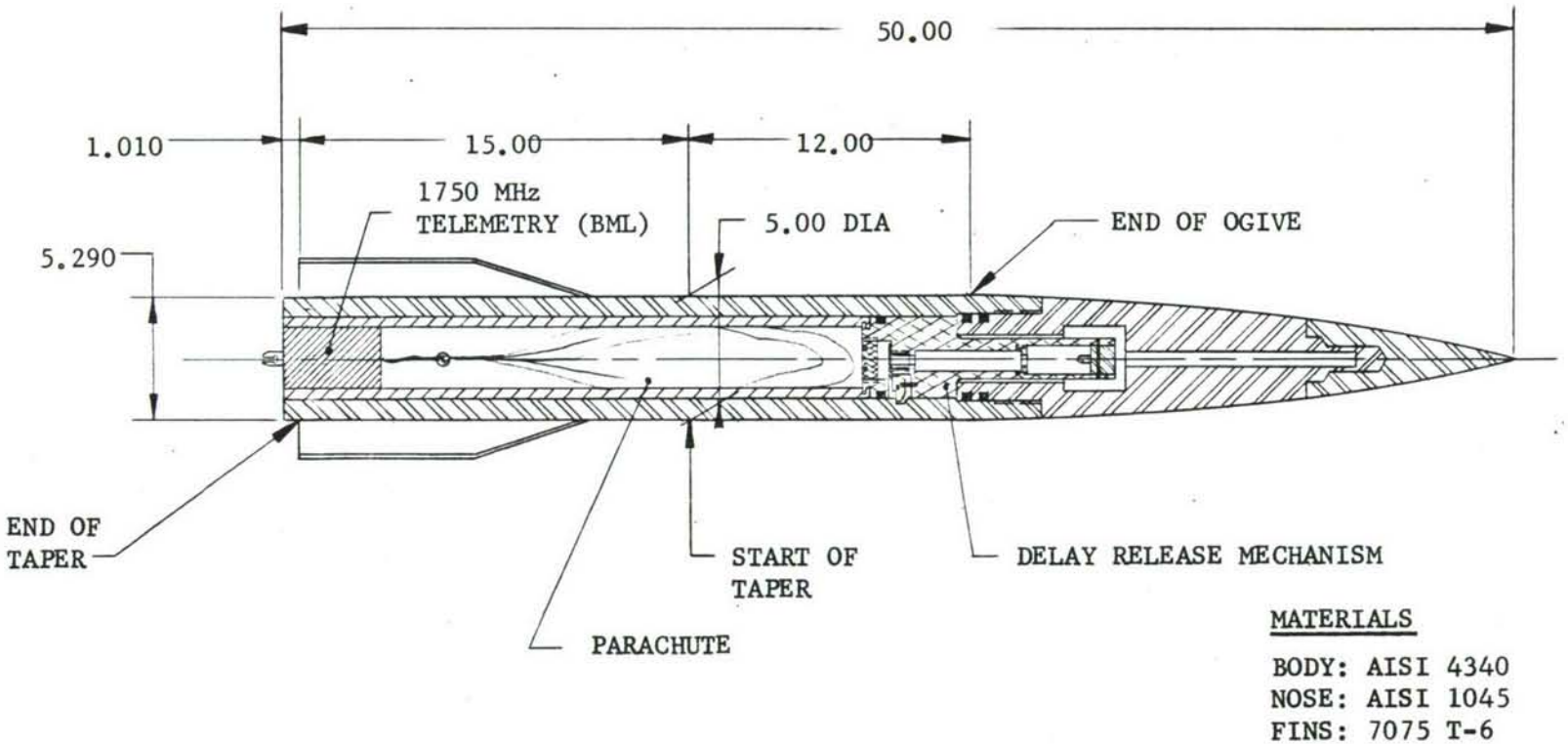


FIG. 1.4 MARTLET 2C (MOD 3)

CHAFF AND PARACHUTE EJECTION PAYLOAD, NOVEMBER 1965

at four different spacings from the telemetry unit. The three shots were fired at an elevation of 85 degrees. Ejection was always apparent; the parachute opened in Round No. 159 after a free fall, did not open in Round No. 168, and performed well in No. 171. The telemetry unit did not perform fully satisfactorily. The telemetry signal was received during varying intervals, with good strength in the first and third rounds, and weak strength in the second round. The GMD tracking was always satisfactory during signal reception periods. The subcarrier oscillator failed in the first and third round but worked in the second round though with noisy periods. No wind or temperature data were obtained except for the second round with good Solistron temperature data though none on the shroud lines.

A summary of the flight results of these four rounds is given in Table VI.

TABLE VI

NOVEMBER 1965 TEST PROGRAM - MARTLET 2C (MOD. 3) FIRINGS

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
157 YORKSHIRE 16 November 1965 1815 AST QE 85 deg	Martlet 2C (Mod. 3) carrying a 12 lb ejection payload of cesium	W_v: 181.5 W_s: 414.5 C: 725 (M8M.22)	RD: 194 in RL: 16 tons ChV: 41,220 in^3 Rec: 37.5 in BE: None	St: 35,000 M11: 35,200 Mk6: 35,600	EP: 5580 5770 5680	R: 390,000 (119)	Successful round
159 BRIDGETOWN 17 November 1965 1616 AST QE 85 deg	Martlet 2C (Mod. 3) carrying a payload consisting of S-band chaff and a parachute telemetry package with thermistors	W_v: 184.5 W_s: 434.0 C: 625 (WMM.225)	RD: 192 in RL: 14 tons ChV: 40,800 in^3 Rec: 33 in BE: None	St: 24,800 M11: 25,700 Mk6: -	EP: 4820 - -	R: 279,000 (85)	Successful launch, trajectory and ejection. Telemetry not satisfactory as subcarrier oscillator did not function. No wind or temperature data obtained.

TABLE VI (continued)

Flight	Vehicle Description	Weight (lb)	Launch Data	Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Apogee ft(km)	Comments
168 KENDALL 19 November 1965 1330 AST QE 80 deg	Martlet 2C (Mod. 3) carrying a payload consisting of S-band chaff and a parachute telemetry package with thermistors	W_v: 183.5 W_s: 430.5 C: 590 (WMM.225)	RD: 194 in RL: 15 tons ChV: 41,220 in^3 Rec: 30 in BE: None	St: 23,650 M11: 22,150 Mk6: 21,900	EP: 4650 - -	R: 237,000 (72)	Successful launch trajectory and ejection. Parachute did not open, and only partial test results obtained. The telemetry system not fully satisfactory.
171 LANCASTER 20 November 1965 1647 AST QE 85 deg	Martlet 2C (Mod. 3) carrying a payload consisting of S-band chaff and a parachute telemetry package with thermistors	W_v: 183.5 W_s: 431.5 C: 580 (WMM.225)	RD: 194 in RL: 11 tons ChV: 41,220 in^3 Rec: 30 in	St: 17,400 M11: - Mk6: -	EP: - - - (R: 4250)	R: 190,000 (58)	Successful round. The telemetry worked properly except that subcarrier oscillator failed at launch.

W_v: Vehicle Weight
W_s: Shot Weight
C: Charge Weight

RD: Ram Distance
RL: Ram Load
ChV: Chamber Volume
Rec: Recoil
BE: Bore evacuation

St: Strain Gauge
EP: Electrical Probe
R: Radar

4.0 RESULTS

4.1 Gun Ballistic Performance

The maximum breech pressures measured by crusher gauges and a strain gauge are given in Table VII for all rounds of this series. With a few exceptions, the agreement between crusher and strain gauge data is satisfactory. Muzzle velocities were obtained by electrical probes and are shown in Table VIII for all except four rounds, where no probe data were available. In two of these four rounds the radar results obtained using standard drag trajectories are inserted (marked R); it must, however, be remembered that these data may not represent the actual velocities since they are based on an average, or "standard", drag (see Ref. 3, p. I-25).

For comparison purposes the breech and velocity data are corrected for "standard" launch conditions which were arbitrarily taken as 50 tons ram load, 40,000 in^3 chamber volume, and shot weights of 400 or 600 lb.*) The corrections were calculated according to the following formulae:

$$P_{corr} = \left[P \left(1 - \frac{\triangle Vol}{40,000} \right) + C \frac{\triangle R}{15} \right] \left(1 + \frac{\triangle W}{1,000} \right)$$

$$V = V \left(1 - \frac{\triangle Vol}{160,000} + \frac{C}{P} \frac{\triangle R}{15} \right) \left(1 + \frac{\triangle W}{2,000} \right)$$

where:

P = breech pressure, psi
C = charge weight, lbs
V = muzzle velocity, ft/sec

$\triangle$ Vol = change in chamber volume, in^3
$\triangle$ R = change in ram load, tons
$\triangle$ W = change in weight, lbs

*) The correction for weight change differs here somewhat from the one used previously (Ref. 3) where an average correction, independent of the launch condition, was applied.

Both test and corrected data are summarized in Table IX and plotted in Figs. 1.5 and 1.6 versus charge weight. The effect of propellant is clearly indicated. The "standard" curves for M8M.22 have been taken from the previous firings; the corrected data of this series are in good agreement with these curves. The curves for M8M.27 have been drawn through the corrected test points; the effect of the change in web size or lower burning rate is a shift of 115-150 lbs to higher charge weights for the same pressure and velocity. Only seven rounds were fired with WMM.225; the resulting empirical curves for 400 lb shot weight were drawn by using also some previous shots with this propellant. The curves for 600 lb shot weight were then derived by using the above mentioned weight correction. The WMM propellant appears, as already observed at previous firings (Ref. 3), to increase the pressure and decrease the muzzle velocity for the same charge weight of the M8M propellant. Fig. 1.7 shows the relation between muzzle velocity and maximum breech pressure.

In all rounds with M8M.27 the charge was loaded with wooden spacers; in all rounds with the two other propellants no spacers were used except for Round No. 172 - VAUXHALL. No conclusion can therefore be drawn regarding the effect of spacers on the ballistic performance of the gun. A very smooth pressure - time curve, however, was obtained with this method of loading.

In 12 rounds the gun was evacuated to a vacuum of between 21 and 29 inches of Mercury. The velocity results of the rounds with evacuated gun were, on the average, slightly higher than those of the non-evacuated rounds for the same charge weight and propellant.

TABLE VII - NOVEMBER 1965 SERIES - MAXIMUM BREECH PRESSURES

No.	Name	Vehicle	Shot Wt. (lb)	Charge Wt. (lb)	Propellant	Gun Evacuated	Chamber Vol (in^3)	Ram Load (tons)	Breech Pressure (psi) M11	Mk6	Average	Strain
153	TS 1	TS	403.0	735	WMM.225	None	40800	30	41,300	41,100	41,200	---
154	FOAM	3B	570.5	590	WMM.225	None	39750	55	25,100	24,900	25,000	25,400
155	GOOSE	3B	568.5	590	WMM.225	None	39630	36	27,900	24,300	26,100	28,100
156	ZENMAC	2C-2	416.0	725	M8M.220	None	41200	10	32,700	33,900	33,300	33,400
157	YORKSHIRE	2C-3	414.5	725	M8M.220	None	41220	16	35,200	35,600	35,400	35,000
158	HAHA	3B	567.0	540	WMM.225	None	39950	26	19,300	—	—	19,400
159	BRIDGETOWN	2C-3	434.0	625	WMM.225	None	40800	14	25,700	—	—	24,800
160	CHRISTCHURCH	2C-2	415.0	750	M8M.220	Yes	40800	15	40,900	—	—	40,700
161	DOVER	2C-2	416.3	750	M8M.220	None	41300	9	37,900	—	—	37,900
162	ENTERPRISE	2C-2	418.0	770	M8M.220	Yes	41640	12	40,000	—	—	40,000
163	FOUL BAY	2C-2	415.3	770	M8M.220	Yes	41640	15	41,150	—	—	41,400
164	GUN HILL	2C-2	415.5	770	M8M.220	Yes	41640	19	41,500	—	—	41,400
165	HASTINGS	2C-2	417.5	790	M8M.220	Yes	41640	18	53,300	—	—	43,000
166	INDIAN GROUND	2C-2	418.0	750	M8M.220	Yes	41640	16	42,200	—	—	43,600
167	JAMESTOWN	2C-2	415.0	750	M8M.220	None	41640	18	37,900	—	—	38,200
168	KENDALL	2C-3	430.5	590	WMM.225	None	41220	15	22,150	21,900	22,000	23,650
169	TS 2	TS	397.5	750	M8M.270	None	41860	12	21,900	26,600	24,200	23,300
170	WORTHING	2C-2	380.0	850	M8M.270	Yes	41640	20	31,400	31,100	31,300	32,900
171	LANCASTER	2C-3	431.5	580	WMM.225	None	41220	11	—	—	—	17,400
172	VAUXHALL	2C-2	383.0	780	M8M.220	Yes	41640	18	39,800	—	—	39,000
173	MAXWELL	2C-2	380.8	915	M8M.270	None	39300	100	49,500	—	—	49,200
174	NEEDHAM'S POINT	2C-2	387.5	930	M8M.270	Yes	41640	17	42,800	—	—	42,200
175	OLDBURY	2C-2	391.0	975	M8M.270	Yes	41640	12	49,100	—	—	47,400
176	PARAGON	2C-2	391.0	930	M8M.270	Yes	42500	10	45,100	—	—	43,900
177	QUEEN'S FORT	2C-2	388.0	930	M8M.270	None	42500	10	42,400	—	—	42,300
178	ROCKLEY	2C-2	381.1	950	M8M.270	Yes	42500	10	45,000	—	—	43,800
179	SEAWELL	2C-2	388.5	975	M8M.270	None	43100	10	46,200	—	—	46,000

TABLE VIII - NOVEMBER 1965 SERIES - MUZZLE VELOCITIES

No.	Name	Vehicle	Shot Wt. (lb)	Charge Wt. (lb)	Propellant	Gun Evacuated	Muzzle Velocity (ft/sec)
153	TS 1	TS	403.0	735	WMM.225	None	--
154	FOAM	3B	570.5	590	WMM.225	None	4520
155	GOOSE	3B	568.5	590	WMM.225	None	4580
156	ZENMAC	2C-2	416.0	725	M8M.220	None	5640
157	YORKSHIRE	2C-3	414.5	725	M8M.220	None	5680
158	HAHA	3B	567.0	540	WMM.225	None	4080
159	BRIDGETOWN	2C-3	434.0	625	WMM.225	None	4820
160	CHRISTCHURCH	2C-2	415.0	750	M8M.220	Yes	6010
161	DOVER	2C-2	416.3	750	M8M.220	None	5760
162	ENTERPRISE	2C-2	418.0	770	M8M.220	Yes	5990
163	FOUL BAY	2C-2	415.3	770	M8M.220	Yes	6120
164	GUN HILL	2C-2	415.5	770	M8M.220	Yes	5970
165	HASTINGS	2C-2	417.5	790	M8M.220	Yes	--
166	INDIAN GROUND	2C-2	418.0	750	M8M.220	Yes	5980
167	JAMESTOWN	2C-2	415.0	750	M8M.220	None	5670
168	KENDALL	2C-3	430.5	590	WMM.225	None	4650
169	TS 2	TS	397.5	750	M8M.270	None	4780
170	WORTHING	2C-2	380.0	850	M8M.270	Yes	5620
171	LANCASTER	2C-3	431.5	580	WMM.225	None	(4250)R*
172	VAUXHALL	2C-3	383.0	780	M8M.220	Yes	6140
173	MAXWELL	2C-2	380.8	915	M8M.270	None	(6300)R*
174	NEEDHAM'S POINT	2C-2	387.5	930	M8M.270	Yes	6090
175	OLDBURY	2C-2	391.0	975	M8M.270	Yes	6420
176	PARAGON	2C-2	391.0	930	M8M.270	Yes	6240
177	QUEEN'S FORT	2C-2	388.0	930	M8M.270	None	6090
178	ROCKLEY	2C-2	381.1	950	M8M.270	Yes	6210
179	SEAWELL	2C-2	388.5	975	M8M.270	None	6230

* Radar results for Standard Trajectory. All other data are Muzzle Velocity Probe results

TABLE IX - NOVEMBER 1965 SERIES - BREECH PRESSURES AND MUZZLE VELOCITIES

Shot No.		Name	Test Data		Corrected Data	
			Breech Pressure (psi)	Muzzle Velocity (ft/sec)	Breech Pressure (psi)	Muzzle Velocity (ft/sec)
153	□	TS 1	41,200	--	42,900	--
154	□	FOAM	25,400	4,520	25,800	4,440
155	□	GOOSE	28,100	4,580	29,300	4,520
156	△	ZENMAC	33,400	5,640	35,800	5,810
157	△	YORKSHIRE	35,000	5,680	37,200	5,830
158	□	HAHA	19,400	4,080	20,900	4,060
159	□	BRIDGETOWN	24,800	4,820	25,900	5,000
160	△	CHRISTCHURCH	40,700	6,010	42,600	6,150
161	△	DOVER	37,900	5,760	40,500	5,930
162	△	ENTERPRISE	40,000	5,990	42,800	6,180
163	△	FOUL BAY	41,400	6,120	44,200	6,300
164	△	GUN HILL	41,400	5,970	44,000	6,140
165	△	HASTINGS	43,000	--	45,600	--
166	△	INDIAN GROUND	43,600	5,980	46,200	6,160
167	△	JAMESTOWN	38,200	5,670	40,700	5,830
168	□	KENDALL	23,700	4,650	25,000	4,830
169	○	TS 2	23,300	4,780	26,400	4,930
170	○	WORTHING	32,900	5,620	36,700	5,690
171	□	LANCASTER	17,400	4,250	18,800	4,440
172	△	VAUXHALL	39,000	6,140	43,000	6,220
173	○	MAXWELL	49,200	6,300	46,200	6,120
174	○	NEEDHAM'S POINT	42,200	6,090	46,500	6,190
175	○	OLDBURY	47,400	6,420	52,300	6,540
176	○	PARAGON	43,900	6,240	49,600	6,400
177	○	QUEEN'S FORT	42,300	6,090	48,000	6,230
178	○	ROCKLEY	43,800	6,210	50,000	6,340
179	○	SEAWELL	46,000	6,230	52,860	6,400

Corrected Values for:
Chamber Volume 40,000 in^3, Ram Load 50 tons, Shot Weight 400 lbs (except for Shot No. 154,155,158 where Shot Weight 600 lbs.)

□ WMM.225
△ M8M.220
○ M8M.270
} propellant used

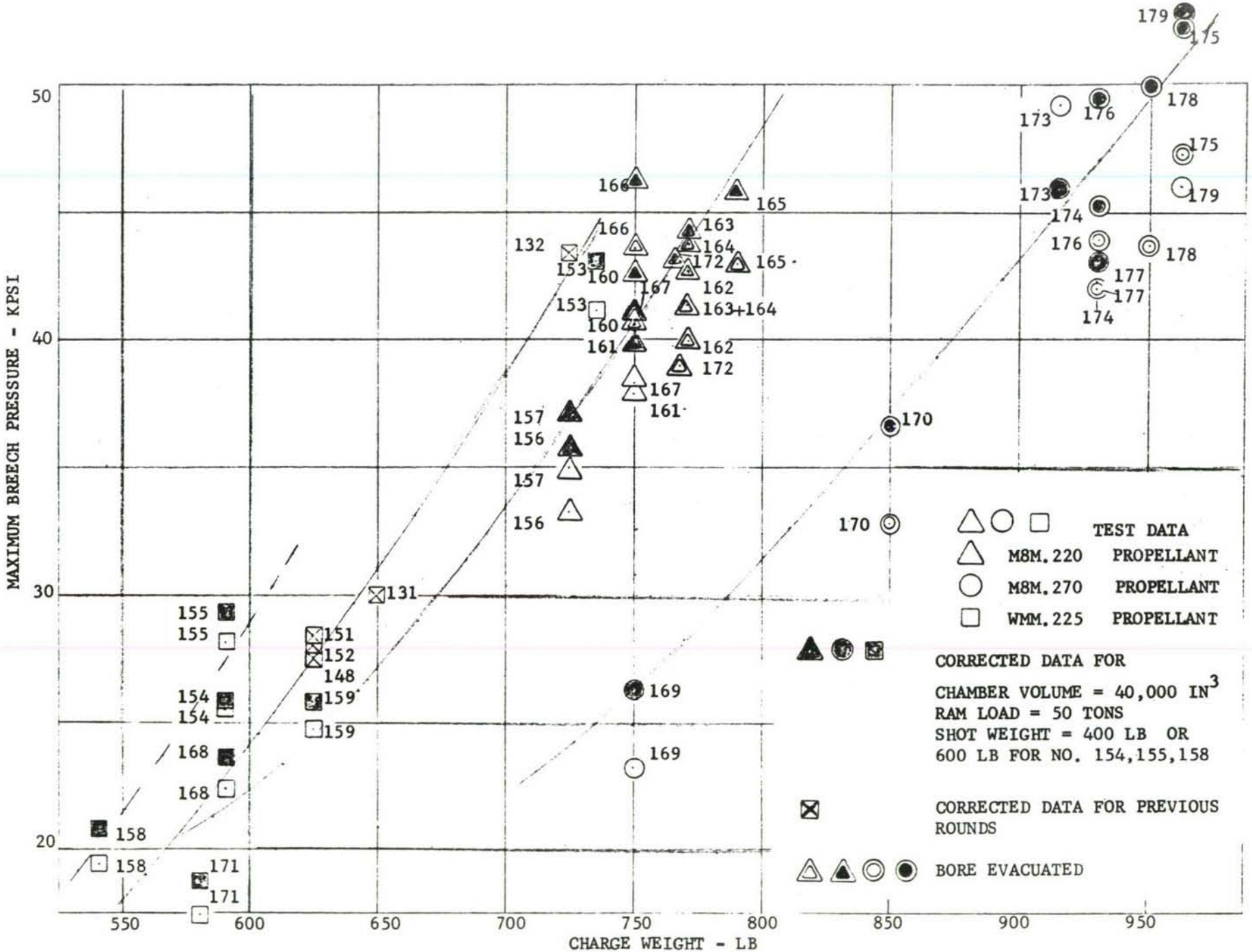


FIG. 1.5 BREECH PRESSURE VS CHARGE WEIGHT

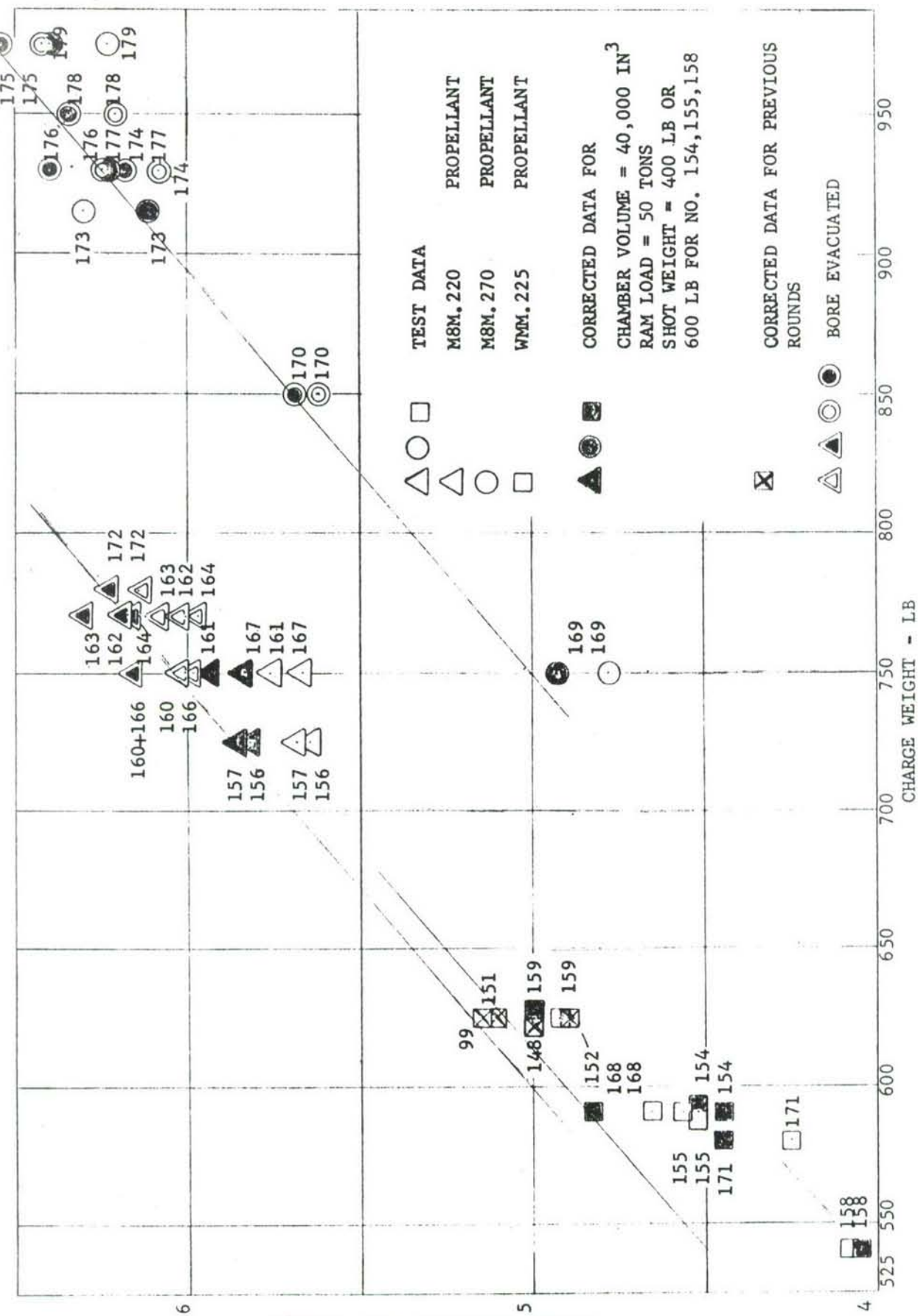


FIG. 1.6 MUZZLE VELOCITY VS CHARGE WEIGHT

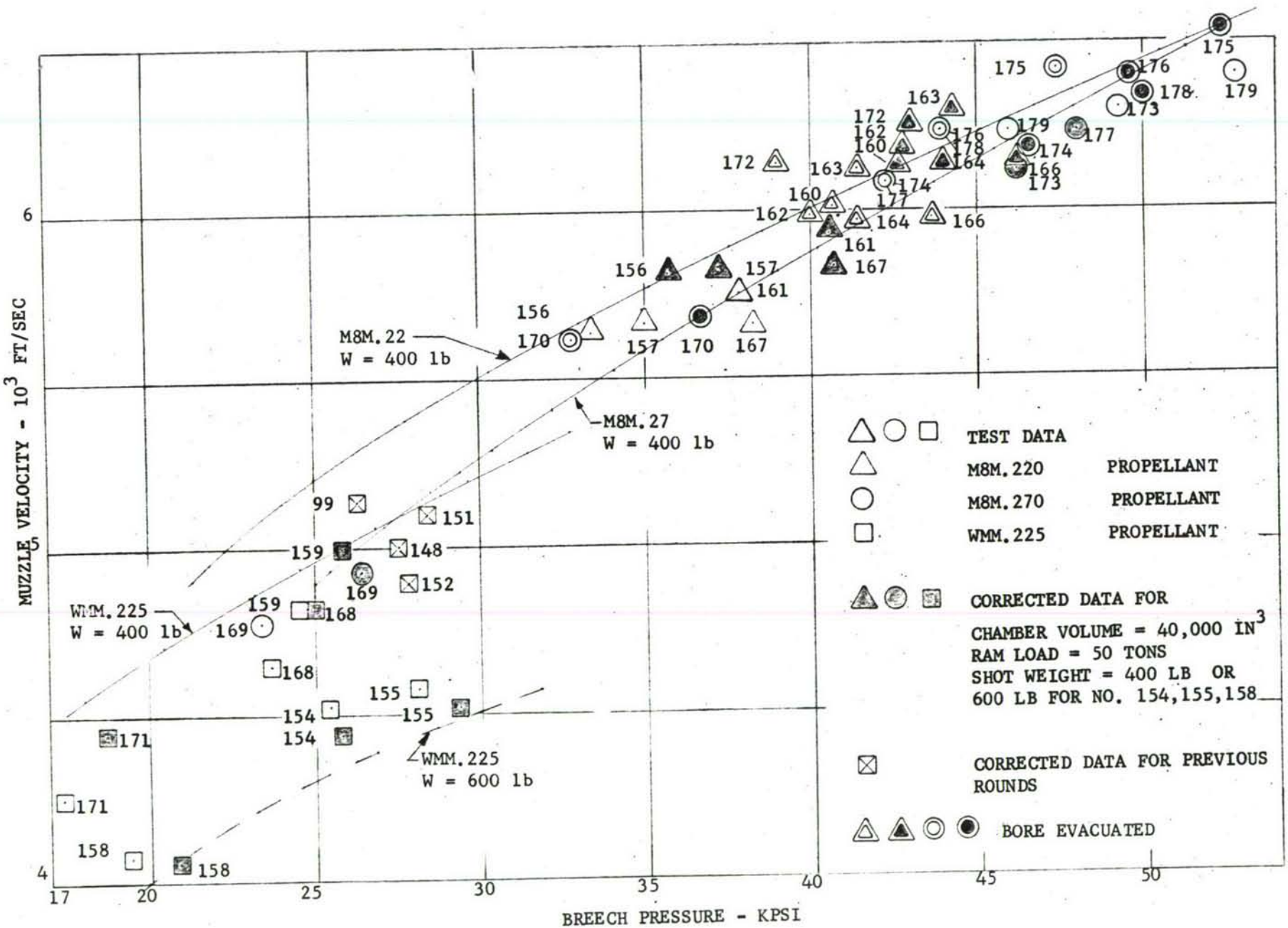


FIG. 1.7 MUZZLE VELOCITY VS BREECH PRESSURE

4.2 Trajectory Results

A summary of the apogees and ranges obtained is given in Table X for all rounds except the two test slugs. The apogee figures obtained by calculation using the radar data were found to be in good agreement with the data obtained from the trail analysis in the TMA rounds. The total range data were estimated from the available radar data, with the exception of a few rounds where the range was measured. The total ranges are approximately 1/3 of the apogee for 65 deg firings and approximately 2/3 of the apogee for the 80 deg firings.

The TMA rounds reached apogees between 119 and 127 km in the first night series, when M8M.22 was used. In the second night series, with M8M.27 propellant and spacers, apogees of between 133 and 143 km were obtained.

Tables of the MPS-19 and M-33 radar trajectory data are given in Part III.

4.3 Wind Data

Twelve of the fifteen TMA release rounds fired in two synoptic night series, and the one Cesium release round, furnished trails which where analysed by Space Instruments Research to give wind components, wind speed and direction (Ref. 4 and 5). In Table XI, a summary of the thirteen data shots is given.*)

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*) For a summary of previous trails, see Appendix A-2.

TABLE X - APOGEE AND RANGE DATA - NOVEMBER 1965 TEST SERIES

Round No.	Veh.Wt. lb.	Muzzle Vel. ft/sec	Elevation deg.	Apogee ft.	Apogee km	Estimated Range ft	
154	299	4520	75	36,000	11	17,000*	
155	298	4580	75	--		--	Vehicle damaged
156	176	5640	80	360,000	110	252,000*	~~Cesium trail~~
157	182	5680	85	390,000	119	130,000	Cesium trail
158	296	4080	75	38,600	12	25,700*	
159	185	4820	85	279,000	85	93,000	
160	182	5010	85	392,000	120	105,000	
161	184	5760	85	400,000	122	129,000	
162	185	5990	85	231,000	71	79,000	Vehicle damaged
163	184	6120	85	404,000	123	141,000	
164	184	5970	85	413,000	126	140,000	
165	184		85	104,000	32		Vehicle damaged
166	184	5980	85	400,000	122	140,000	
167	184	5670	85	391,000	119	124,000	
168	184	4650	80	237,000	72	155,000	
169						4,000*	
170	180	5620	80	340,000	104	247,000	
171	184	4250(R)	85	190,000	58	63,000	
172	183	6140	80	418,000	128	287,000	
173	181	6300(R)	85	467,000	142	156,000	
174	184	6090	85	435,000	133	145,000	
175	186	6420	85	102,000	31	10,000*	Vehicle damaged
176	186	6240	85	442,000	135	148,000	
177	184	6090	85	436,000	133	148,000	
178	184	6210	85	470,000	143	159,000	
179	183	6230	85	464,000	141	156,000	

* Measured

Round 157 - YORKSHIRE differed from the twelve other TMA rounds in that Cesium was released as a point at T + 94 seconds at an altitude of 101 km, so that no "trail" over an altitude band was obtained. The point release remained visible for approximately 100 seconds and showed a considerable vertical motion of about 38 m/sec to above 105 km before fading from view. A comprehensive discussion of this round can be found in Ref. 6.

In the TMA rounds, uptrail and downtrail results were usually similar, with a few exceptions.

Examples of trail photographs are presented in Fig. 1.8a to d which show the trail development of the INDIAN GROUND shot from 124 to 252 seconds after launch. The change of wind components during the night of 17/18 November 1965 is shown in Fig. 1.9 a and b versus altitude, and for the second night series 22/23 November 1965 in Fig. 1.10 a and b. All these figures demonstrate that remarkable change of wind speed and direction can occur with altitude as well as with time. The contour charts, Fig. 1.11 a,b and 1.12 a,b show this even more conspicuously. A more detailed discussion is given in Ref. 7.

Tables and graphs of wind components, speed, and direction for all thirteen rounds are given in Part IV.

TABLE XI - SUMMARY OF TRAILS

Trail No.	Name	Shot No.	Date 1965	Time AST	Altitude km	Comments
30	YORKSHIRE	157	16 Nov.	1815	101	Cesium Point release
31	CHRISTCHURCH	160	17 Nov.	1815	92 - 119	TMA Release Series
32	DOVER	161	17 "	1934	91 - 122	
33	FOUL BAY	163	17 "	2315	93 - 127	
34	GUN HILL	164	18 "	0045	96 - 127	
35	INDIAN GROUND	166	18 "	0330	98 - 117	
36	JAMESTOWN	167	18 "	0508	93 - 119	
37	MAXWELL	173	22 "	1809	94 - 120	TMA Release Series
38	NEEDHAM'S POINT	174	22 "	1930	93 - 134	
39	PARAGON	176	22 "	2259	99 - 126	
40	QUEEN'S FORT	177	23 "	0131	100 - 133	
41	ROCKLEY	178	23 "	0328	95 - 138	
42	SEAWELL	179	23 "	0516	91 - 130	



FIG. 1.8a INDIAN GROUND TRAIL
AT T + 124 SEC (PARAGON STATION)



FIG. 1.8b INDIAN GROUND TRAIL
AT T + 154 SEC (PARAGON STATION)



FIG. 1.8c INDIAN GROUND TRAIL
AT T + 214 SEC (PARAGON STATION)



FIG. 1.8d INDIAN GROUND TRAIL
AT T + 251 SEC (PARAGON STATION)

SYNOPTIC SERIES 17/18 NOVEMBER, 1965

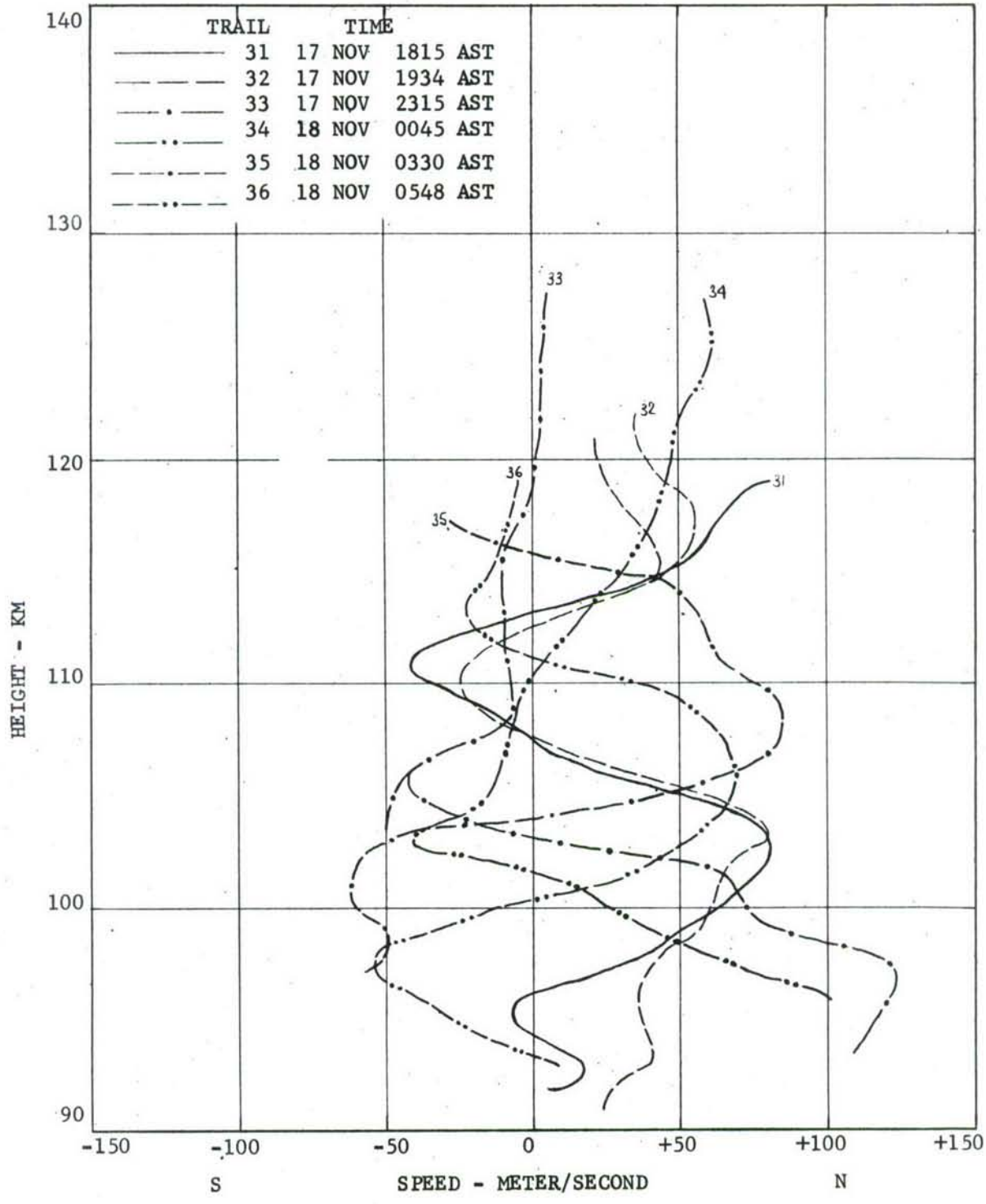


FIG. 1.9a NORTH-SOUTH WIND COMPONENT CHANGE

SYNOPTIC SERIES 17/18 NOVEMBER, 1965

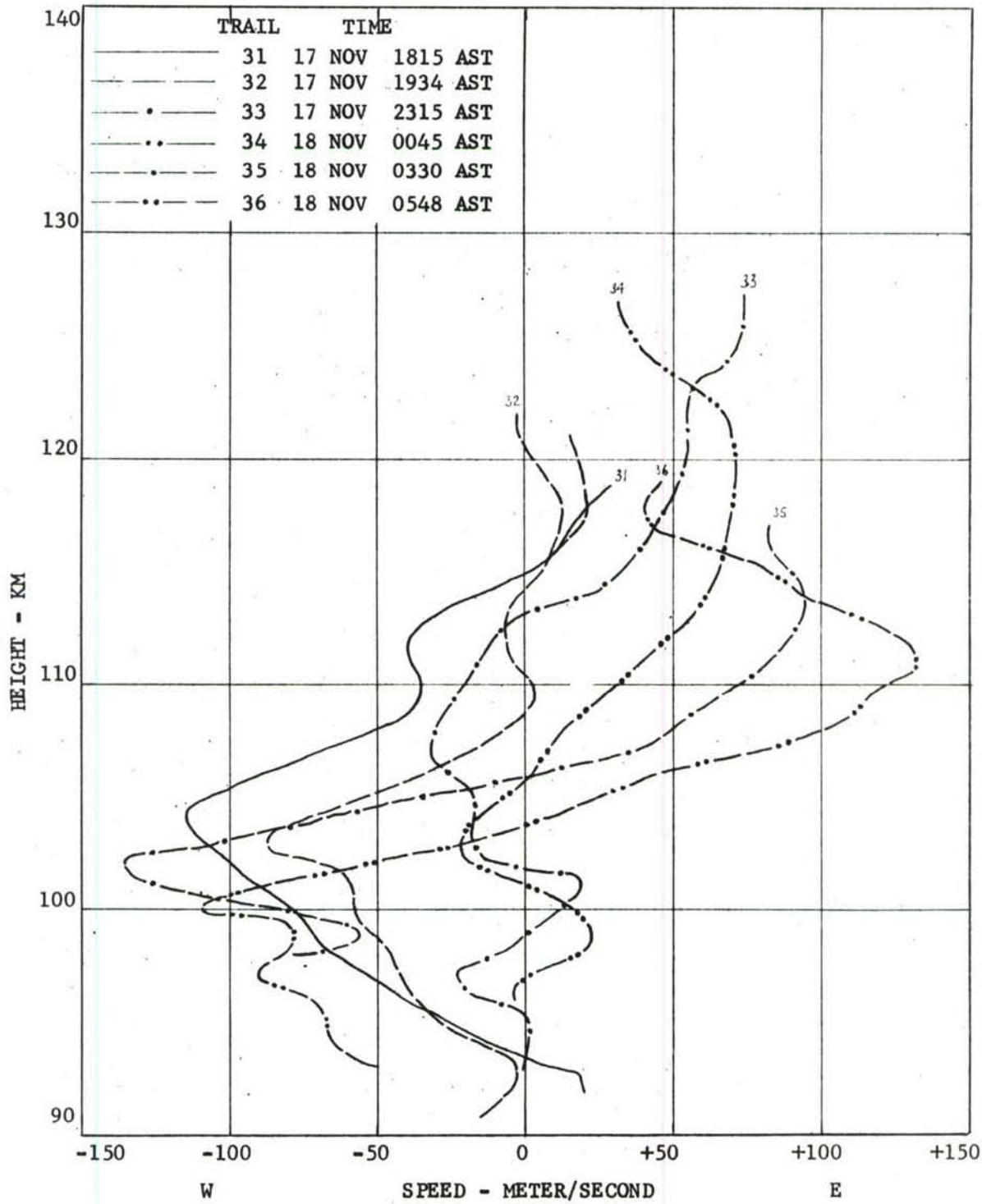


FIG. 1.9b EAST-WEST WIND COMPONENT CHANGE

SYNOPTIC SERIES 22/23 NOVEMBER, 1965

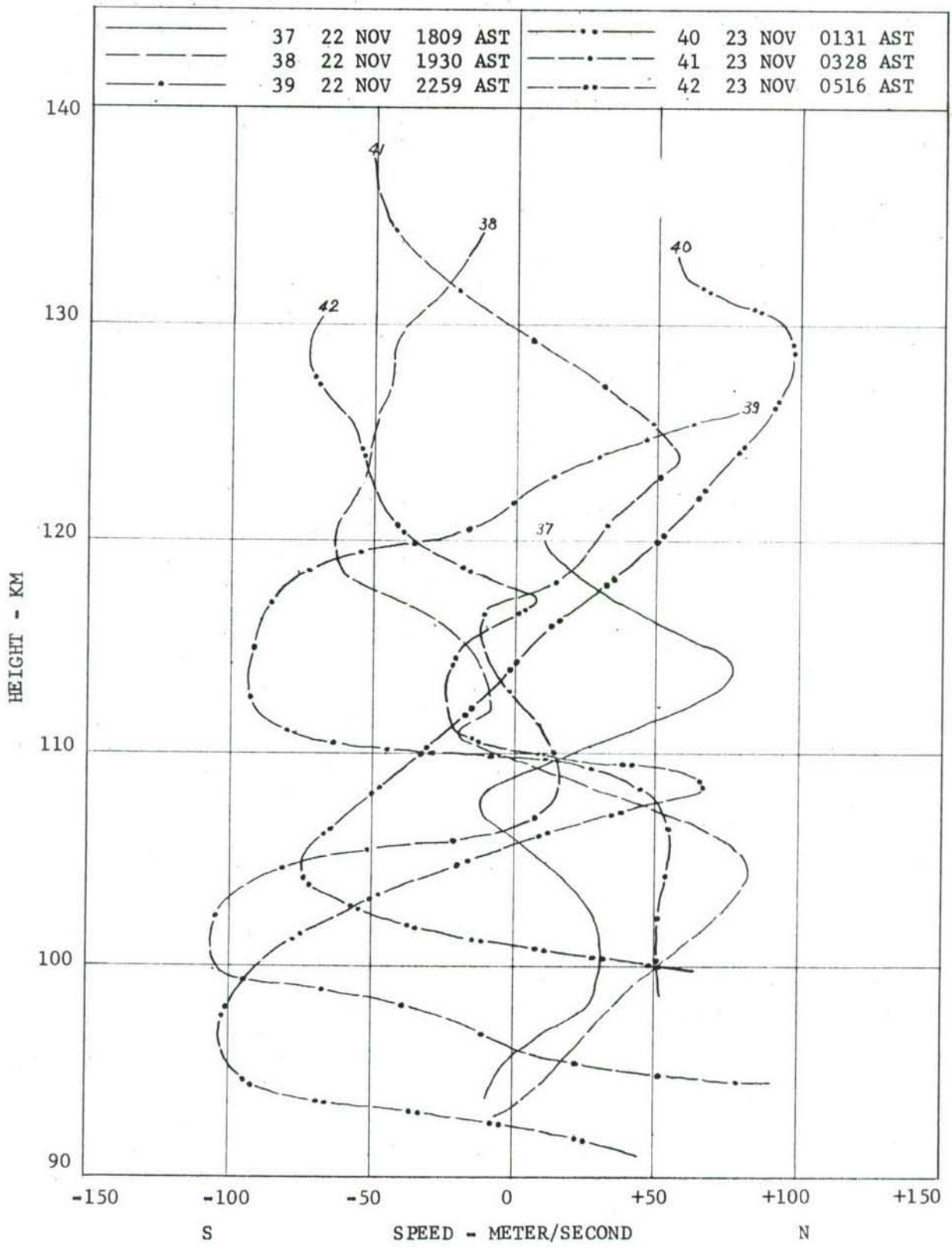


FIG. 1.10a NORTH-SOUTH WIND COMPONENT CHANGE

SYNOPTIC SERIES 22/23 NOVEMBER, 1965

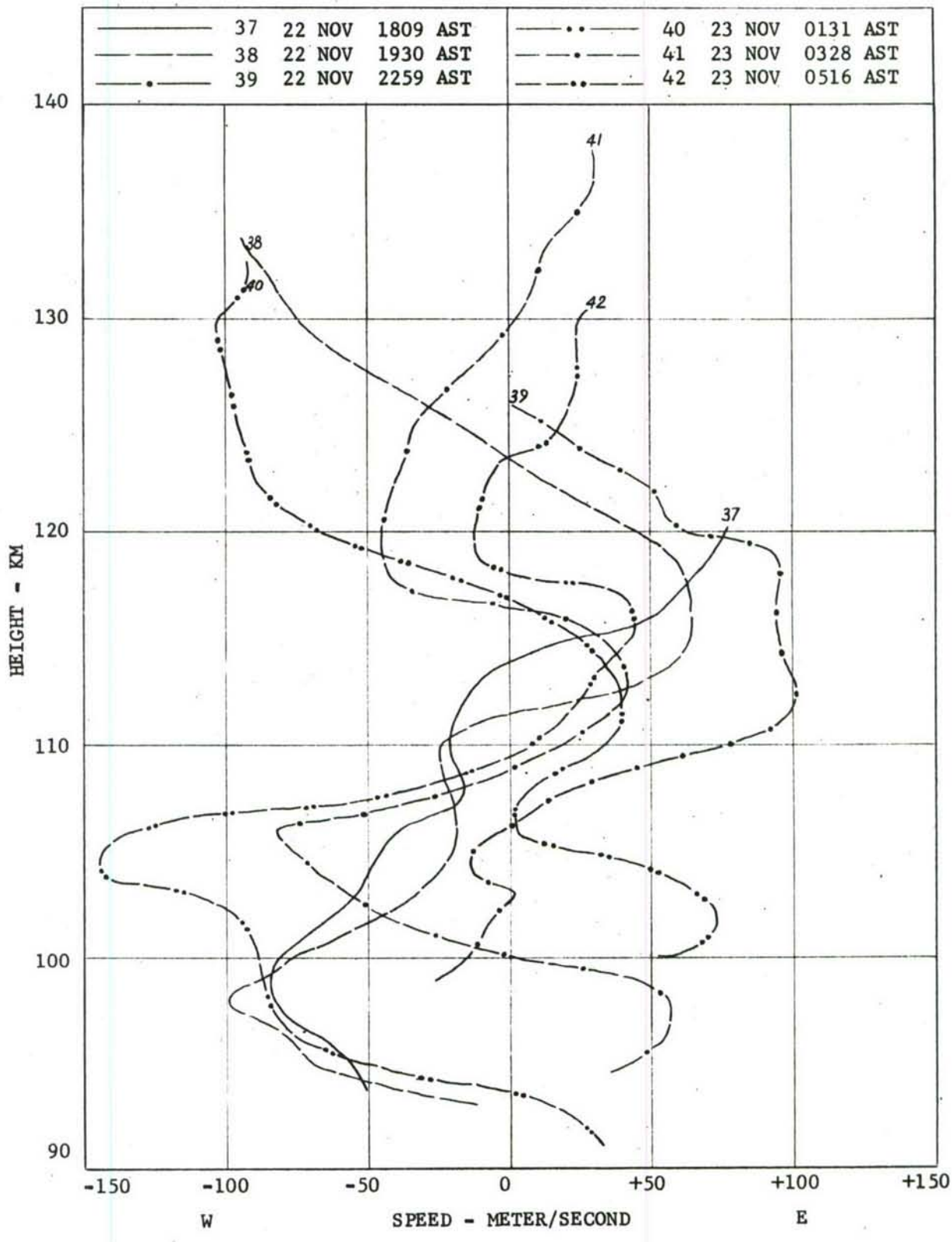
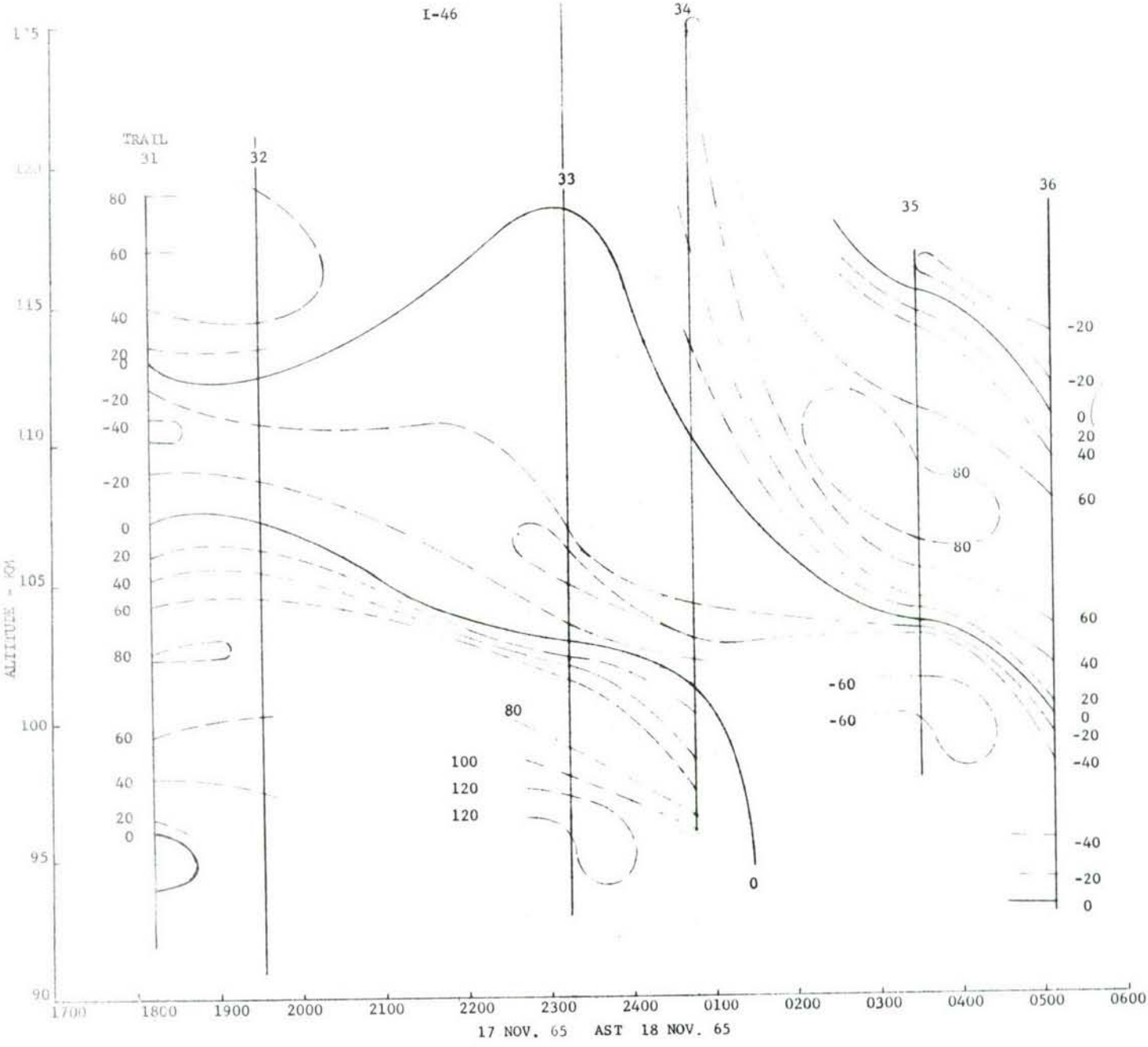
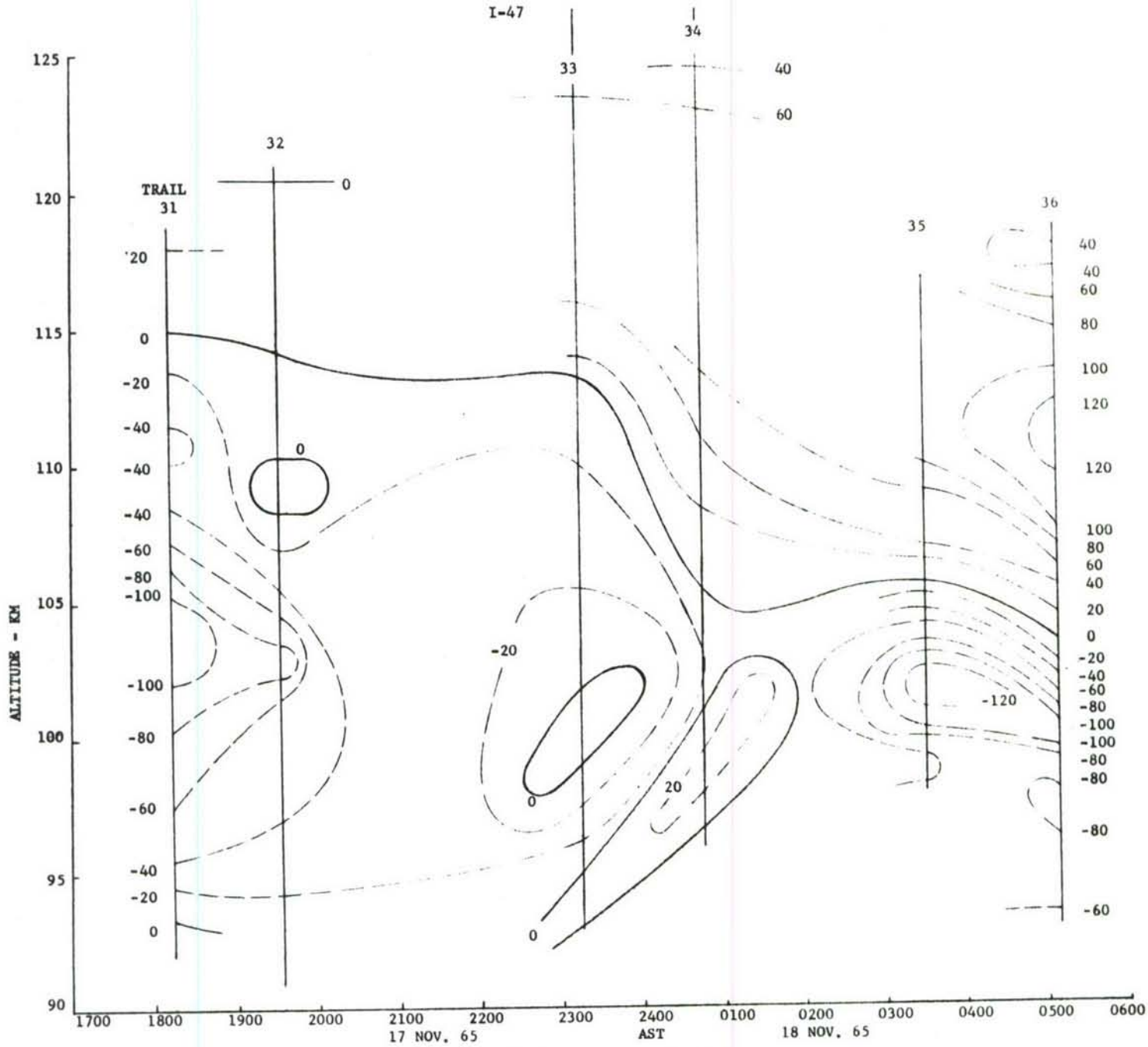


FIG. 1.10b EAST-WEST WIND COMPONENT CHANGE



SYNOPTIC WIND MEASUREMENTS
17/18 NOVEMBER 1965

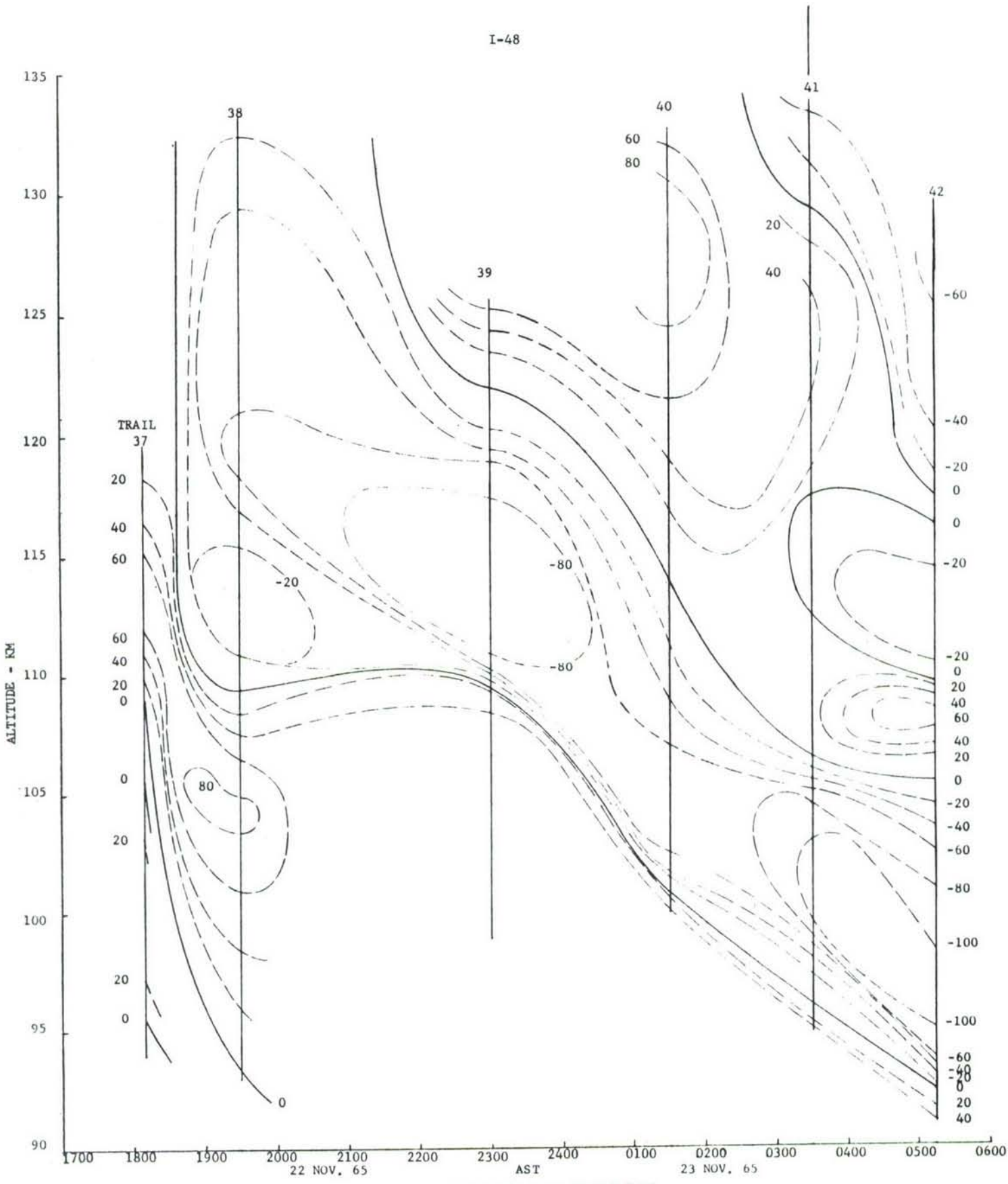
MERIDIONAL WINDS (m/sec)
(UPTRAIL DATA)
FIG. 1.11a



SYNOPTIC WIND MEASUREMENTS
17/18 NOVEMBER 1965

UPTRAIL ZONAL WINDS (m/sec)

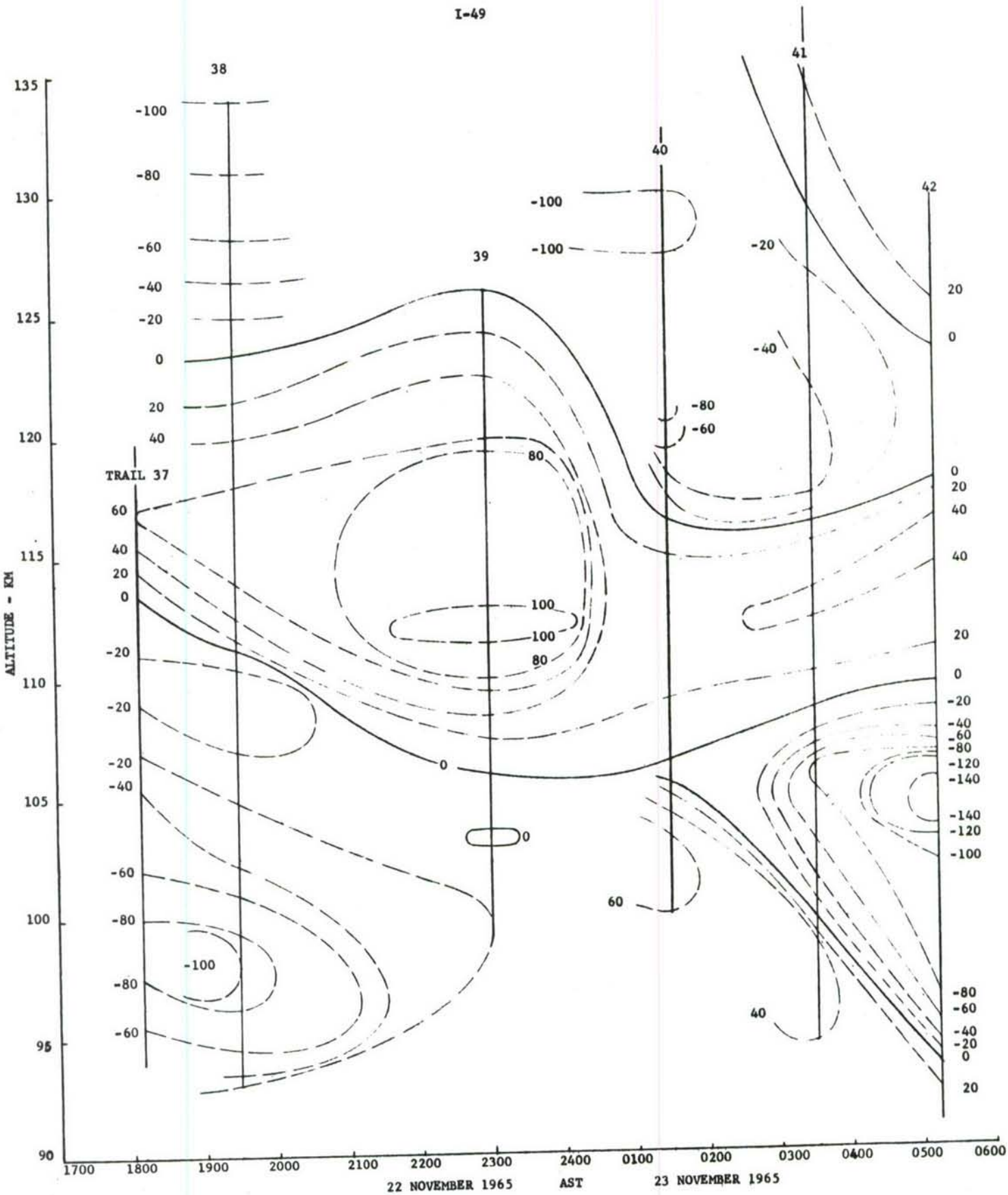
FIG. 1.11b



SYNOPTIC WIND MEASUREMENTS
22/23 NOVEMBER 1965

MERIDIONAL WINDS (m/sec)
(UPTRAIL DATA)

FIG. 1.12a



SYNOPTIC WIND MEASUREMENTS
22/23 NOVEMBER 1965

ZONAL WINDS (m/sec)
(UPTRAIL DATA)

FIG. 1.12b

5.0 SUMMARY AND CONCLUSIONS

The Barbados firing series of November 1965 continued the vehicle, instrumentation and payload development tests in addition to its main purpose, the obtaining of wind data in synoptic firings and their correlation with ionosonde drift data. The results are summarized in the following by discussing (1) gun and propellant performance, (2) vehicle performance, (3) instrumentation and payload performance, and (4) scientific results.

5.1 Gun and Propellant Performance

The gun ballistic performance was satisfactory, and previous results with M8M.220 and WMM.225 propellants were confirmed. The use of a slower burning M8M propellant with a web size of .270 gave the expected results. The performance curves of M8M.220 and WMM.225 vs the charge weight are similar, with a somewhat higher pressure and lower velocity for WMM.225 at a given charge. Higher charge weights, however, are required for the M8M.270 propellant to obtain the same pressure and velocity data as for M8M.220. Regarding the whole breech pressure range from 20 to over 50 Kpsi, M8M.220 shows the best velocity performance, with M8M.270 competing in the high pressure levels.

The effect of gun barrel evacuation appears, on the average, to be a slight increase of muzzle velocity. A new loading technique which used wooden spacers to achieve a more uniform spacing and burning of the charge, proved successful in that a very smooth pressure-time curve was obtained. No conclusion can be drawn regarding the effect on performance since, with the exception of one round, all rounds with one propellant were fired either with spacers or without spacers.

The semi-empirical formulae used to correct the pressure and velocity data for "standard" values of diameter, chamber volume, ram load, and weight, in order to make a comparison of the rounds possible, also proved useful.

In this series an apogee record was set with 143 km, at a breech pressure of 43,800 psi and a muzzle velocity of 6210 ft/sec. 950 lbs of M8M.270 with spacers were used in this shot of a Martlet 2C, fired from an evacuated gun at 85 degrees.*)

5.2 Vehicle Performance

The Martlet 2C vehicles, used in all but five rounds of this series, displayed its usual reliability. Three out of twenty-two Martlet 2C rounds were not successful apparently because of sabot failure and subsequent vehicle damage. In the latter part of the series a strengthened aluminum sabot was used, and a correspondingly changed pusher plate. This resulted in a weight reduction of approximately 30 lbs of shot weight.

The Martlet 3B vehicles, used to test the destruct system, were fitted with flip-out fins to obtain some aerodynamic stability. In one round the fins were damaged as indicated by photographic records, and no trajectory records were obtained. The other two rounds achieved satisfactory trajectories.

5.3 Instrumentation and Payload Performance

The performance of the TMA and Cesium payload was good, and satisfactory trails were obtained except in the three rounds of vehicle failure.

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*) The present record obtained with the 16 inch gun in Yuma, November 1966, is 180 km = 112 miles.

The tests of the destruct system in the Martlet 3B rounds were not successful since in one round the destruct system was fired before the set time, and in another probably activated when the vehicle was still in the gun. In both cases the destruction was not activated through ground control. In the third round no Pentolite destruct charge was carried. The HDL 250 MHz telemetry package worked until the probable firing time of the destruct system; however the receiver of the command destruct system failed in the third round.

One of the Martlet 2C rounds with TMA carried in the nose cone a telemetry package consisting of a 231 MHz transmitter with two subcarrier oscillators, to measure time pulses and temperature, and to test a high gain differential amplifier. Although good performance was indicated by pre-test data, the telemetry failed in flight, either because of power supply or transmitter failure. A further Martlet 2C round, without TMA and carrying a similar payload had partial success only. Apparently the quadraloop antenna was broken so that no temperature data were obtained.

The 1750 MHz telemetry packages attached to a parachute in three Martlet 2C (Mod 3) rounds did not perform to complete satisfaction. The telemetry signal was received during various intervals, and the GMD tracking was good during these periods but the subcarrier oscillator failed in two rounds. Temperature data at the Solistron were obtained in one round, but none however at the shroud lines.

The ejection system appeared to have worked in all three rounds, but the parachute did not open in one round.

In the sea impact payload tests there was no evidence of the SOFAR bomb in one round; however the bomb was successful in the other round.

5.4 Scientific Results

Wind measurements were obtained in two nights from sunset to sunrise, with six trails each. From these results, wind chart data could be drawn, showing not only wind changes with altitude but also with time. Ionosonde drift data were also obtained in all these rounds by the Environmental Sciences Services Administration (ESSA) of the U.S. Department of Commerce, Boulder, Colorado.

5.5 Conclusions

In general, the November 1965 series was successful. The synoptic TMA release series during two nights gave useful information on wind and ionospheric drift data at the 100 km level. The engineering development tests of ejection systems were satisfactory, and the ejection devices appear to be reliable. The telemetry units, however, were not yet perfect in all their parts although progress has been made; the high launch accelerations do not appear to present a problem, but further development and studies are required to obtain satisfactory performance of all telemetry parts.

The launching technique has been further improved by using spacers between the charge bags to spread the charge more evenly within the chamber and to achieve smoother burning. Summarizing, the series has demonstrated again that progress has been made with the gun launching technique, and that valuable information on properties of the upper atmosphere can be gained by this method.

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3. Luckert, H.J., Brathwaite, K. — Report of the August/September Test Firing Series, Project H.A.R.P., Report SRI-R-17

4. Space Instruments Research — Photographic Prints of TMA Releases, H.A.R.P. Series, 16-23 November 1965. Vols. I and II, December 1965

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6. Murphy, C.H., Bull, G.V., Wright, J.W. — Motions of an Electron-Ion Cloud Released at 100 kilometers from a Gun-Launched Projectile, Journal of Geophysical Research, Vol. 72, No. 13, July 1, 1967

7. Murphy, C.H., Bull, G.V. — Nighttime Variation of Ionospheric Winds over Barbados, West Indies, Journal of Geophysical Research, Vol. 72, No. 19, October 1, 1967

PART II

DETAILED FLIGHT PERFORMANCE

ROUNDS NO. 153 - 179

NOVEMBER 1965

Round No.	Name	Vehicle Martlet		Page	Figures
153	TEST SLUG 1	Test slug		II-2	
154	FOAM	3B		II-4	2.1,a,b,c
155	GOOSE	3B		II-11	2.2
156	ZENMAC	2C Mod 2		II-14	2.3,a,b
157	YORKSHIRE	2C Mod 3		II-19	2.4,a,b
158	HAHA	3B		II-25	2.5,a,b,c
159	BRIDGETOWN	2C Mod 3		II-32	2.6 a,b
160	CHRISTCHURCH	2C Mod 2		II-37	2.7,a,b
161	DOVER	2C Mod 2		II-42	2.8,a,b
162	ENTERPRISE	2C Mod 2		II-47	2.9,a,b
163	FOUL BAY	2C Mod 2	*	II-52	2.10,a,b
164	GUN HILL	2C Mod 2		II-57	2.11,a,b
165	HASTINGS	2C Mod 2		II-62	2.12,a,b
166	INDIAN GROUND	2C Mod 2		II-67	2.13,a,b
167	JAMESTOWN	2C Mod 2		II-72	2.14,a,b
168	KENDALL	2C Mod 3		II-77	2.15 a,b
169	TEST SLUG 2	Test slug		II-83	2.16, a
170	WORTHING	2C Mod 2		II-87	2.17,a,b
171	LANCASTER	2C Mod 3		II-92	2.18 a
172	VAUXHALL	2C Mod 2		II-96	2.19,a,b
173	MAXWELL	2C Mod 2		II-101	2.20,a,b
174	NEEDHAM'S POINT	2C Mod 2		II-106	2.21,a,b
175	OLDBURY	2C Mod 2	*	II-111	2.22
176	PARAGON	2C Mod 2		II-114	2.23,a,b
177	QUEEN'S FORT	2C Mod 2		II-119	2.24,a,b
178	ROCKLEY	2C Mod 2		II-124	2.25,a,b
179	SEAWELL	2C Mod 2		II-129	2.26,a,b

* Synoptic Series

Round No. 153 - TEST SLUG NO. 1

Date: 10 November 1965 - 1525 AST

Vehicle Description: Aluminum test slug

Purpose of Test: Engineering test

Weights: Vehicle and shot 403 lb

Gun Evacuation: None

Launch Data:

Charge Weight	735 lb WMM.225 (8 bags) LOT No. CAD 7502
Swedish Additive	15 sheets
Igniter	900 grams/bag
Gun Elevation	80 deg
Crusher Gauges	M11: 4 Mk6: 3
Ram Distance	192 in
Ram Load	30 tons
Chamber Volume	40,800 in^3
Recoil	36.3 in
Breech Pressure	M11: 41,300 psi Mk6: 41,100 psi Average: 41,200 psi Strain: Not Available
Muzzle Velocity (Probe)	Not Available

Camera Records:

No photographs were obtained; the film jammed in the one smear camera used, and the Fastax cameras were not in operation.

Radar Records:

The MPS-19 furnished no data.

The M-33 plot was too small for an accurate interpretation. The range at impact was recorded as 3,500 ft at T + 60 sec.

Trajectory:

No trajectory data were obtained.

Summary:

The round was successful as an engineering test.

Round No. 154 - FOAM

Date: 15 November 1965 - 1200 AST

Vehicle Description: Martlet 3B vehicle with "flip-out" fins, carrying an HDL 250 MHz telemetry package and a pentolite charge (0.5 lb) for the destruct system. Destruct was planned at T + 20 sec.

Destruct System:

The Command destruct system consisted of a 426 MHz FM receiver in the vehicle with logic circuits to enable destruction from the launch control office, and 250 MHz transmitter with a 40 KHz subcarrier oscillator to monitor the firing pulses.

Purpose of Test: Engineering test to prove the destruct system.

Weights:		
	Vehicle	298.5 lb
	Pusher and Obturator	143.0 lb
	Sabot	129.0 lb
	Shot Weight	570.5 lb

Centre of Gravity: 31.2 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	590 lb WMM.225 (6 bags), Lot No. CAD 7502
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	75 deg
Crusher Gauges	M11: 4 Mk6: 2
Ram Distance	187 in
Ram Load	55 tons
Chamber Volume	39,750 in^3
Recoil	31.5 in
Breech Pressure	M11: 25,100 psi Mk6: 24,900 psi Average: 25,000 psi Strain: 25,400 psi (Fig. 2.1)

Muzzle Velocity (Probe)

Left: 4,500 ft/sec
Right: 4,540 ft/sec
Average: 4,520 ft/sec

Camera Records:

The smear cameras, the Fastax stations and a cine-theodolite were in operation. Good photographs were obtained with the exception of the cine-theodolite since the vehicle did not reach the field of view anticipated.

Radar Records:

Both radars, M-33 and MPS-19 tracked the vehicle to splash-down.

Trajectory:

The resulting trajectory is shown in Fig. 2.1a. An abrupt change in velocity was apparent between T + 8 sec and T + 12 sec (see Fig. 2.1c). The apogee of 36,000 ft was obtained at T + 25 sec, and the total range was 17,000 ft.

Telemetry:

The telemetry was functioning at launch but the transmitter apparently did not work from T + 10 seconds on which probably indicates the destruction of the system. The destruction initiation could have been due to the transmitter squedging.

Destruct System:

The system probably fired at around T + 8 seconds though not as a result from ground control. This perturbation, however, did not damage the vehicle significantly; no dispersed vehicle parts were found or observed. The vehicle however was considerably decelerated, (approximately 30 g) between T + 8 and T + 9 seconds.

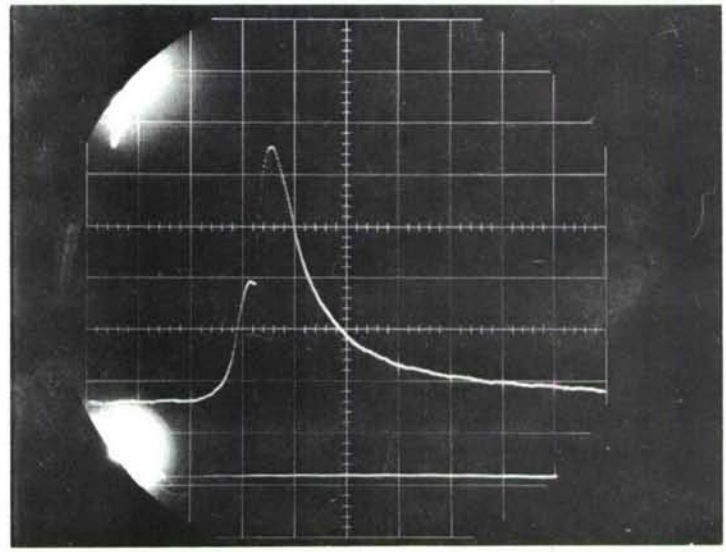
Summary:

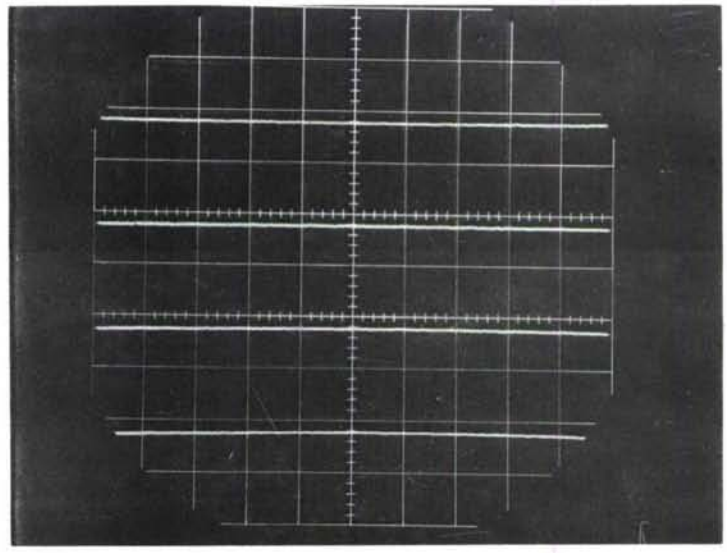
The gun and the vehicle apparently performed well at launch, with breech pressures and muzzle velocity as expected. The destruct system, however, did not work satisfactorily.

F O A M

15 NOVEMBER 1965 - 1200 AST

5085 psi/division
BREECH PRESSURE





10,350 psi/ohm
CALIBRATION
2 ohm

TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 25,400 psi

Charge: 590 lb WMM.225

FIG. 2.1 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND FOAM

F O A M

15 NOVEMBER 1965 - 1200 AST

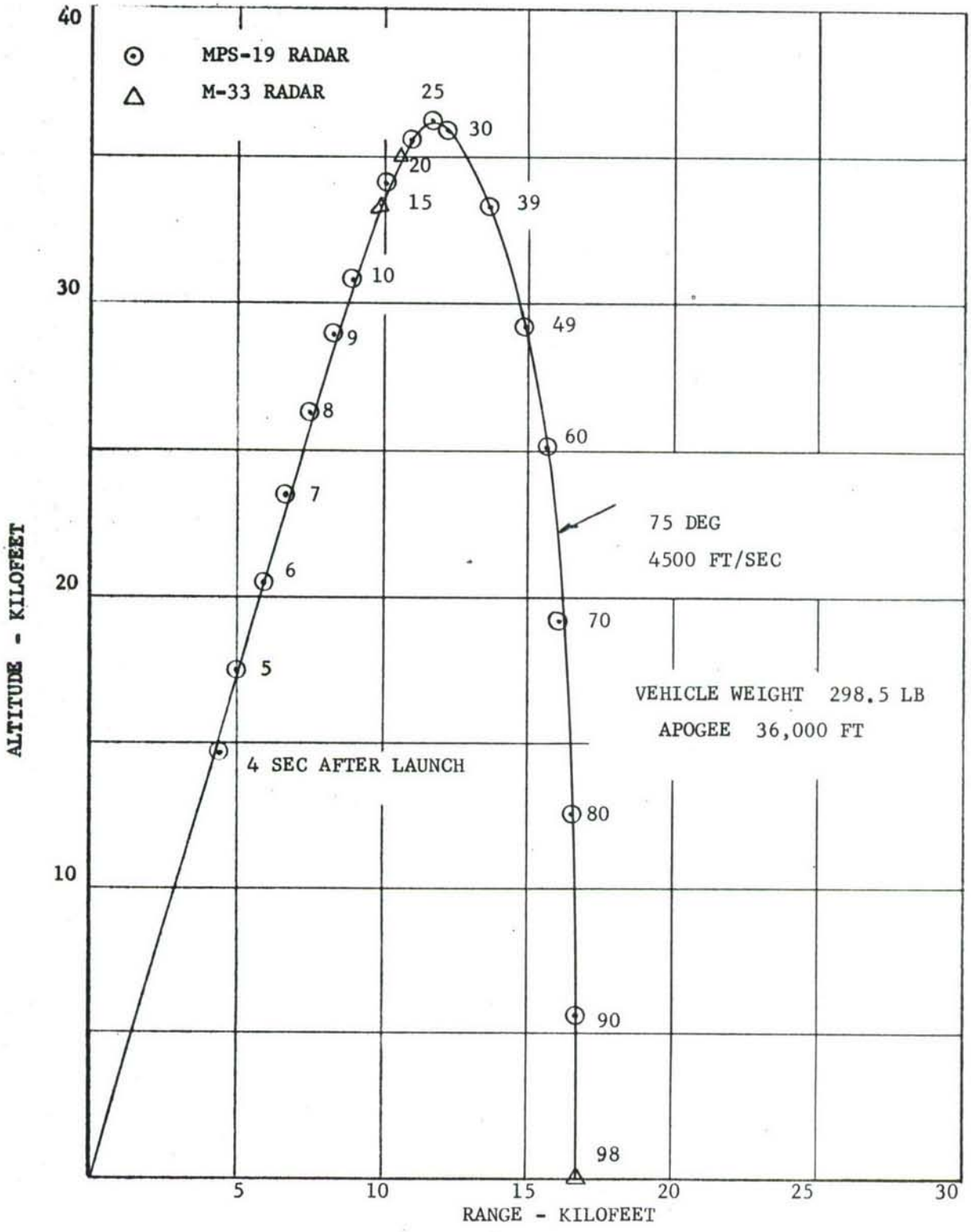


FIG. 2.1a MARTLET 3B FOAM ALTITUDE VS RANGE

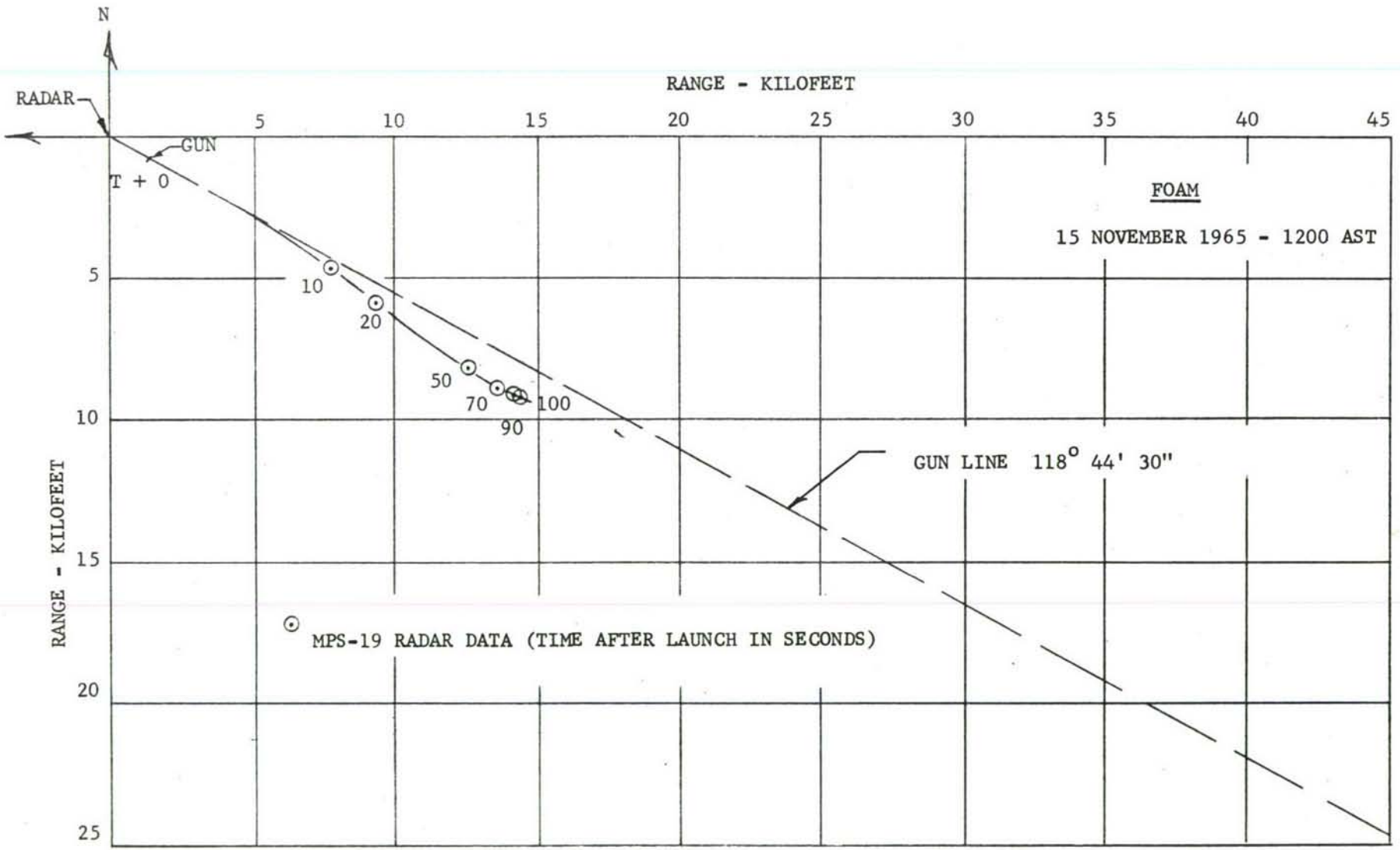


FIG. 2.1b PLAN VIEW OF MARTLET 3B FOAM TRAJECTORY

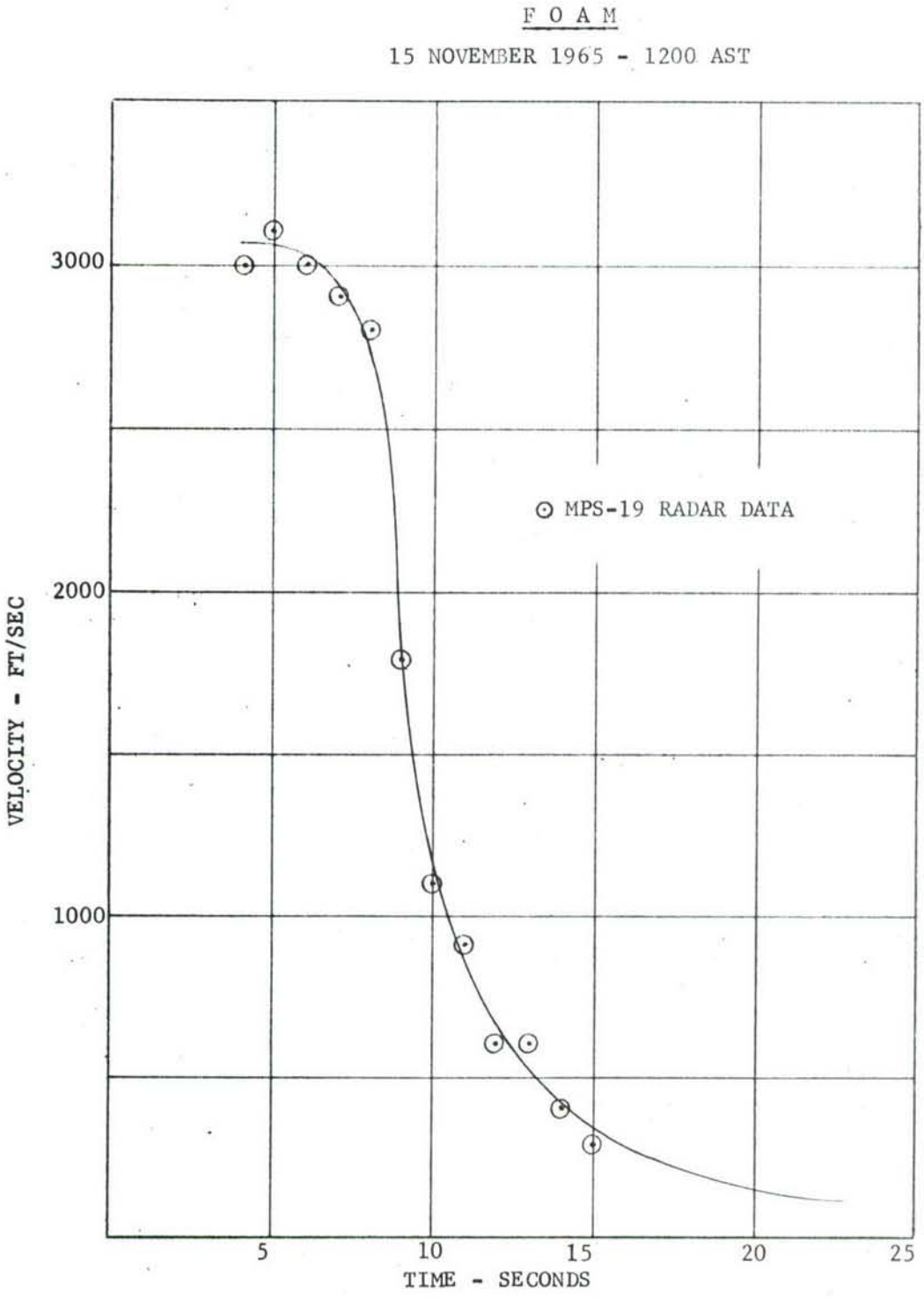


FIG. 2.1c MARTLET 3B FOAM
VELOCITY VS TIME

Round No. 155 - GOOSE

Date: 15 November 1965 - 1603 AST

Vehicle Description: Martlet 3B vehicle with "flip out" fins, carrying and HDL 250 MHz telemetry package and a pentolite charge (0.5 lb) for the destruct system. Destruct planned at T + 20 sec.

Destruct System: The command destruct system consisted of a 426 MHz FM receiver in the vehicle with logic circuits to enable destruction from the launch control office, and 250 MHz transmitter with a 40 KHz subcarrier oscillator to monitor the firing pulses.

Purpose of Test: Engineering test to prove the destruct system.

Weights:

Vehicle	297.5 lb
Pusher and Obturator	142.0 lb
Sabot	129.0 lb
Shot Weight	568.5 lb

Centre of Gravity: 31.1 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	590 lb WMM.225 (6 bags) Lot No. CAD 7502
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	75 deg
Crusher Gauges	M11: 4 Mk6: 2
Ram Distance	186.5 in
Ram Load	36 tons
Chamber Volume	39,630 in^3
Recoil	32.0 in
Breech Pressure	M11: 27,900 psi Mk6: 24,300 psi *) Average: 26,100 psi Strain: 28,100 psi (Fig. 2.2)

*) Note: Mk6 results may not be correct as 10 tons precompression used.

Muzzle Velocity (Probe)

Left: 4,630 ft/sec
Right: 4,530 ft/sec
Average: 4,580 ft/sec

Camera Records:

Smear cameras, Fastax stations and a cine-theodolite were in operation and in identical settings to those of Round 154 - FOAM. The photographs indicated damage to the fins and the antenna. No results were obtained from the cine-theodolite since the vehicle did not reach the field of view anticipated.

Radar Records:

Both radars operated but could not find any trace of the vehicle.

Trajectory:

No trajectory data were obtained.

Telemetry and Destruct System:

No telemetry signal at all was obtained; a broken antenna alone would have given a few seconds of weak data. This together with the damage seen on the photographs suggests that the destruct system may have been activated when the vehicle was still in the barrel, although this is not conclusive.

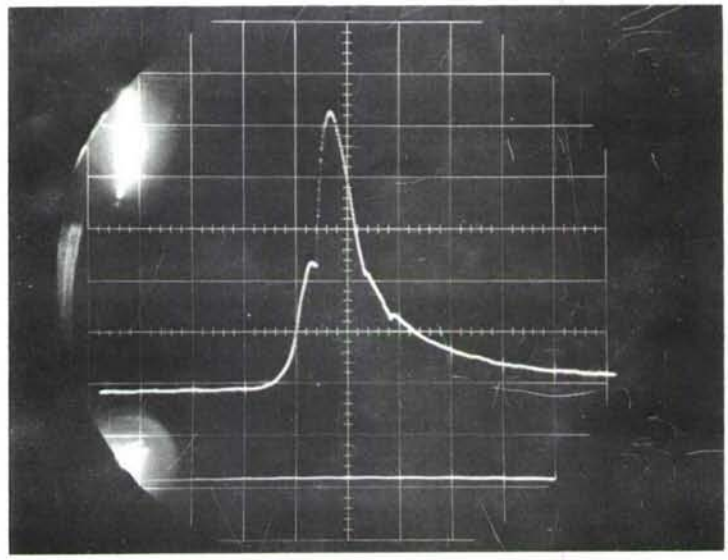
Summary:

The round was not successful regarding both vehicle and destruct system performance.

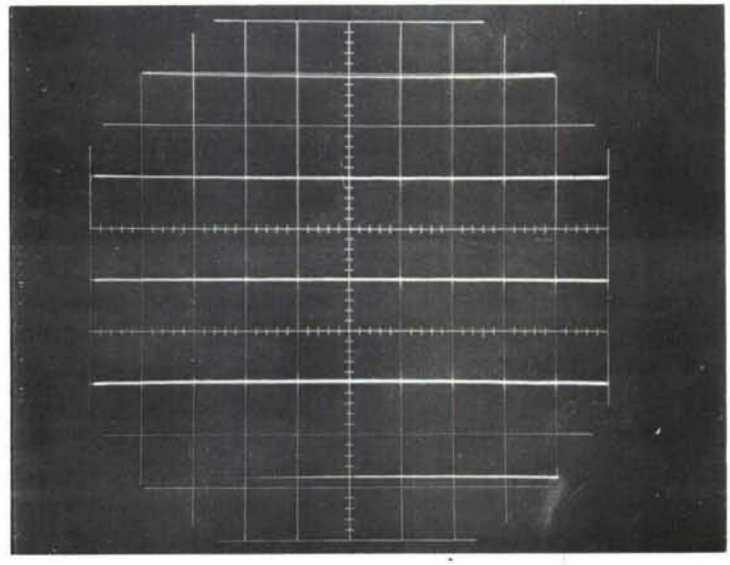
G O O S E

15 NOVEMBER 1965 - 1603 AST

5200 psi/division
BREECH PRESSURE



10,350 psi/ohm
CALIBRATION
2 ohm



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 28,100 psi

Charge: 590 lb WMM.225

FIG. 2.2 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND GOOSE

Round No. 156 - ZENMAC

Date: 16 November 1965 - 1318 AST

Vehicle Description: Martlet 2C (Mod 2) carrying a sofar impact test payload.

Purpose of Test: Engineering test of payload.

Weights:		
	Vehicle	176.0 lb
	Pusher and Obturator	132.0 lb
	Sabot	108.0 lb
	Shot Weight	416.0 lb

Centre of Gravity: 22.5 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	725 lb M8M.22 (8 bags) Lot No. CAD 9030
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	80 deg
Crusher Gauges	M11: 4 Mk6: 2
Ram Distance	194 in
Ram Load	10 tons
Chamber Volume	41,200 in^3
Recoil	35.5 in
Breech Pressure	M11: 32,700 psi Mk6: 33,900 psi Average: 33,300 psi Strain: 33,400 psi (Fig. 2.3)
Muzzle Velocity (Probe)	Left: Not available Right: 5640 ft/sec

Camera Records:

No results were obtained from the smear cameras because of malfunction (rear smear) or improper alignment (front smear). The Fastax cameras gave satisfactory photographs with the following results

for muzzle velocity:

East Fastax (10" lens)	5940 ft/sec
West Fastax (6" lens)	5520 ft/sec

Radar Records:

The M-33 radar tracked to 26 seconds after launch, and the MPS-19 radar to 60 seconds after launch, also observing splashdown at T + 298 seconds with a maximum range of 252,000 ft.

Trajectory:

The radar data are compared with a standard trajectory for 5650 ft/sec muzzle velocity in Figs. 2.3a and b. The agreement is satisfactory. The apogee derived from the radar data is 360,000 ft = 110 km, and the measured total range 252,000 ft.

SOFAR Bomb:

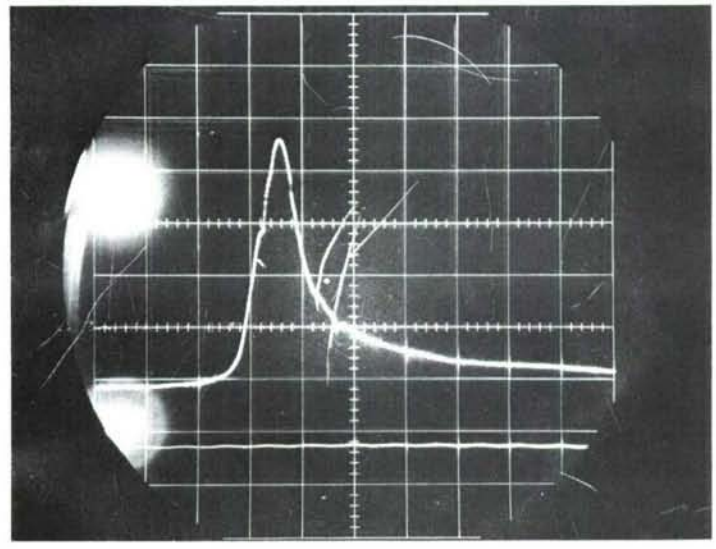
There was no evidence of the Sofar bomb. The Navy did not report a splash either.

Summary:

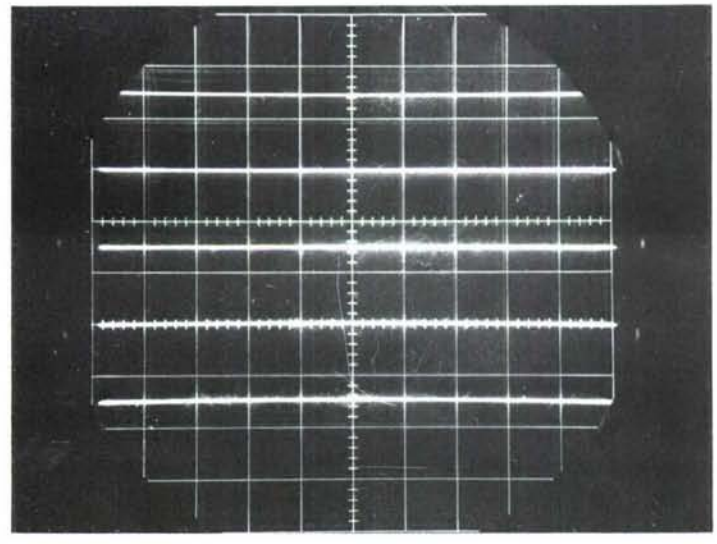
The gun and vehicle performance was satisfactory. The round was not successful, however, regarding the payload.

Z E N M A C

16 NOVEMBER 1965 - 1318 AST



7000 psi/division
BREECH PRESSURE



10,350 psi/ohm
CALIBRATION
4 ohm

TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 33,400 psi

Charge: 725 lb M8M.220

FIG. 2.3 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND ZENMAC

Z E N M A C

15 NOVEMBER 1965 - 1318 AST

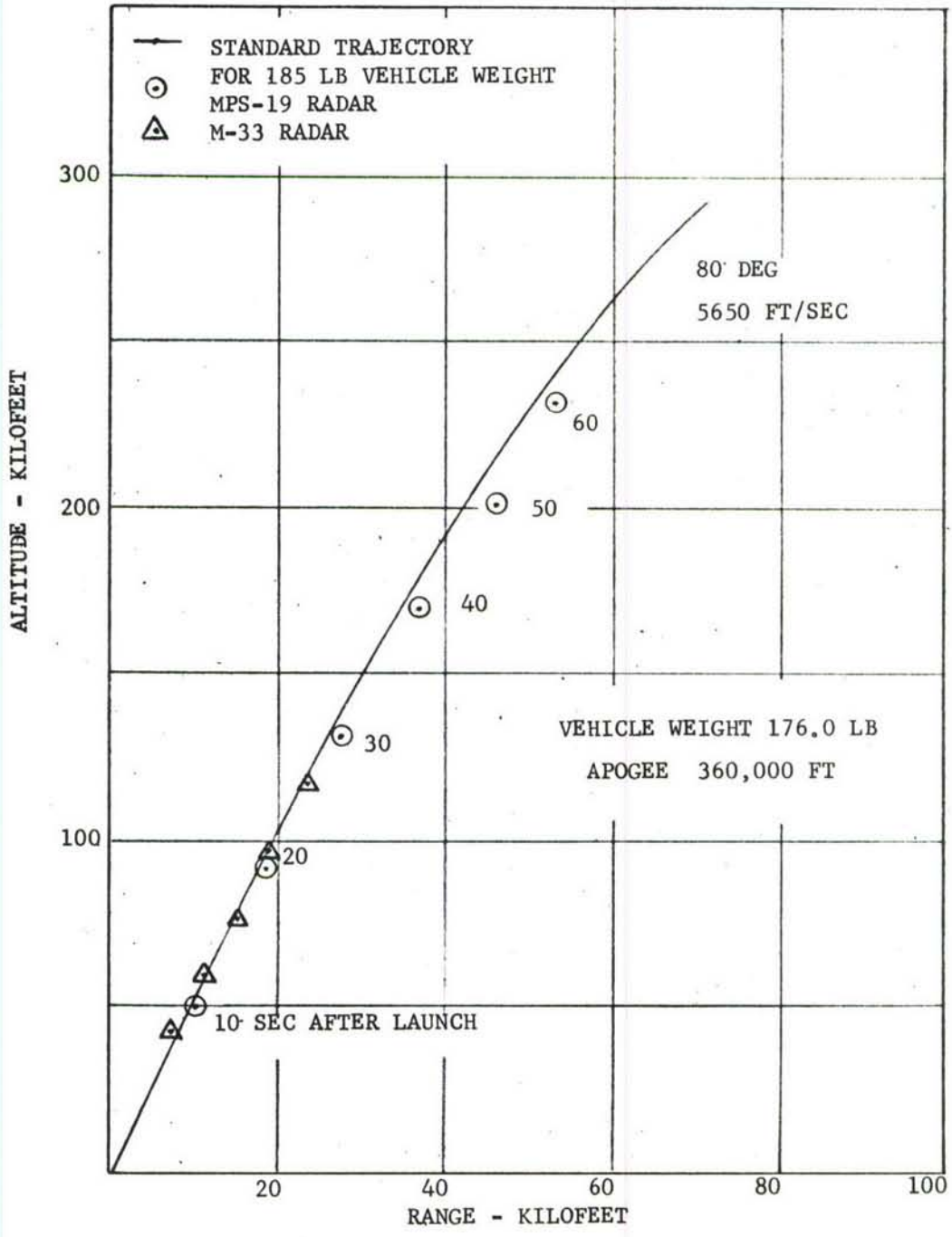


FIG. 2.3a MARTLET 2C (MOD 2) ZENMAC

ALTITUDE VS RANGE

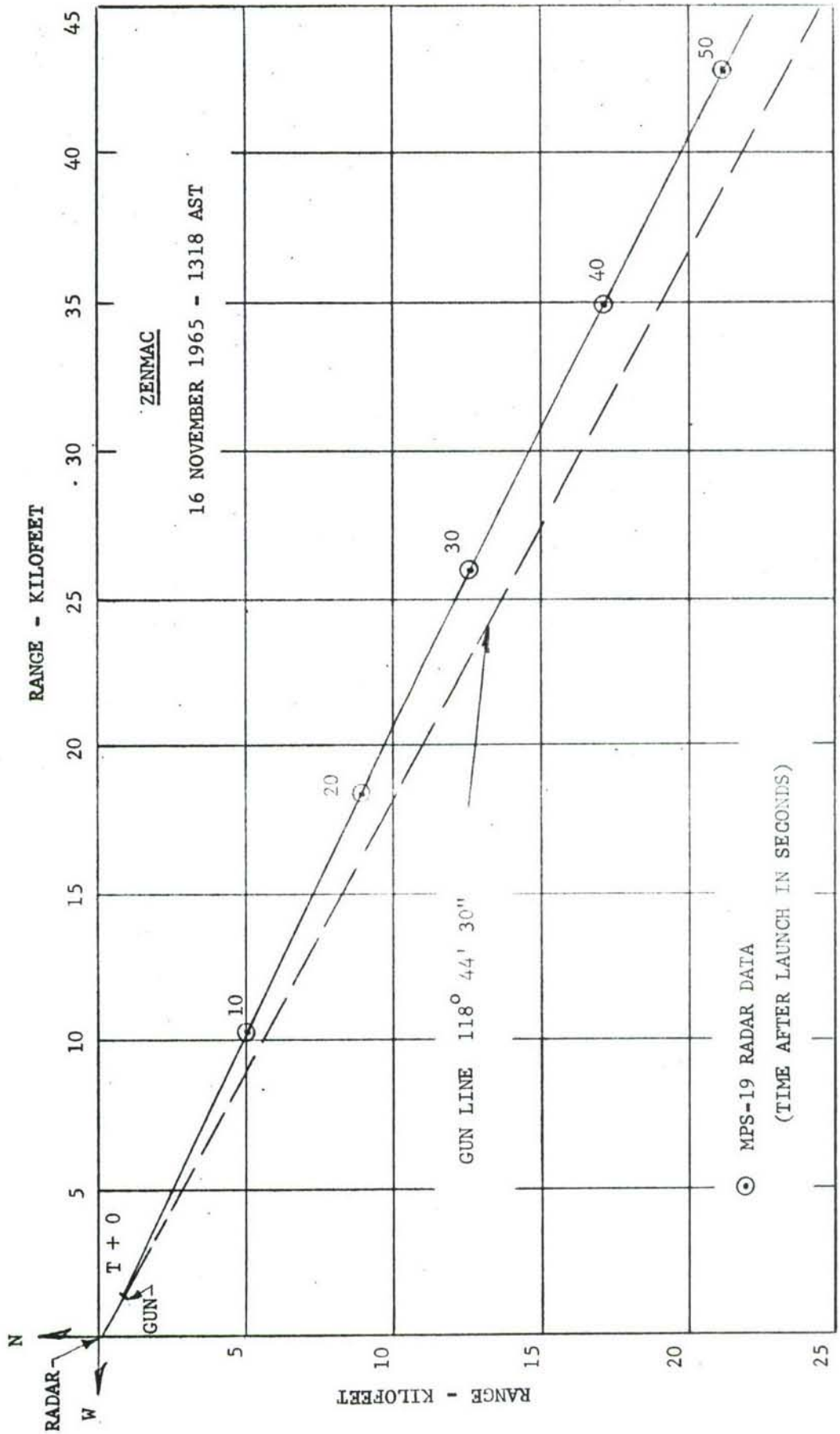


FIG. 2.3b PLAN VIEW OF MARTLET 2C (MOD 2) ZENMAC TRAJECTORY

Round No. 157 - YORKSHIRE

Date: 16 November 1965 - 1815 AST

Vehicle Description: Martlet 2C (Mod 3) carrying a 12 lb ejection payload of cesium.

Purpose of Test: To generate electrons for ionospheric studies and to obtain wind data.

Weights:		
	Vehicle	181.5 lb
	Pusher and Obturator	132.0 lb
	Sabot	101.0 lb
	Shot Weight	414.5 lb

Centre of Gravity: 20.4 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	725 lb M8M.22 (8 bags) Lot No. CAD 9030
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4 Mk6: 2
Ram Distance	194 in
Ram Load	16 tons
Chamber Volume	41,220 in^3
Recoil	37.5 in
Breech Pressure	M11: 35,200 psi Mk6: 35,600 psi Average: 35,400 psi Strain: 35,000 psi (Fig. 2.4)
Muzzle Velocity (Probe)	Left: 5580 ft/sec Right: 5770 ft/sec Average: 5680 ft/sec

Camera Records:

The smear cameras used a new type of film (ASA 1600) but the image was too weak to see the fin area.

The Fastax stations operated properly with the same angles as in the previous three rounds. A high speed film (Kodak 2475) was tried, with unsatisfactory results.

Radar Records:

Both radars tracked satisfactorily.

Trajectory:

The radar results are compared with the standard trajectory data for a muzzle velocity of 5800 ft/sec in Figs. 2.4a. The plan view of the trajectory is shown in Fig. 2.4b to T + 50 seconds only since no azimuth data were available beyond that time.

The apogee as derived from the radar data was 390,000 ft = 119 km, and the estimated total range was 130,000 ft.

Payload:

The K-24 camera stations in Barbados North and South, St. Vincent North, and Grenada North could see the cesium trail, at Barbados for about 4 minutes after a 3 second bright flash as a cloud like ball, in the other stations as a 1 second flash. No theodolite readings could be taken due to the short duration of the flash. The ejection of the cesium occurred at about 94 seconds after launch. An increase in ionization was noticed during the 10 minutes after launch, with sporadic results at a height of 100 km. During the following 8 minutes, the trace went beyond the limit of the equipment (10 MHz), and thereafter the signal strength faded.

The evaluation of the K-24 camera photographs showed a considerable vertical motion of about 38 m/sec, rising from 101 km at

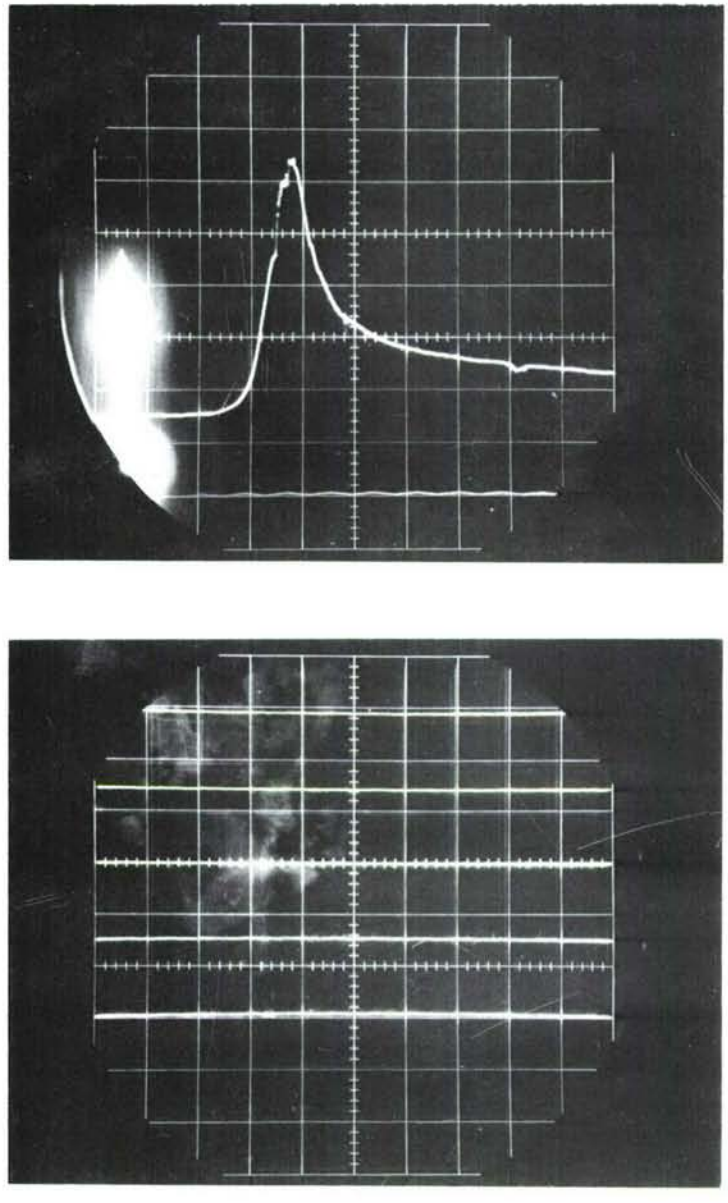
release (T + 94 sec) to above 105 km before fading from view (Ref. 5). The wind velocity was found to be 92.4 m/sec.

Summary:

The round was successful regarding vehicle and payload performance.

Y O R K S H I R E

16 NOVEMBER 1965 - 1815 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 35,000 psi

Charge: 725 lb M8M.220

FIG. 2.4 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND YORKSHIRE

Y O R K S H I R E

16 NOVEMBER 1965 - 1815 AST

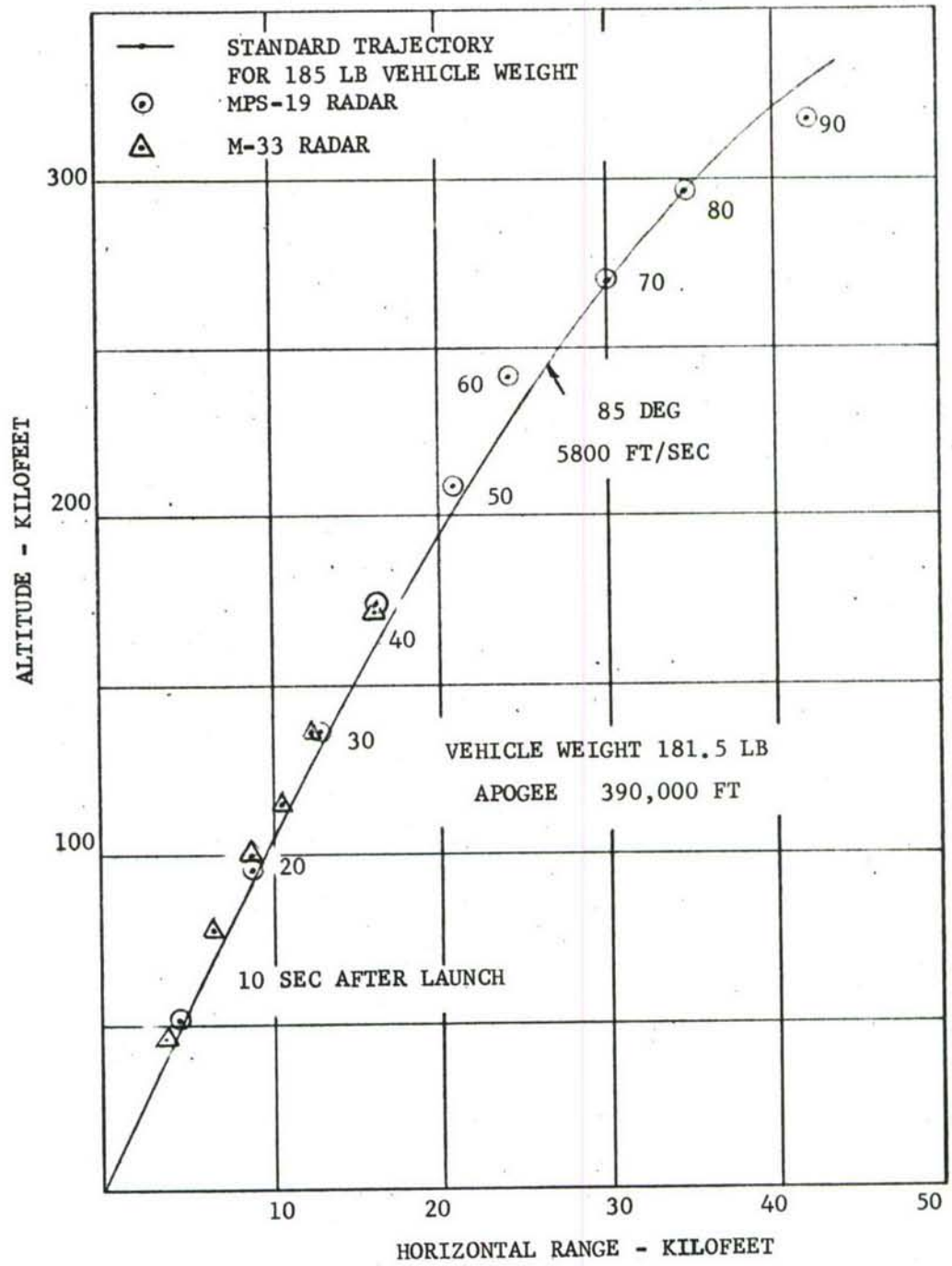


FIG. 2.4a MARTLET 2C YORKSHIRE
ALTITUDE VS RANGE

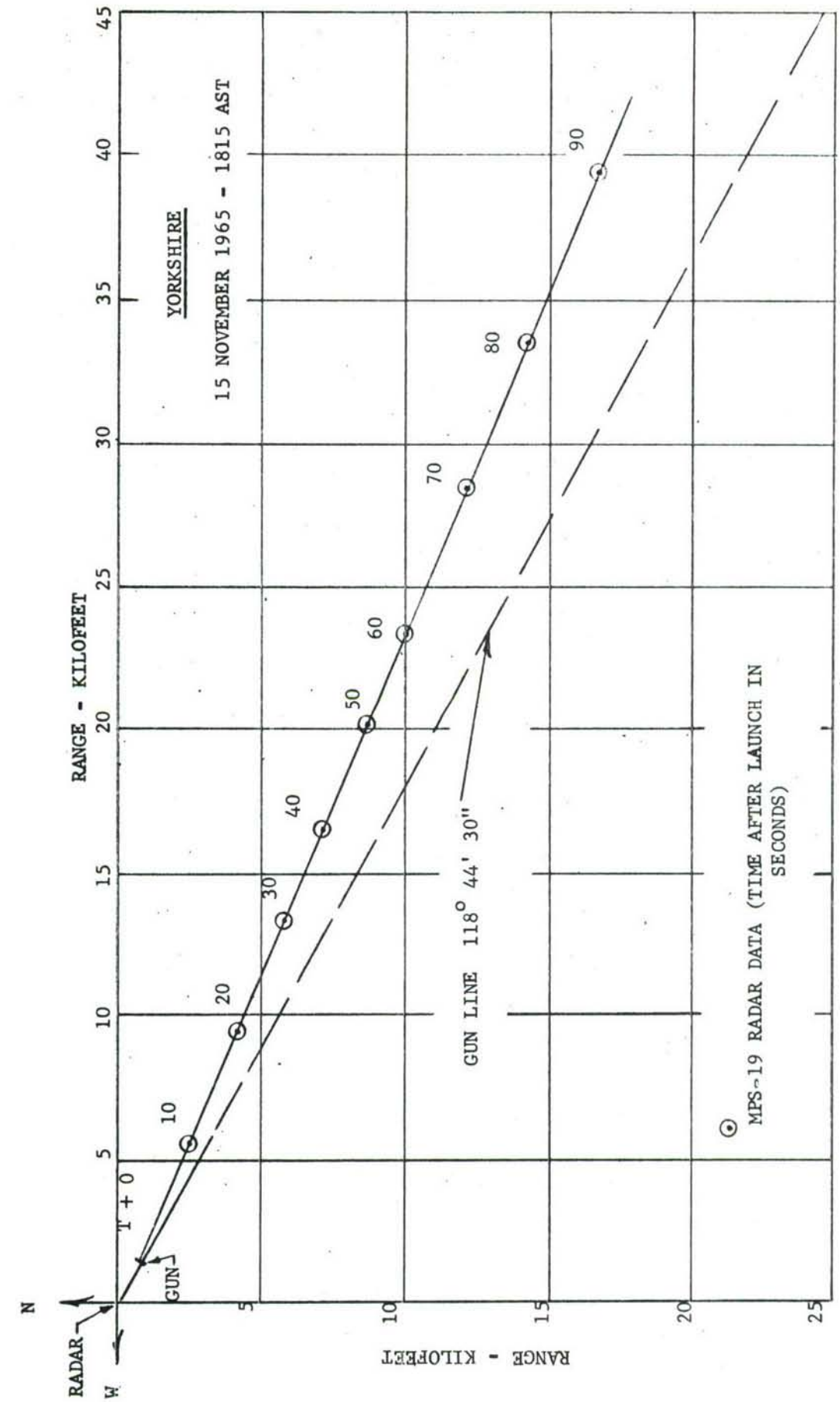


FIG. 2.4b PLAN VIEW OF MARTLET 2C (MOD 3) YORKSHIRE TRAJECTORY

Round No. 158 - HAHA

Date: 17 November 1965 - 1431 AST

Vehicle Description: Martlet 3B with flip-out fins, carrying an HDL 250 MHz telemetry package but no pentolite charge for the destruct system.

Destruct System:

The command destruct system consisted of a 426 MHz FM receiver, crystal controlled, in the vehicle, and a 250 MHz transmitter with a 40 KHz subcarrier oscillator.

Purpose of Test: Engineering test to check the destruct system telemetry.

Weights:

Vehicle	296.0 lb
Pusher and Obturator	143.0 lb
Sabot	128.0 lb
Shot Weight	567.0 lb

Centre of Gravity: 28.6 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	540 lb WMM.225 (6 bags) Lot No. CAD 7502
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	75 deg
Crusher Gauges	M11: 4
Ram Distance	188 in
Ram Load	26 tons
Chamber Volume	39,950 in^3
Recoil	29.5 in
Breech Pressure	M11: 19,300 psi Strain: 19,400 psi (Fig. 2.5)
Muzzle Velocity (Probe)	Left: 4040 ft/sec Right: 4120 ft/sec Average: 4080 ft/sec

Camera Records:

On the rear smear photographs one pop-out fin appears to be missing or not yet extended. The front smear did not give any result owing to a malfunction. All Fastax records were satisfactory and gave the following muzzle velocities:

East Fastax (10" lens, 140 ft ahead of muzzle)	4430 ft/sec
West Fastax (6" lens, 160 ft ahead of muzzle)	3950 ft/sec.

Radar Records:

The M-33 radar tracked a naval aircraft during the firing and therefore could not furnish any data on the vehicle.

The MPS-19 radar tracked the vehicle until impact.

Trajectory:

The trajectory as obtained by the MPS-19 radar is shown in Fig. 2.5a, with an apogee of 38,600 ft = 11.8 km(T + 36) and a total range of 25,700 ft (T + 105). (Two distinct splashes, approximately 5 to 6 seconds apart, were observed from the West Fastax station. The plan view of the trajectory is shown in Fig. 2.5b, and the velocity vs time in Fig. 2.5c.

Telemetry Records:

The telemetry signal was picked up at T + 8 seconds and indicated that the vehicle was spinning at 10 rps, decreasing to 4 rps within 14 seconds. The AGC radar record verified the spinning. At 10 seconds, an AGC blip and a slightly different telemetry oscillation was noticed from this time on. Another telemetry blip occurred at 15 seconds after launch. No complete explanation can be given for this except that it could have been caused by the marginal stability of the vehicle. At apogee with a velocity of 300 ft/sec (Fig. 2.5c) a tumbling

motion became apparent in the telemetry trace and was also verified in the AGC trace. With increasing velocity after apogee a slow rate of spin was seen to increase from 1/8 rps to 1/6 rps as verified by the AGC trace.

The MPS-19 radar lost track of the missile at T + 105 seconds, indicating impact. The telemetry experienced a severe frequency shift of 3 MHz at this time whereas the subcarrier oscillator continued to oscillate at 37 KHz. The telemetry trace was lost at T + 112.5 seconds.

Command Destruct System:

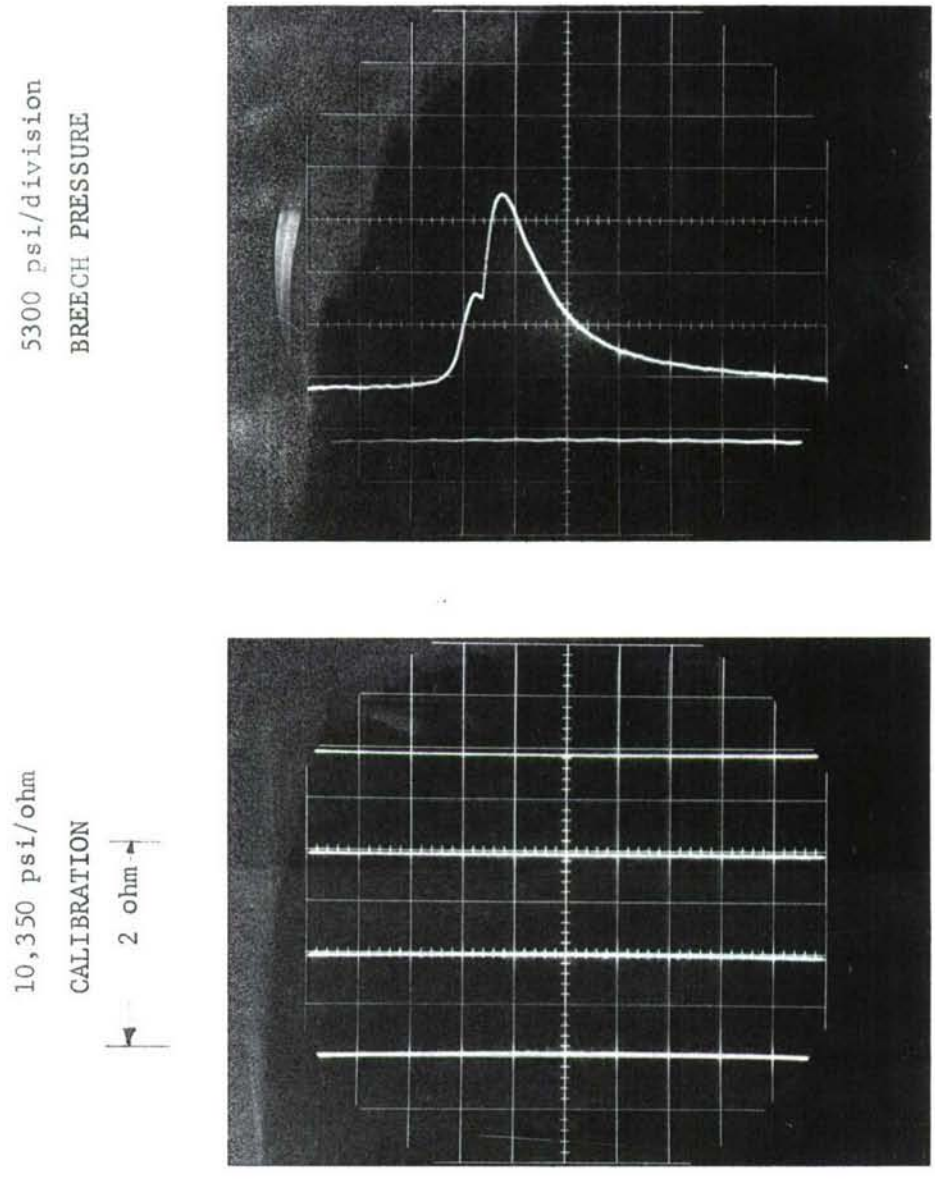
The transmitter section of the system performed satisfactorily; the receiver, however, did not work at all. The antenna pattern was good, indicating a structurally sound antenna.

Summary:

The round was successful regarding vehicle and ballistics. The payload performance, however, was not satisfactory as the telemetry but not the receiver of the command destruct system worked.

H A H A

17 NOVEMBER 1965 - 1431 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 19,400 psi

Charge: 540 lb WMM.225

FIG. 2.5 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND HAHA

H A H A

17 NOVEMBER 1965 - 1432 AST

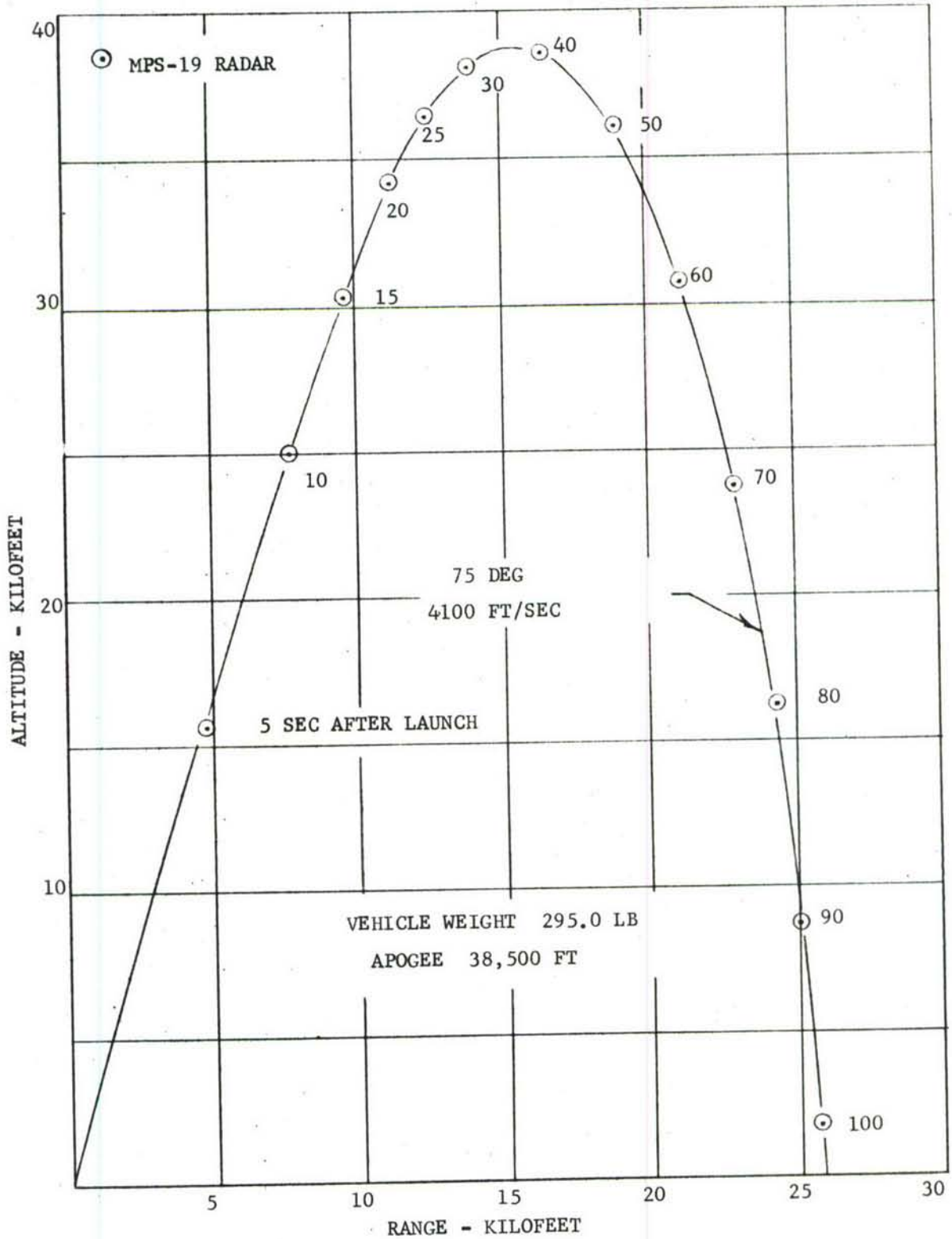


FIG. 2.5a MARTLET 3B HAHA

ALTITUDE VS RANGE

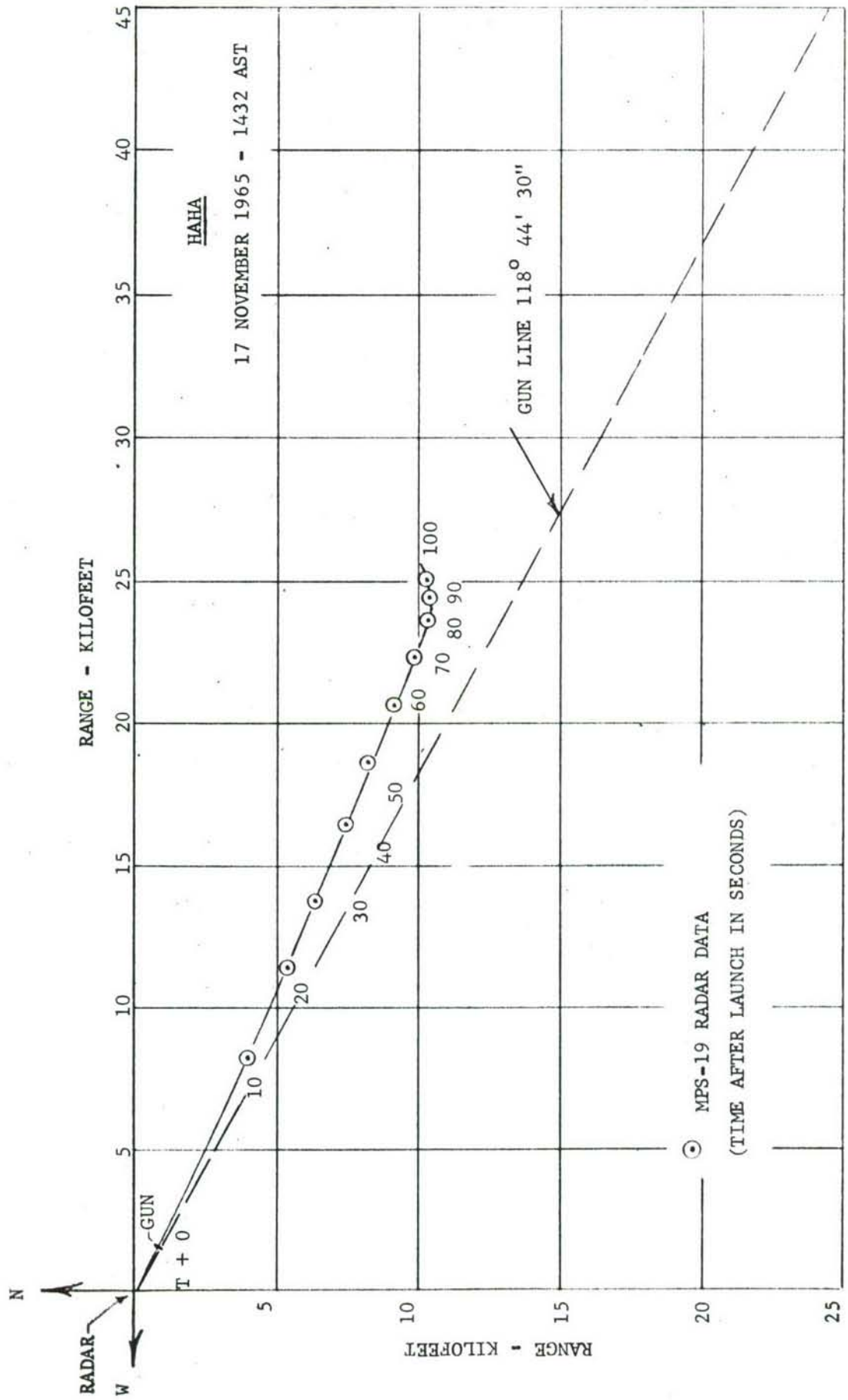


FIG. 2.5b PLAN VIEW OF MARTLET 3B HAHA TRAJECTORY

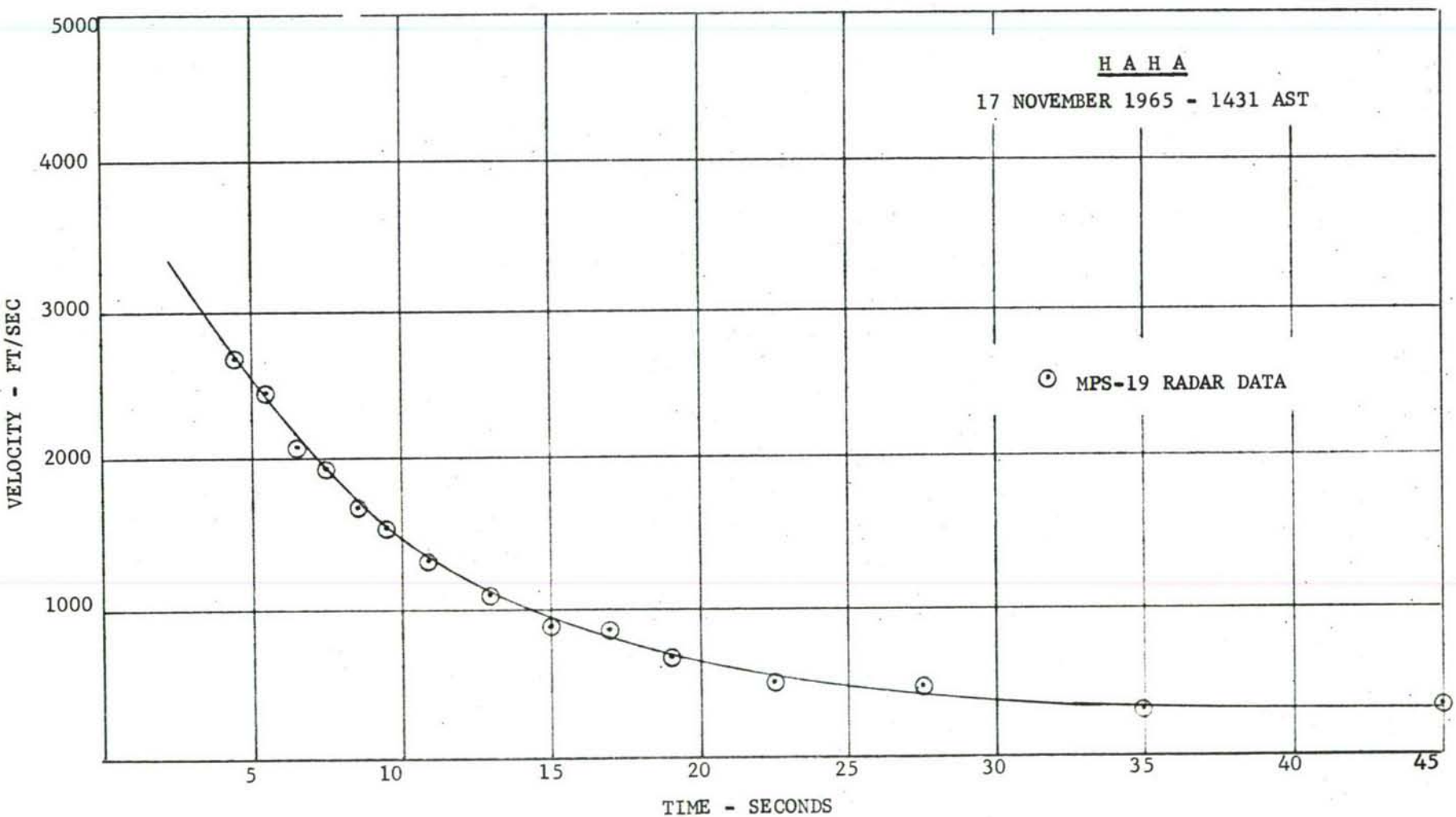


FIG. 2.5c MARTLET 3B SHOT HAHA
VELOCITY VS TIME

Round No. 159 - BRIDGETOWN

Date: 17 November 1965 - 1616 AST

Vehicle Description: Martlet 2C (Mod 3) carrying a payload consisting of S-band chaff and a parachute with a telemetry package and thermistors.

Payload Description: The 14 ft^2 metallized silk parachute was packed in the upper 14 3/4 in. section of a split cylinder 19 3/4 in. long by 2.85 in. in diameter. The 1750 MHz telemetry unit, 5 3/8 in. long, 2½ in. in diameter, and weighing 30 ounces, a SOLISTRON production model, was attached to the parachute and held in the split cylinder with a retaining ring at the aft end. A combined slot-loop ("sloop") antenna was used, protruding out of the end of the projectile to provide tracking and telemetry data from launch through ejection to impact. Four bead thermistors were attached to the 18 ft shroud.

Purpose of Test: Measurement of upper atmosphere air temperature and winds; furthermore tests of i) the revised parachute ejection system with tethered ejection slug to prevent parachute damage, ii) the performance of the thermistors on the parachute shroud lines at four different spacings from the telemetry unit, and iii) the performance of the telemetry transmitter, a seven segment BRL subcarrier oscillator, a nicket-cadmium battery pack and the sloop antenna, particularly at low temperatures.

Weights:

Vehicle	184.5 lb
Pusher and Obturator	135.5 lb
Sabot	102.0 lb
Pusher Plate Spacer	12.0 lb
Shot Weight	434.0 lb

Centre of Gravity: 20.25 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	625 lb WMM.225 (7 bags)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	192 in
Ram Load	14 tons
Chamber Volume	40,800 in^3
Recoil	33 in
Breech Pressure	M11: 25,700 psi Strain: 24,800 psi
Muzzle Velocity (Probe)	4820 ft/sec

Camera Records:

The evaluation of the Fastax photographs gave the following muzzle velocities:

West Fastax (6" lens, 160 ft ahead of muzzle)	4950 ft/sec
East Fastax (10" lens, 140 ft ahead of muzzle)	5130 ft/sec.

Radar Records:

The M-33 radar tracked to T + 42 seconds. Neither parachute nor chaff ejection were recorded, nor were apogee and splashdown observed. The MPS-19 radar tracked the vehicle to T + 100 seconds, and was switched at T + 104 seconds to track the chaff and the parachute. The chaff was observed at T + 290 seconds, and the parachute from T + 392 to T + 495 seconds, with an average azimuth of 117 deg.

Trajectory:

The radar data are plotted in Figs. 2.6a and b and are compared with a standard trajectory for 5050 ft/sec muzzle velocity. The apogee

derived from these data was 279,000 ft = 85 km, and the total range was estimated to be 93,000 ft.

Telemetry:

The periods of telemetry reception were from 3 to 37 seconds, 99 to 106 seconds, and 130 to 529 seconds after launch. The signal strength was good, also the GMD tracking during the signal reception periods. No signal was obtained from the subcarrier oscillator.

Payload Performance:

The payload went into free fall before the parachute opened, it descended from 25,000 ft to 10,000 ft in 100 seconds. No temperature data were obtained from the four bead thermistors which were attached to the 18 ft shroud; the reason for the failure were possibly broken beads. Wind data were not obtained.

Summary:

The round was successful regarding flight and ejection. The telemetry package did not perform satisfactorily in all aspects; although reception was acquired with good signal strength, the subcarrier oscillator did not function, and no wind or temperature data were obtained.

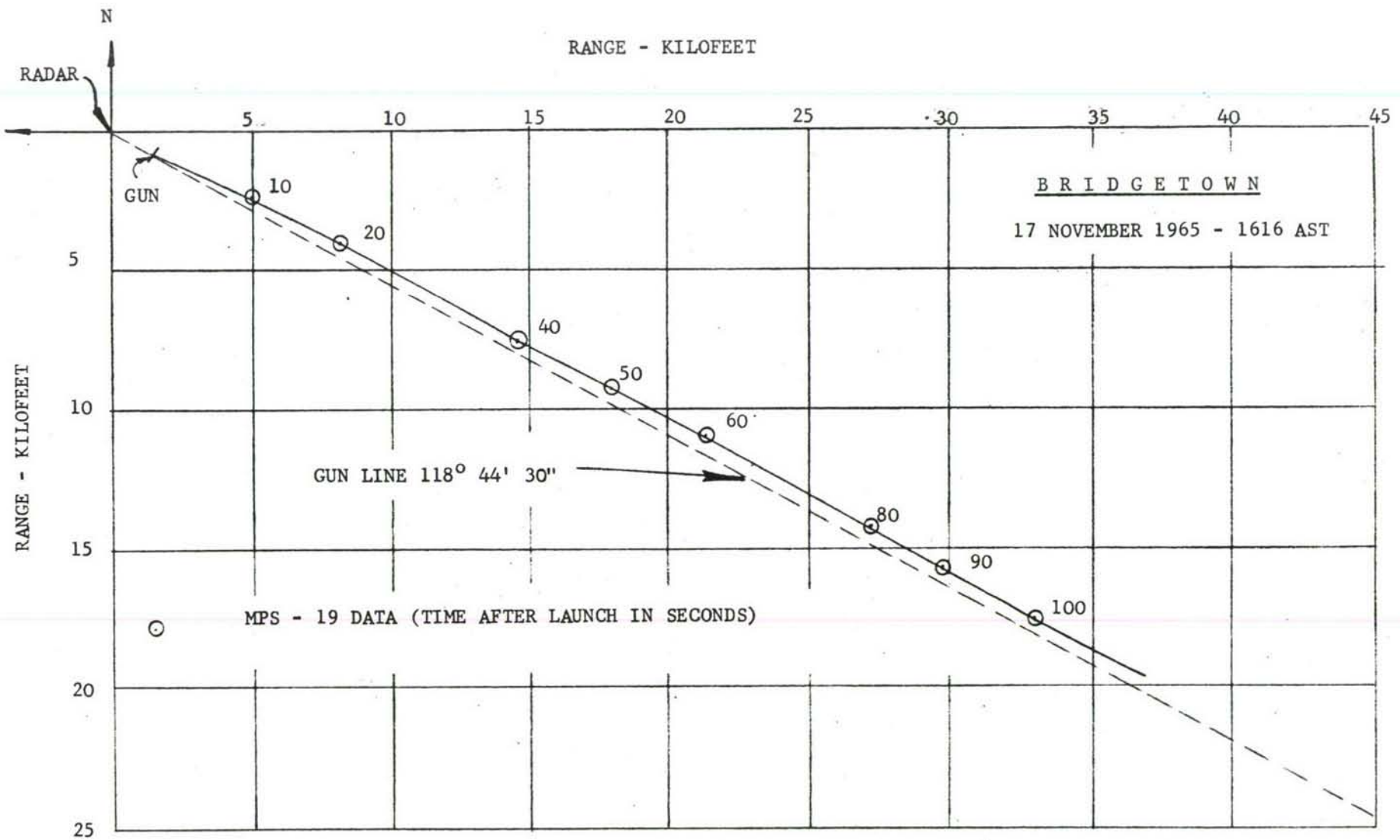


FIG. 2.6b PLAN VIEW OF MARTLET 2C (MOD. 3) BRIDGETOWN TRAJECTORY

B R I D G E T O W N

17 NOVEMBER 1965 - 1616 AST

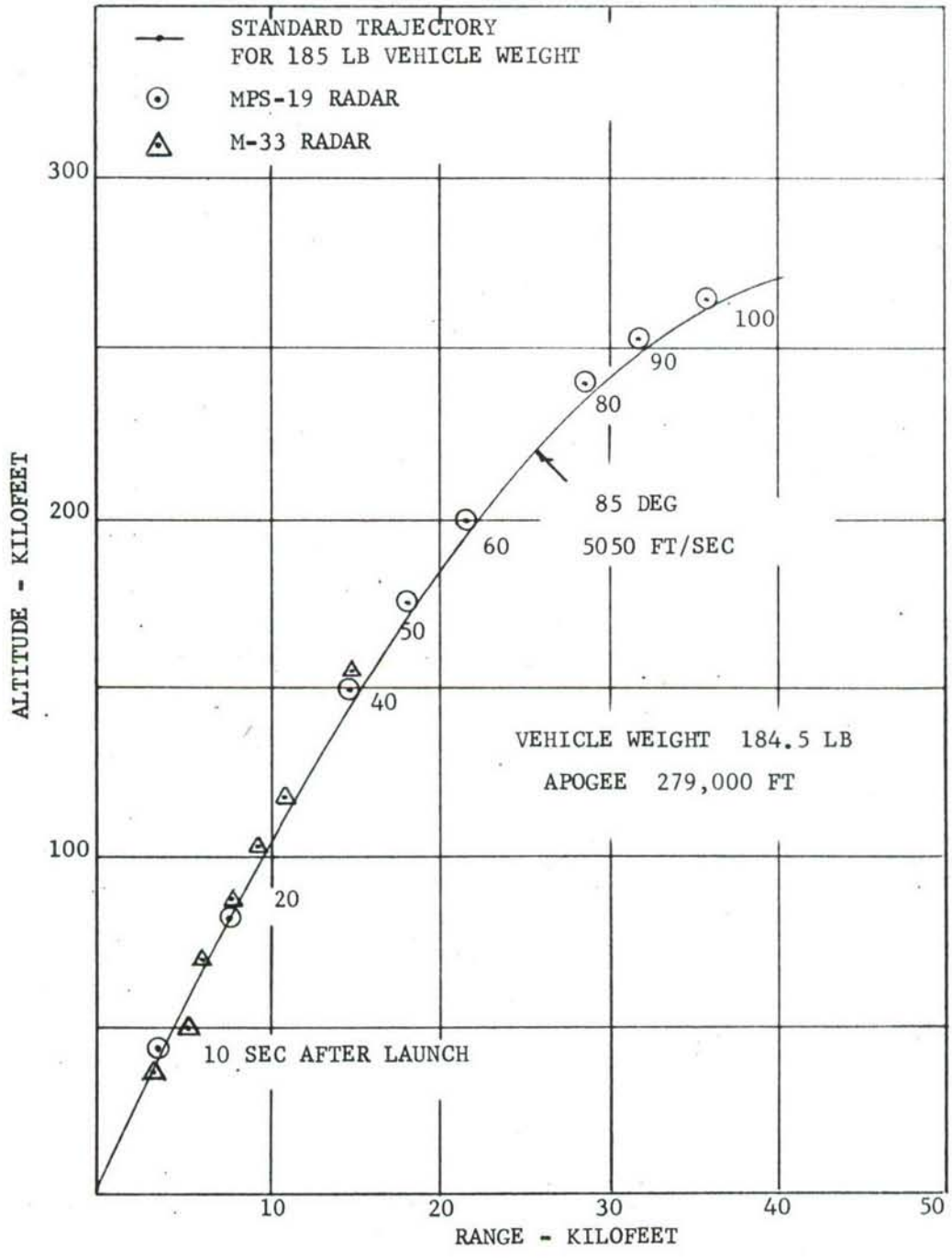


FIG. 2.6a MARTLET 2C (MOD 3) BRIDGETOWN
ALTITUDE VS RANGE

Round No. 160 - CHRISTCHURCH

Date: 17 November 1965 - 1815 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	182 lb
	Pusher and Obturator	131 lb
	Sabot	102 lb
	Shot Weight	415 lb

Centre of Gravity: 21.5 inches from base

Gun Evacuation: Evacuated to a vacuum of 28 inches of mercury.

Launch Data:

Charge Weight	750 lb M8M.22 (8 bags) Lot No. CAD 9029
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	192 in
Ram Load	15 tons
Chamber Volume	40,800 in^3
Recoil	37.5 in
Breech Pressure	M11: 40,900 psi Strain: 40,700 psi (Fig. 2.7)
Muzzle Velocity (Probe)	Left: 5990 ft/sec Right: 6030 ft/sec Average: 6010 ft/sec

Camera Records:

No smear and Fastax cameras were in operation.

Radar:

The M-33 radar tracked from T + 6 seconds to T + 35 seconds. Neither apogee nor splashdown was observed. The MPS-19 radar did not

track due to incorrect information on gun elevation.

Trajectory:

The M-33 radar data are plotted in Figs. 2.7a and b in comparison with standard drag trajectories for 6000 ft/sec, 85 deg elevation and 5850 ft/sec, 86 deg elevation. The horizontal range data seem to point to a higher launch elevation than 85 deg, and the good agreement with the standard curve for 5850 ft/sec indicates that the drag was probably somewhat higher than standard.

The apogee derived from the radar data was 392,000 ft = 120 km, in agreement with the TMA trail results, and the estimated range was 105,000 ft.

TMA Trail Results:

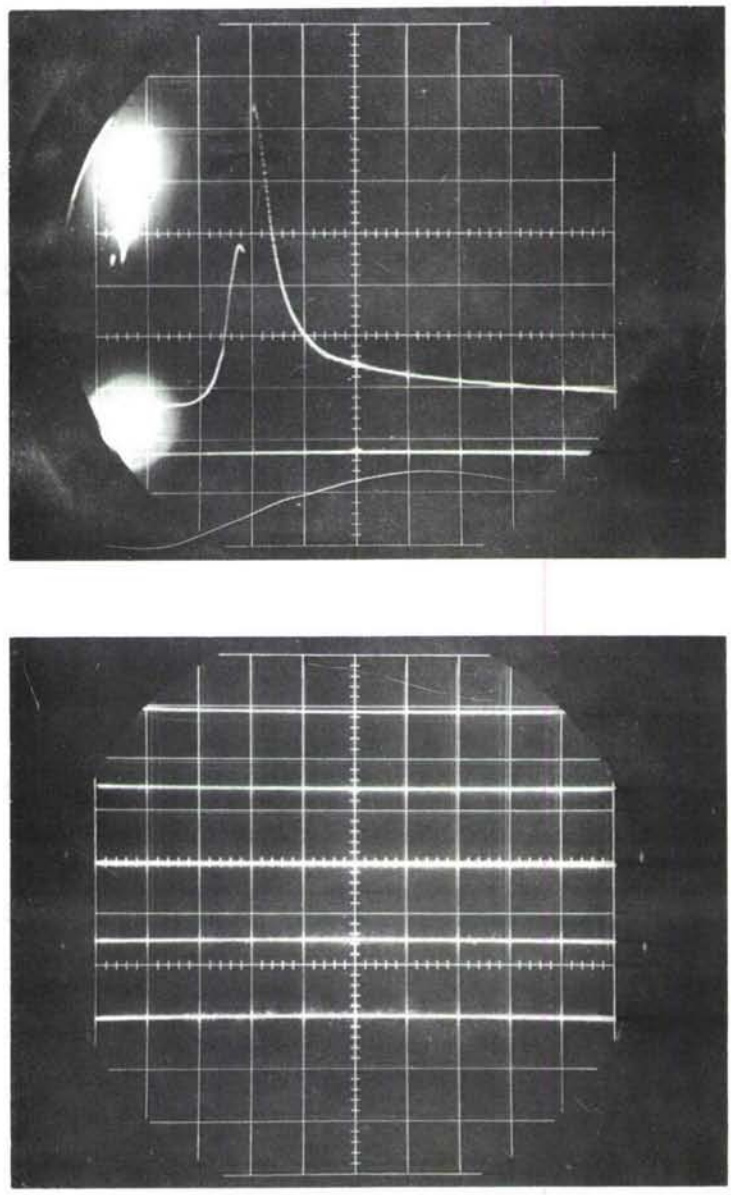
Payload and cameras performed satisfactorily and good trail photographs were obtained. The evaluation gave wind data up-trail and down-trail between 92 km and 119 km.

Summary:

This was a successful shot regarding trajectory and payload.

C H R I S T C H U R C H

17 NOVEMBER 1965 - 1815 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 40,700 psi

Charge: 750 lb M8M.22

FIG. 2.7 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND CHRIST CHURCH

C H R I S T C H U R C H

17 NOVEMBER 1965 - 1815 AST

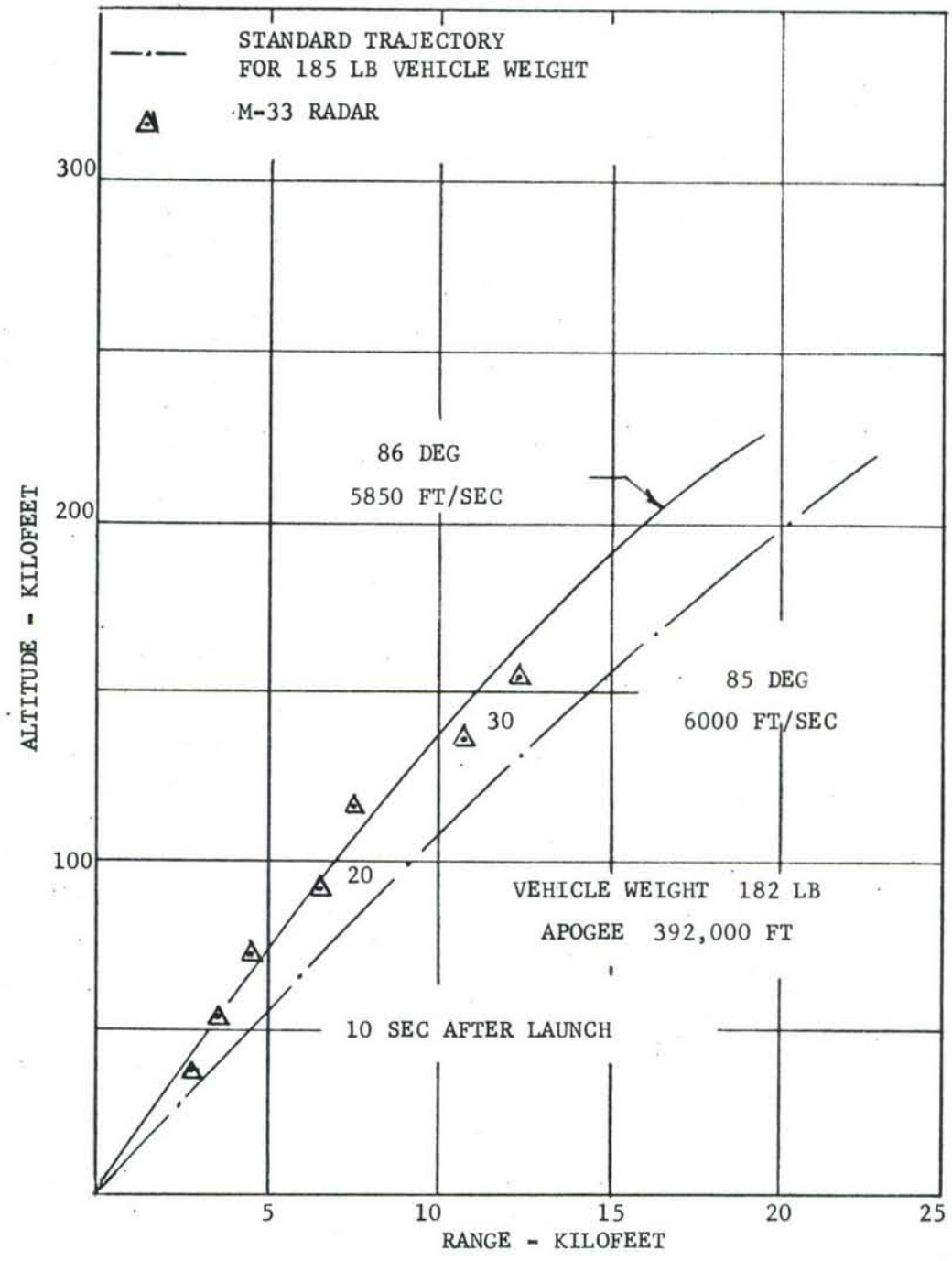


FIG. 2.7a MARTLET 2C CHRIST CHURCH
ALTITUDE VS RANGE

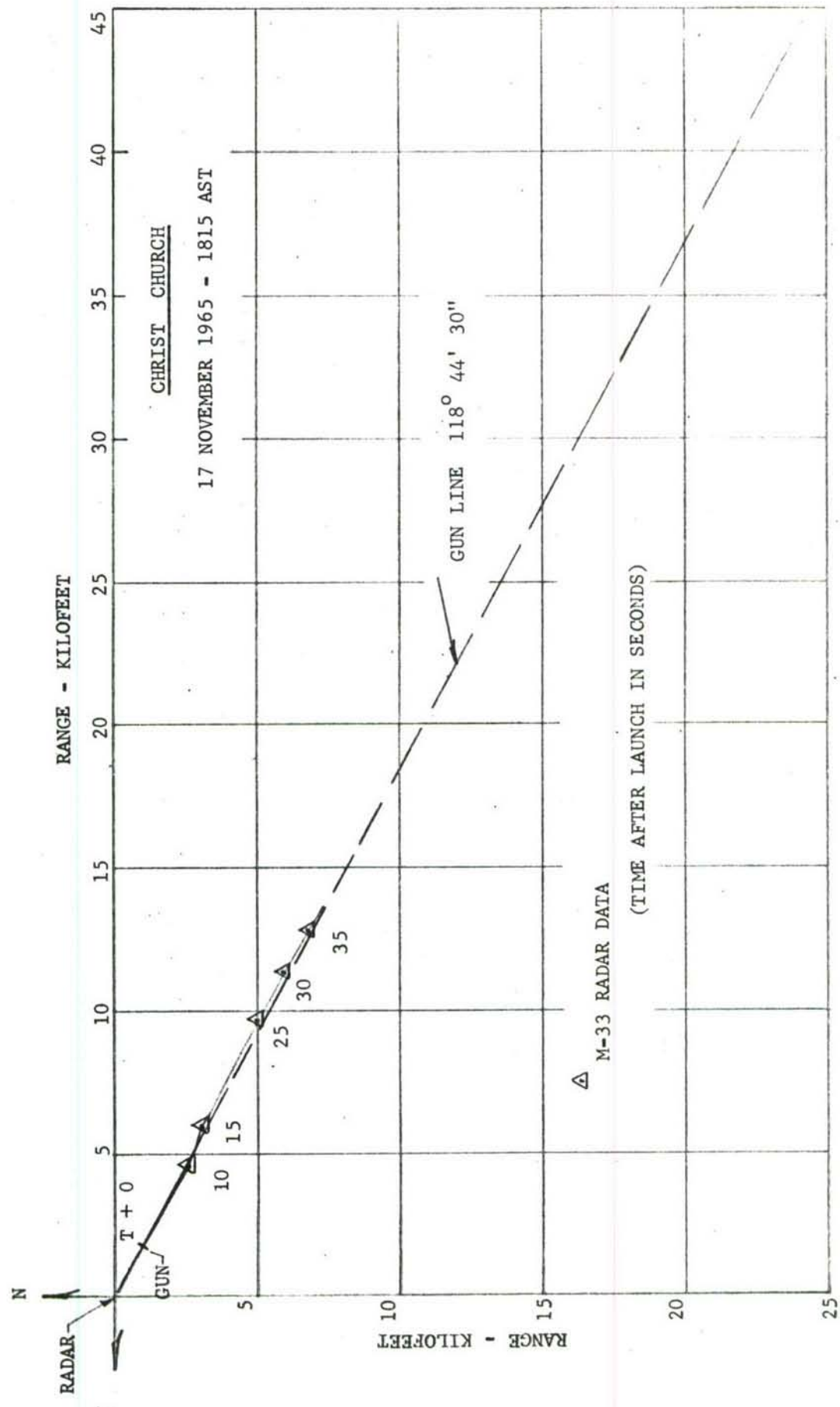


FIG. 2.7b PLAN VIEW OF MARTLET 2C CHRIST CHURCH TRAJECTORY

Round No. 161 - DOVER

Date: 17 November 1965 - 1934 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	183.5 lb
	Pusher and Obturator	131.3 lb
	Sabot	101.5 lb
	Shot Weight	416.3 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	750 lb M8M.22 (8 bags) Lot No. CAD 9029
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	195 in
Ram Load	9 tons
Chamber Volume	41,300 in^3
Recoil	38 in
Breech Pressure	M11: 37,900 psi Strain: 37,900 psi (Fig. 2.8)
Muzzle Velocity (Probe)	Left: 5730 ft/sec Right: 5780 ft/sec Average: 5760 ft/sec

Camera Records:

No smear and Fastax cameras were in operation.

Radar Records:

The M-33 radar tracked to T + 35 sec. The MPS-19 radar tracked to T + 70 sec, with a normal AGC trace.

Trajectory:

The radar data are compared in Figs. 2.8 a and b with a standard drag trajectory for 5800 ft/sec and 85 deg elevation.

The apogee calculated from these data was 400,000 ft = 122.0 km, which is in good agreement with results obtained from the TMA trail, but somewhat higher than that expected from the standard trajectory. The estimated range was 129,000 ft.

TMA Trail Results:

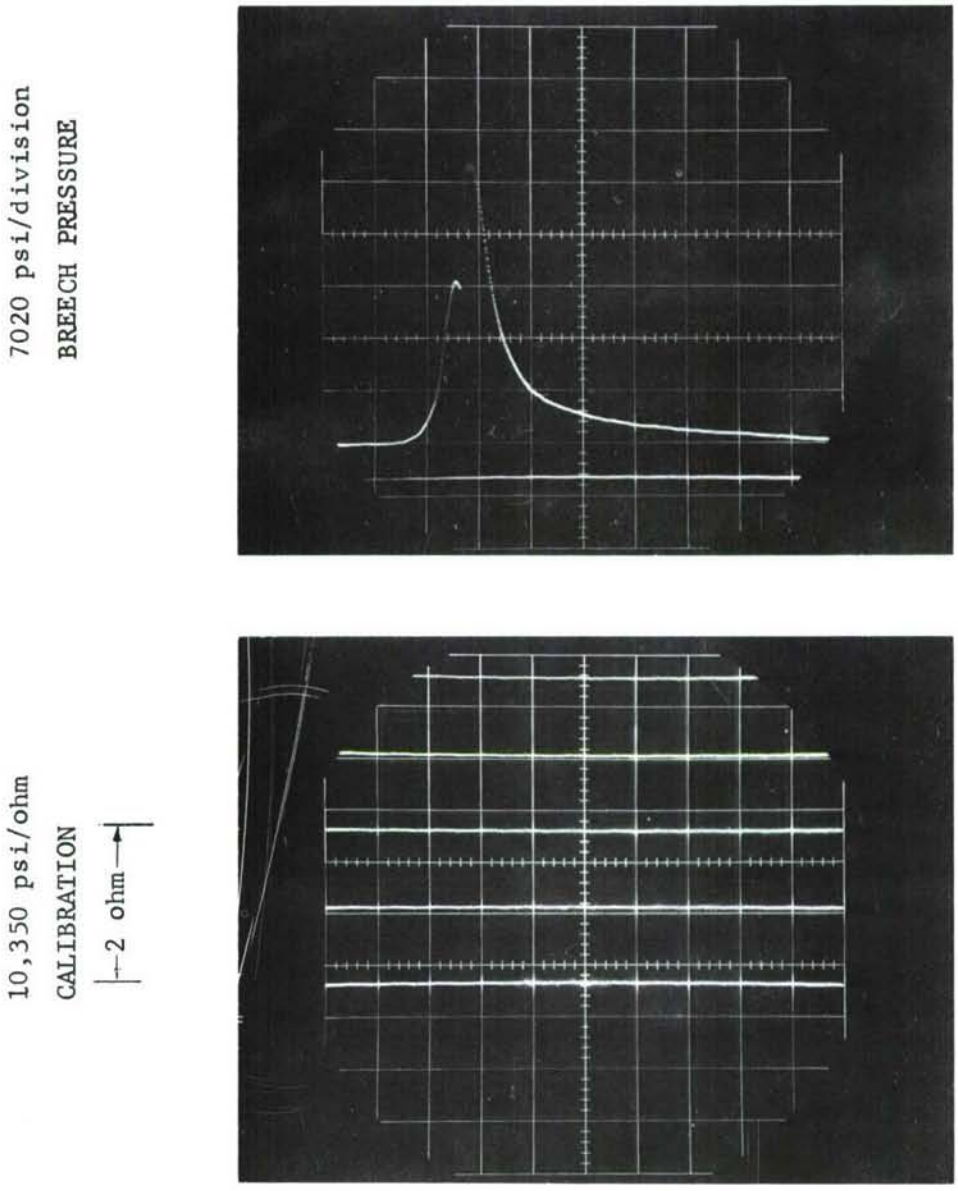
The cameras and the payload performed satisfactorily. The evaluation of trail photographs gave wind data up-trail and down-trail between 91.0 km and 122.0 km.

Summary:

This was a successful shot regarding trajectory and payload.

D O V E R

17 NOVEMBER 1965 - 1934 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 37,900 psi

Charge: 750 lb M8M.22

FIG. 2.8 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND DOVER

D O V E R

17 NOVEMBER 1965 - 1934 AST

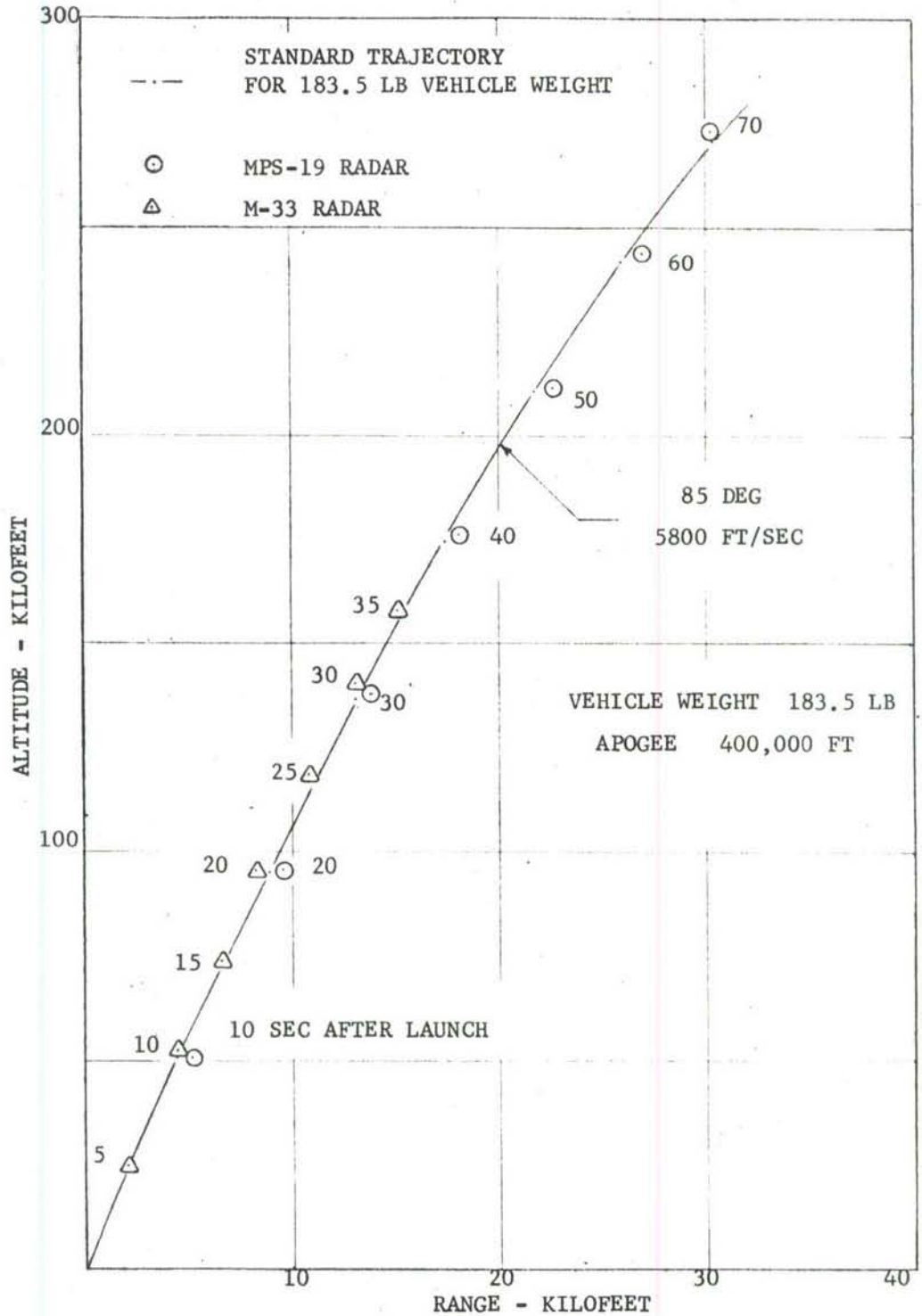


FIG. 2.8a MARTLET 2C DOVER
ALTITUDE VS RANGE

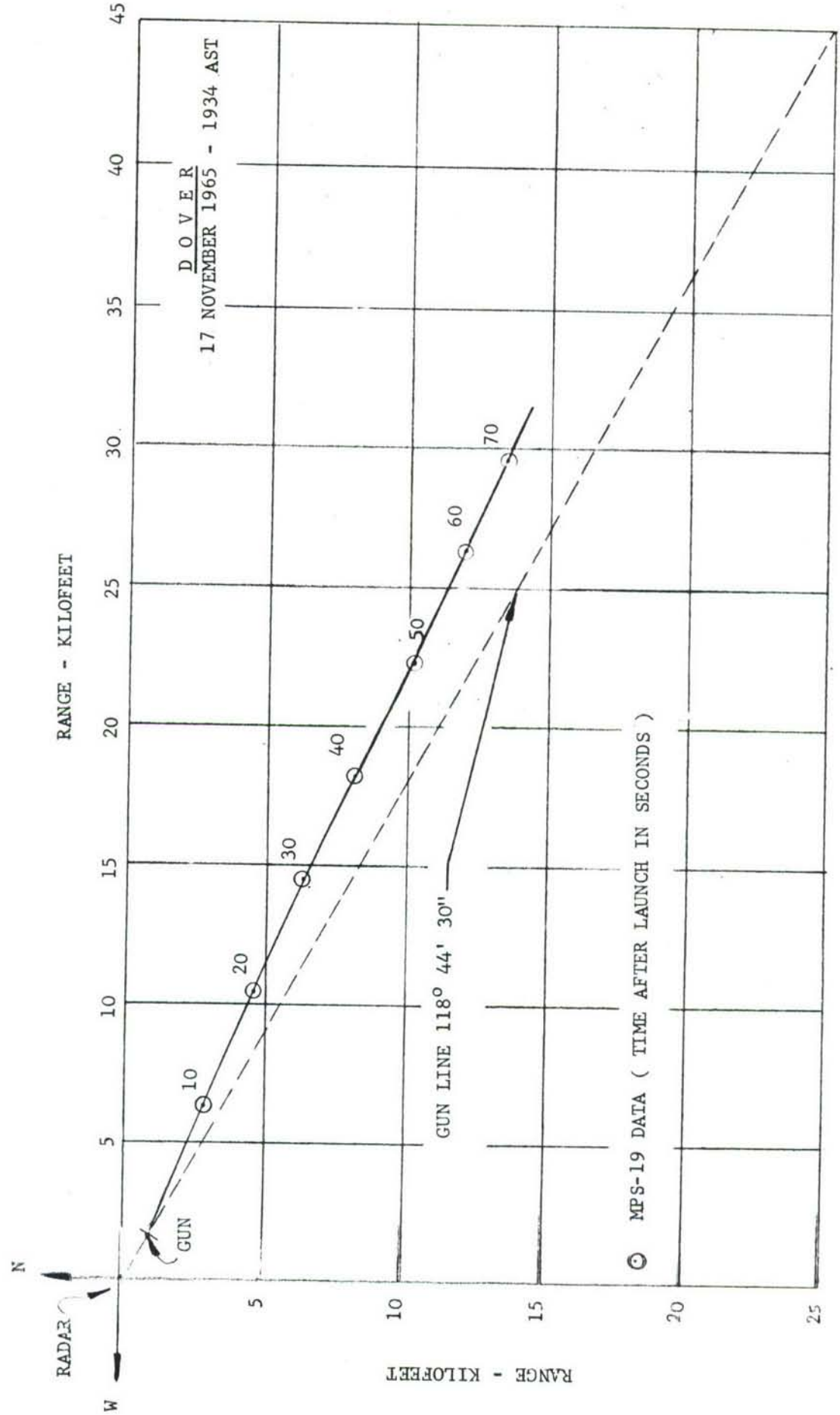


FIG. 2.8b PLAN VIEW OF MARTLET 2C DOVER TRAJECTORY

Round No. 162 - ENTERPRISE

Date: 17 November 1965 - 2038 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:	Vehicle	185.0 lb
	Pusher and Obturator	132.0 lb
	Sabot	101.0 lb
	Shot Weight	418.0 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: Evacuated to a vacuum of 27 inches of mercury.

Launch Data:

Charge Weight	770 lb M8M.22 (8 bags) Lot No. CAD 9029
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	196 in
Ram Load	12 tons
Chamber Volume	41,640 in^3
Recoil	39 in
Breech Pressure	M11: 40,000 psi Strain: 40,000 psi (Fig. 2.9)
Muzzle Velocity (Probe)	Left: 5980 ft/sec Right: 6000 ft/sec Average: 5990 ft/sec

Camera Records:

No smear and Fastax cameras were in operation.

Radar Records:

The M-33 radar received a signal with a strong cyclic variation in strength, which became worse as flight progressed. The signal vanished

between T + 10 sec and T + 15 sec and could not be relocated.

The MPS-19 tracked up to T + 100 sec. Azimuth was 7 deg off to the left, and the AGC trace indicated vehicle tumbling.

Trajectory:

The radar data are compared in Figs. 2.9 a and b with a standard drag trajectory for 4700 ft/sec and 85 deg elevation.

The measured muzzle velocity (5990 ft/sec) was much higher. This in connection with the azimuth reading and subsequent vehicle behaviour indicates some vehicle damage probably caused by a sabot failure. The apogee calculated from the radar data was 231,000 ft = 71 km, and the estimated range was 79,000 ft.

TMA Trail Result:

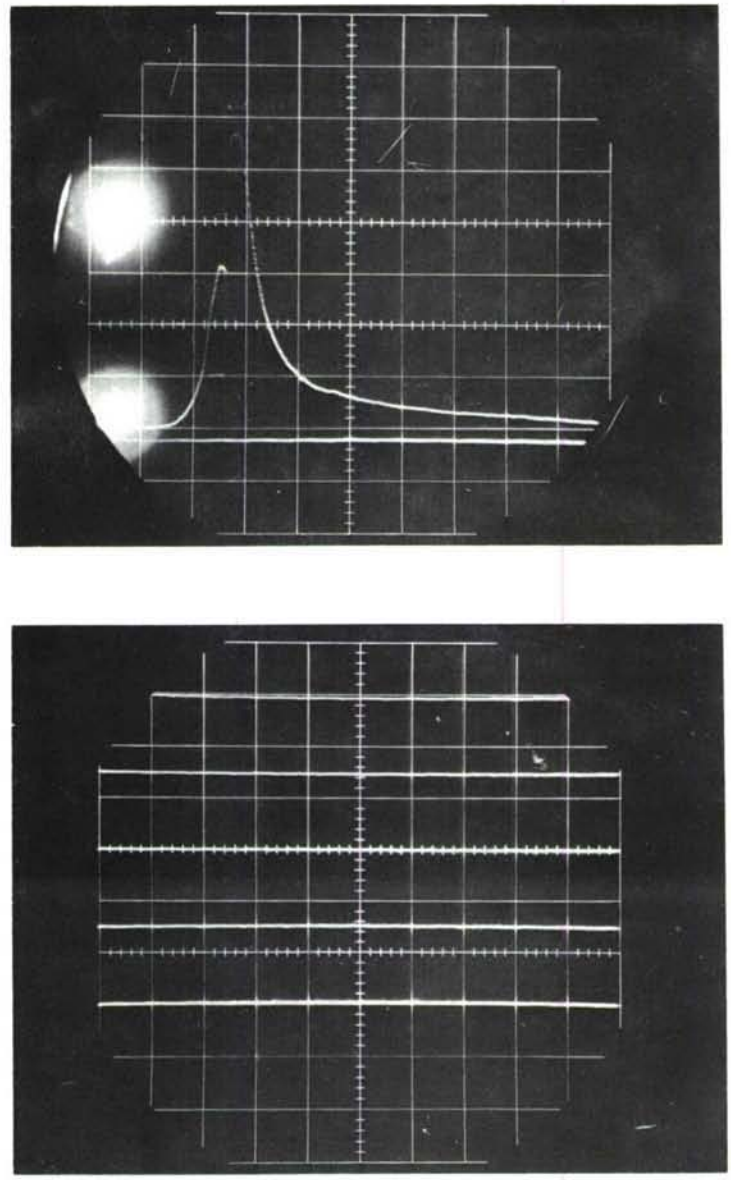
No trail data were obtained.

Summary:

Unsuccessful shot because of a damaged vehicle.

E N T E R P R I S E

17 NOVEMBER 1965 - 2038 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 40,000 psi

Charge: 770 lb M8M.22

FIG. 2.9 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND ENTERPRISE

E N T E R P R I S E

17 NOVEMBER 1965 - 2038 AST

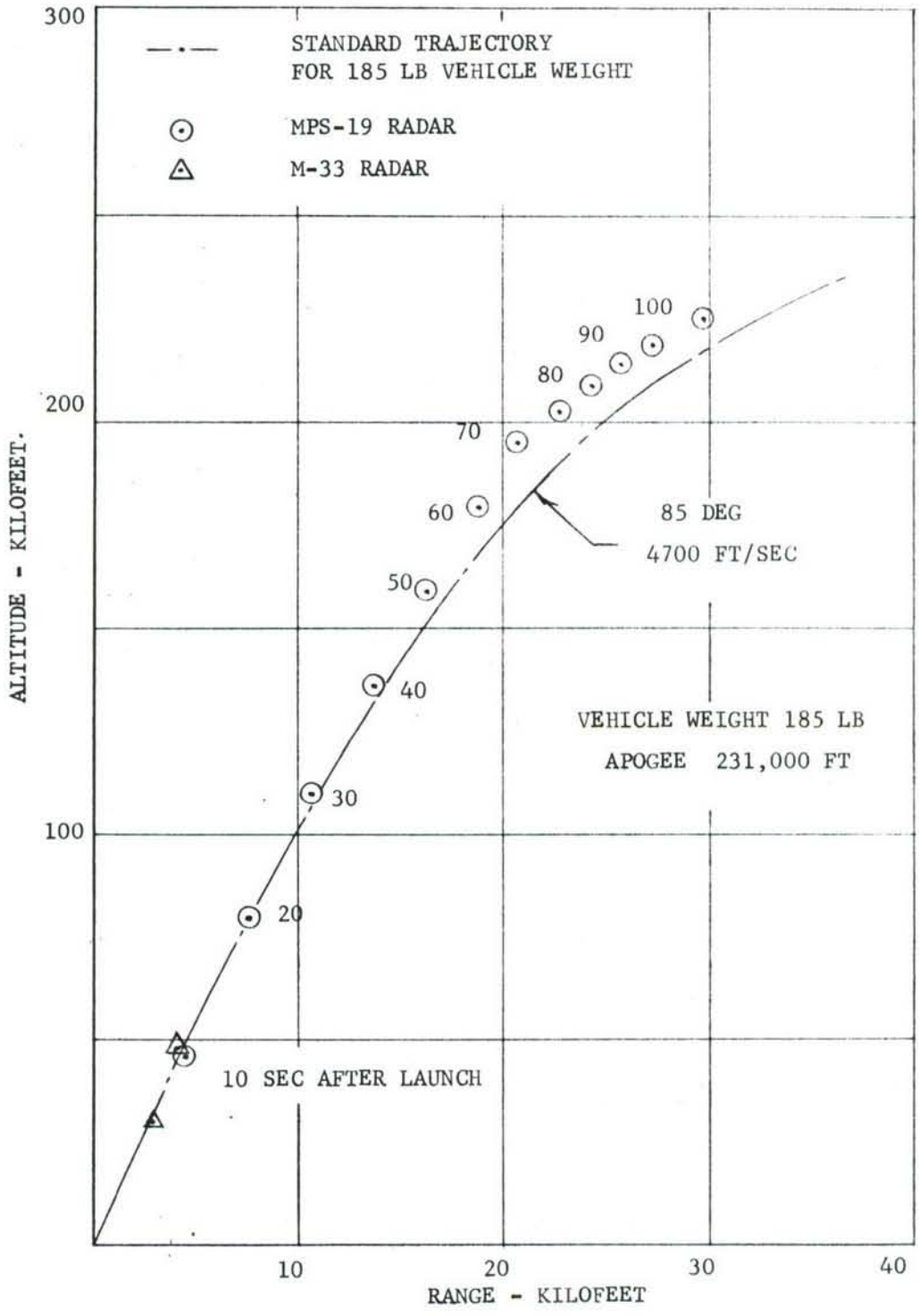


FIG. 2.9a MARTLET 2C ENTERPRISE
ALTITUDE VS RANGE

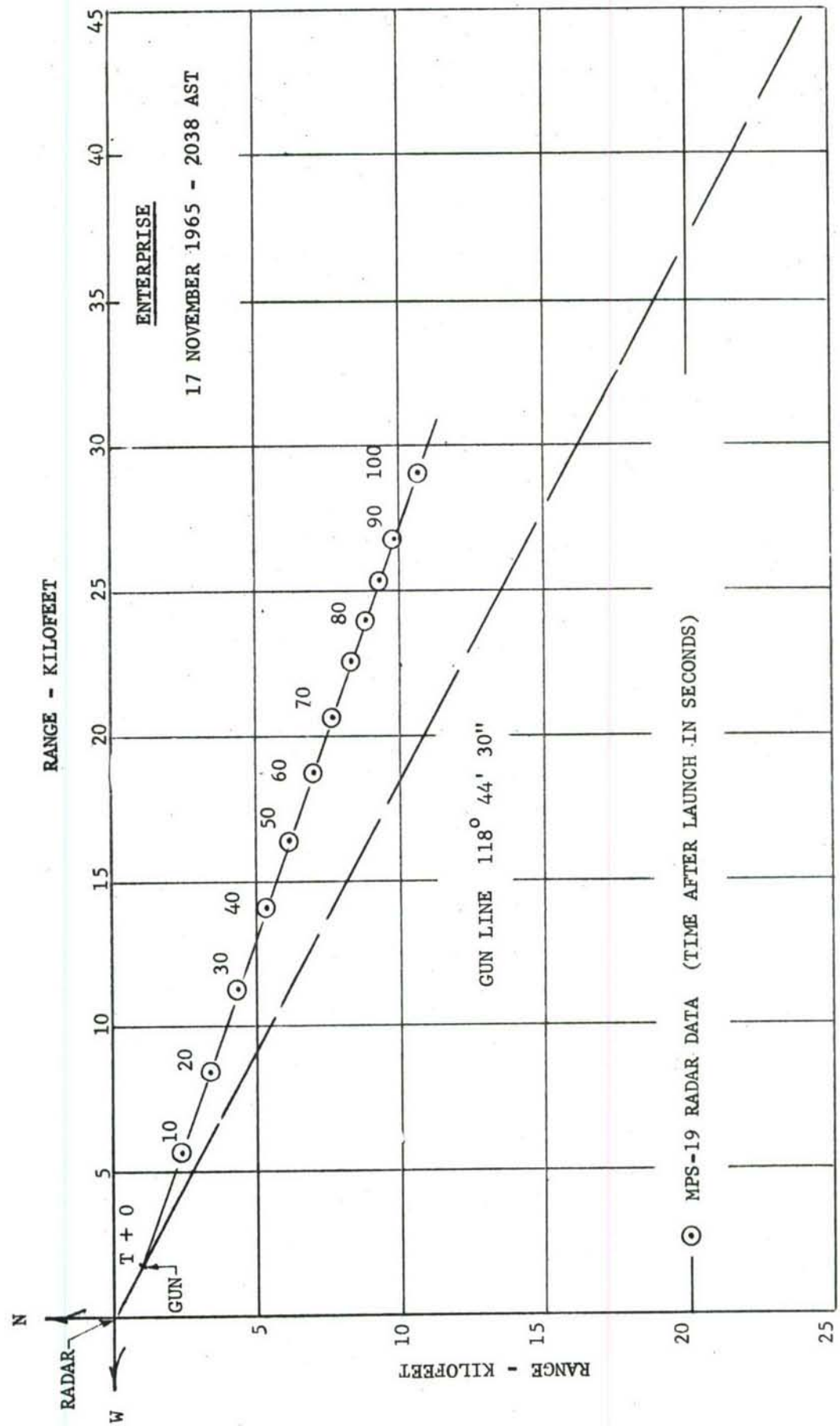


FIG. 2.9b PLAN VIEW OF MARTLET 2C ENTERPRISE TRAJECTORY

Round No. 163 - FOUL BAY

Date: 17 November 1965 - 2315 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	183.8 lb
	Pusher and Obturator	130.5 lb
	Sabot	101.0 lb
	Shot Weight	415.3 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: Evacuated to a vacuum of 28 inches of mercury.

Launch Data:

Charge Weight	770 lb M8M.22 (8 bags) Lot No. CAD 9029
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 3
Ram Distance	196 in
Ram Load	15 tons
Chamber Volume	41,640 in^3
Recoil	39.0 in
Breech Pressure	M11: 41,150 psi Strain: 41,400 psi (Fig. 2.10)
Muzzle Velocity (Probe)	Left: 6130 ft/sec Right: 6100 ft/sec Average: 6120 ft/sec

Camera Records:

No smear and Fastax cameras were in operation.

Radar Records:

The M-33 radar tracked from T + 10 sec to T + 30 sec. The MPS-19 tracked to T + 100 sec and recorded also splashdown at T + 335 sec,

with a total range of 140,800 ft and a velocity of 4400 ft/sec.

Trajectory:

The radar data are compared in Figs. 2.10a and b with a standard drag trajectory for 5900 ft/sec and 85 deg elevation. This velocity is smaller than the muzzle velocity (6100 ft/sec) indicating a higher drag than predicted.

The apogee derived from these data is 404,000 ft = 123 km; the TMA trail data gave 127 km. The total range was 140,800 ft.

TMA Trail Results:

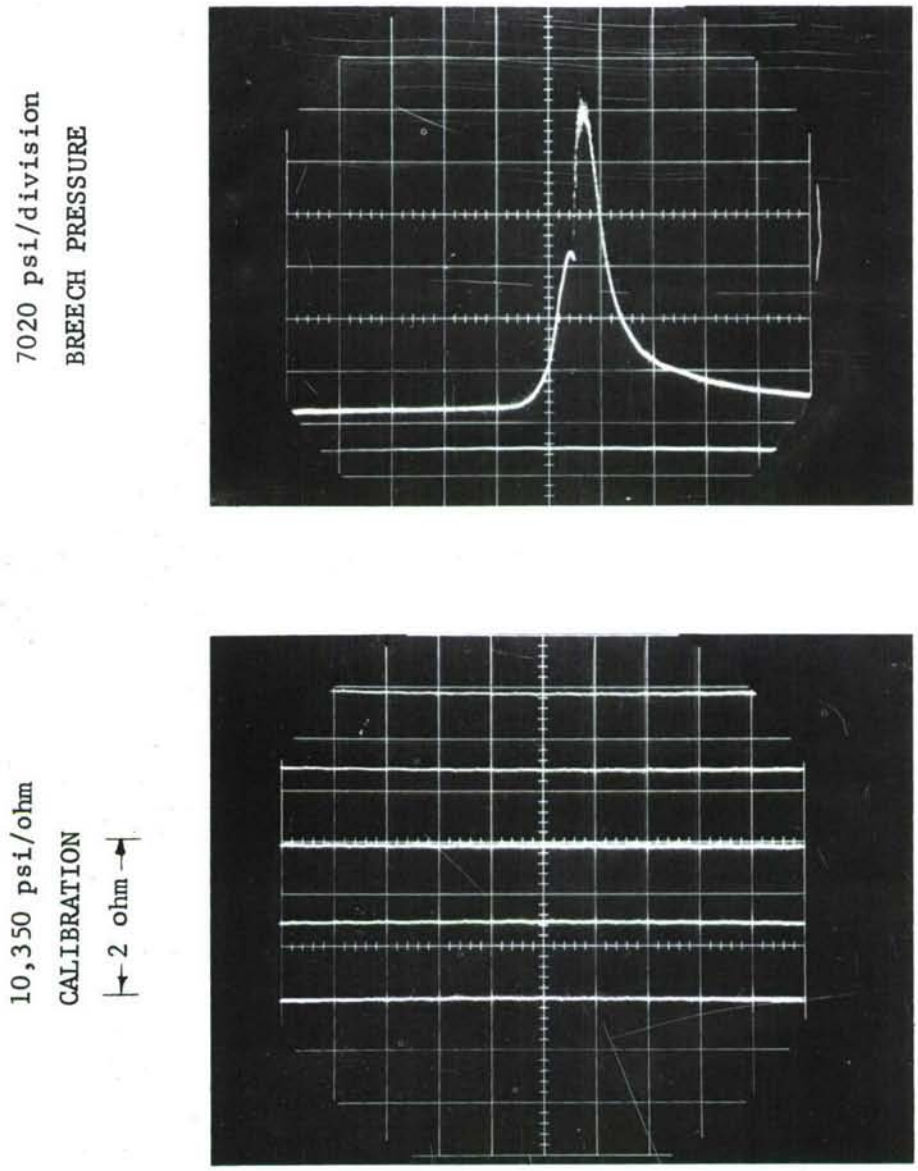
The cameras and the payload performed satisfactorily. The evaluation of trail photographs gave wind data up-trail and down-trail between 93 km and 127 km.

Summary:

This was a successful shot regarding trajectory and payload.

F O U L B A Y

17 NOVEMBER 1965 - 2315 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 41,400 psi

Charge: 770 lb M8M.22

FIG. 2.10 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND FOUL BAY

F O U L B A Y

17 NOVEMBER 1965 - 2315 AST

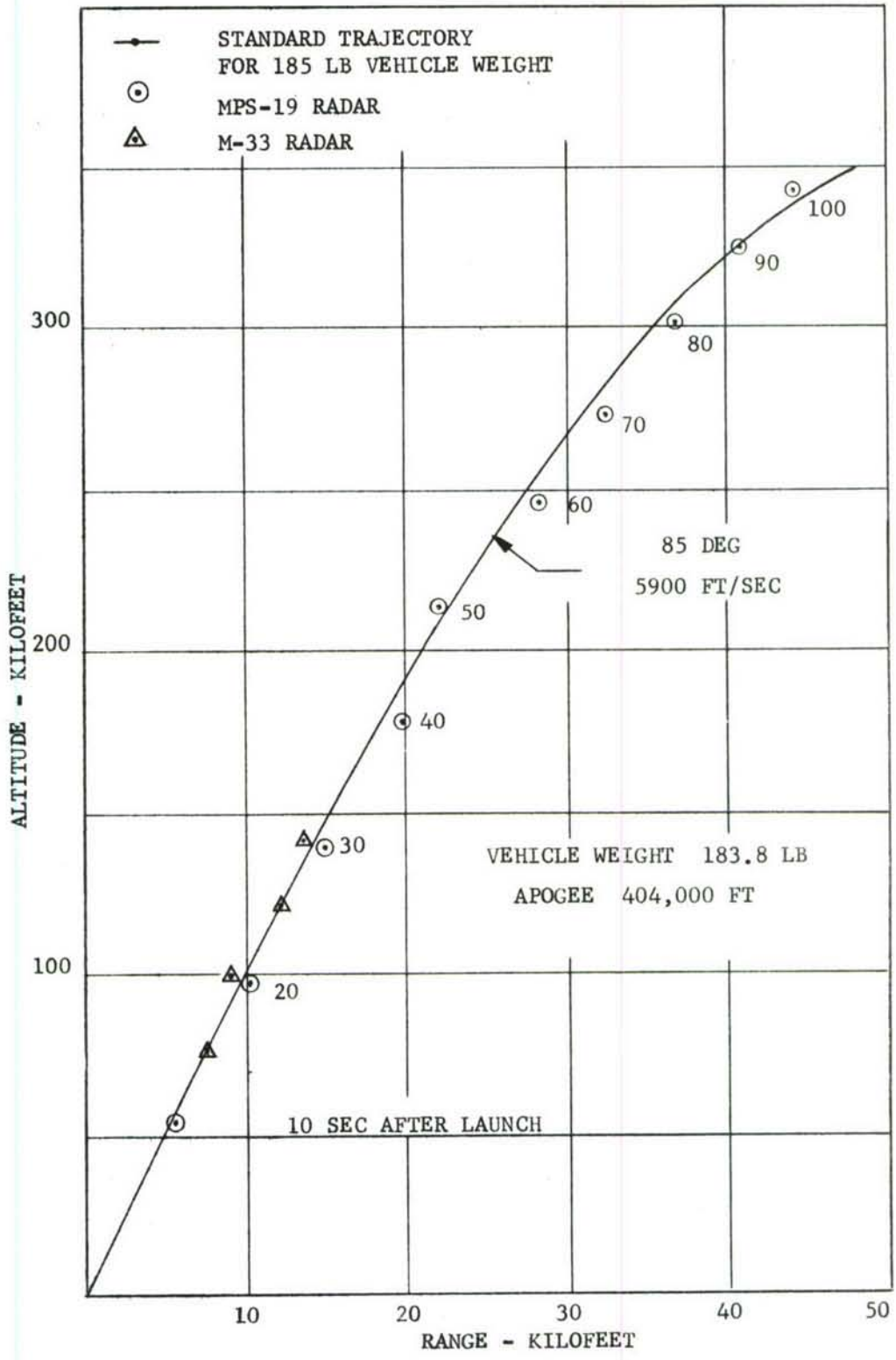


FIG. 2.10a MARTLET 2C FOUL BAY
ALTITUDE VS RANGE

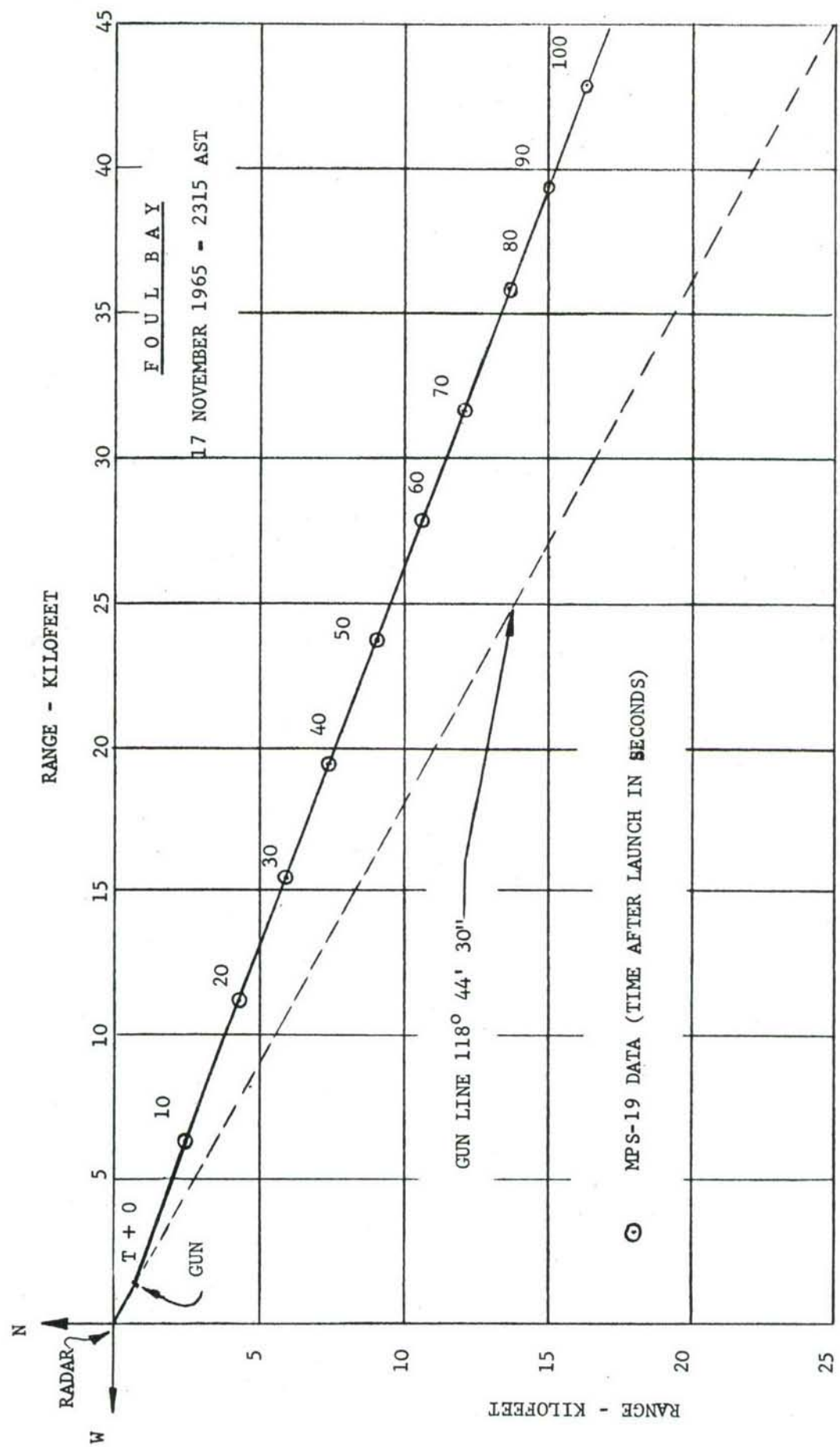


FIG. 2.10b PLAN VIEW OF MARTLET 2C FOUL BAY TRAJECTORY

Round No. 164 - GUN HILL

Date: 18 November 1965 - 0045 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	183.5 lb
	Pusher and Obturator	131.0 lb
	Sabot	101.0 lb
	Shot Weight	415.5 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: Evacuated to a vacuum of 28 inches of mercury.

Launch Data:

Charge Weight	770 lb M8M.22 (8 bags) Lot No. CAD 9029
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 3
Ram Distance	196 inches
Ram Load	19 tons
Chamber Volume	41,640 in^3
Recoil	39.0 in
Breech Pressure	M11: 41,500 psi Strain: 41,400 psi (Fig. 2.11)
Muzzle Velocity (Probe)	Left: 6010 ft/sec Right: 5930 ft/sec Average: 5970 ft/sec

Camera Records:

No smear and Fastax cameras were in operation.

Radar Records:

The M-33 radar tracked from T + 10 sec to T + 30 sec. The MPS-19 radar tracked up to T + 100 sec. The AGC trace was normal.

Trajectory:

The radar data are plotted in Figs. 2.11 a and b in comparison with a standard drag trajectory for 6000 ft/sec and 85 deg elevation.

The apogee derived from these data was 413,000 ft = 126.0 km which is in good agreement with the evaluation of the TMA trail given as 127 km.

The total range was estimated as 140,000 ft.

TMA Trail Results:

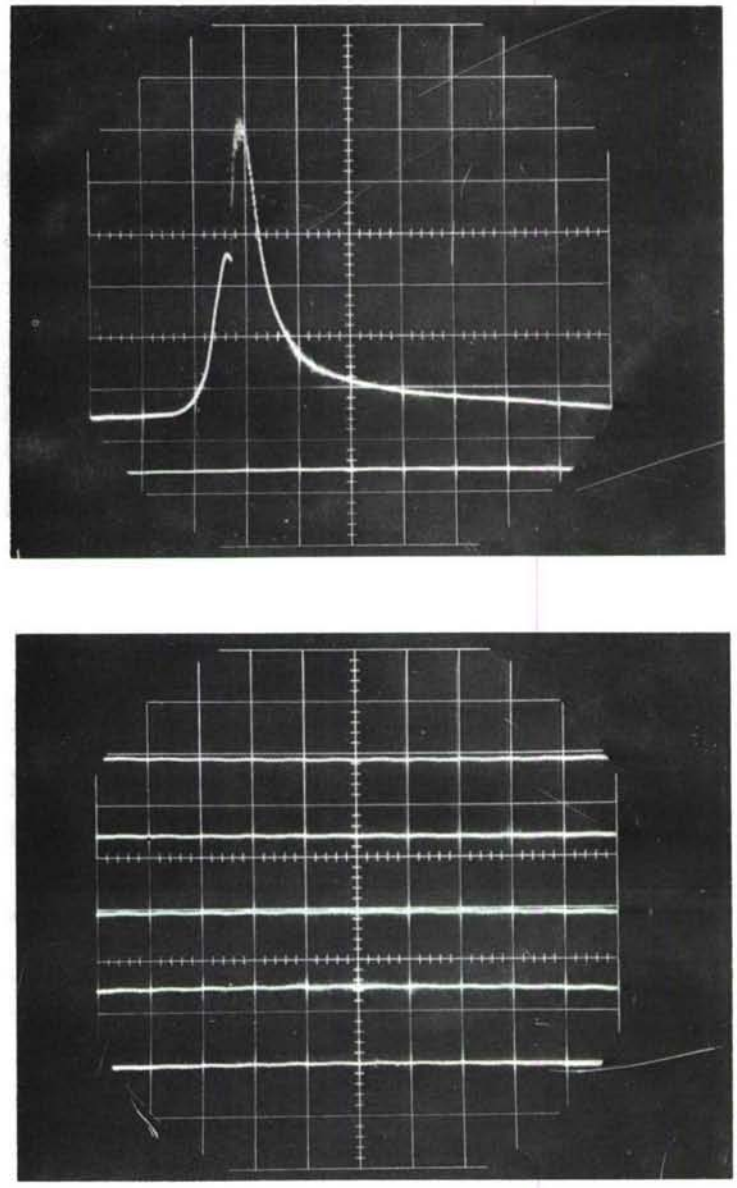
Cameras and payload performed satisfactorily. Evaluation of photographs gave wind data up-trail and down-trail between 95 km and 127 km.

Summary:

This was a successful shot regarding trajectory and payload.

G U N H I L L

18 NOVEMBER 1965 - 0045 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 41,400 psi

Charge: 770 lb M8M.22

FIG. 2.11 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND GUN HILL

G U N H I L L

18 NOVEMBER 1965 - 0045 AST

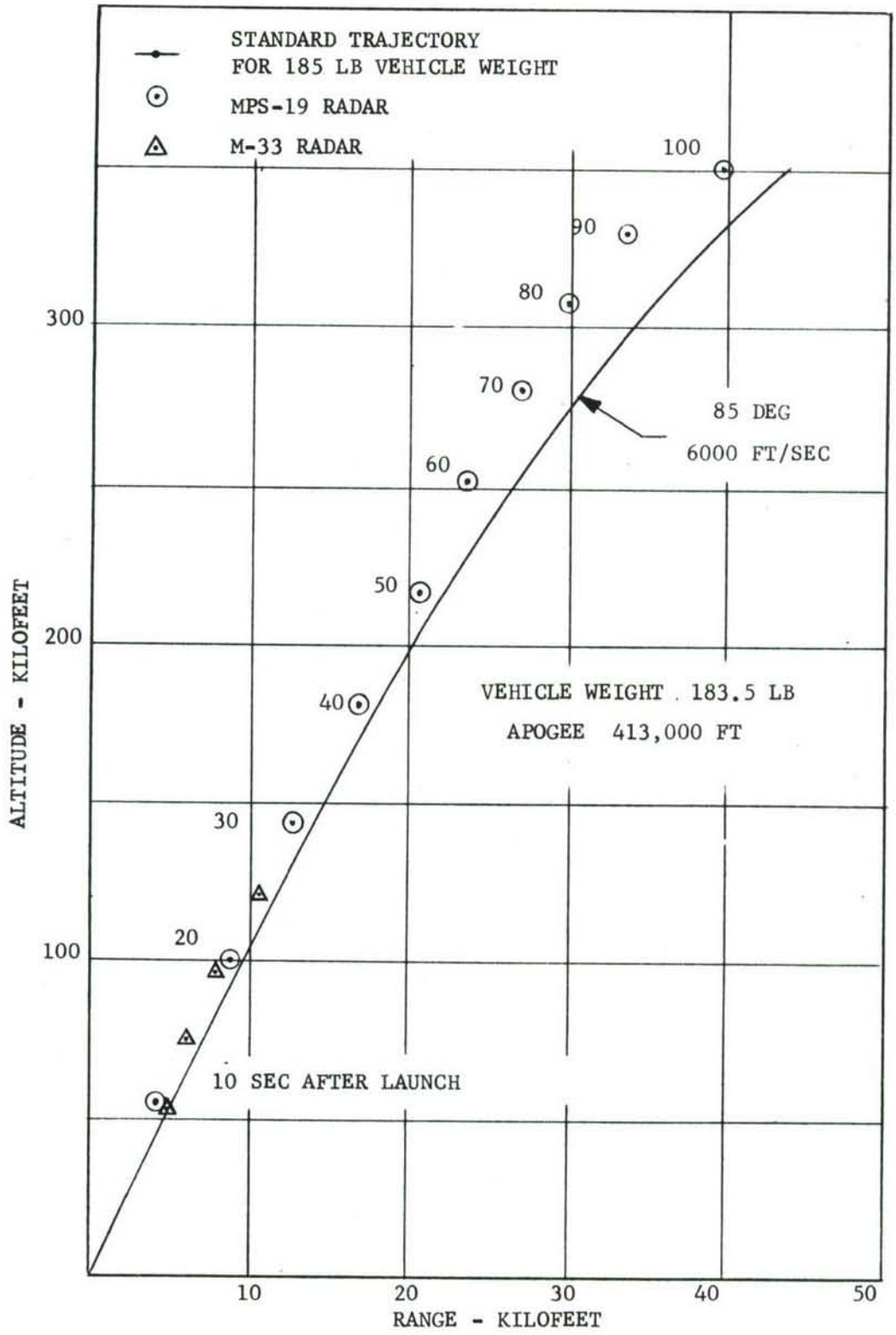


FIG. 2.11a MARTLET 2C GUN HILL

ALTITUDE VS RANGE

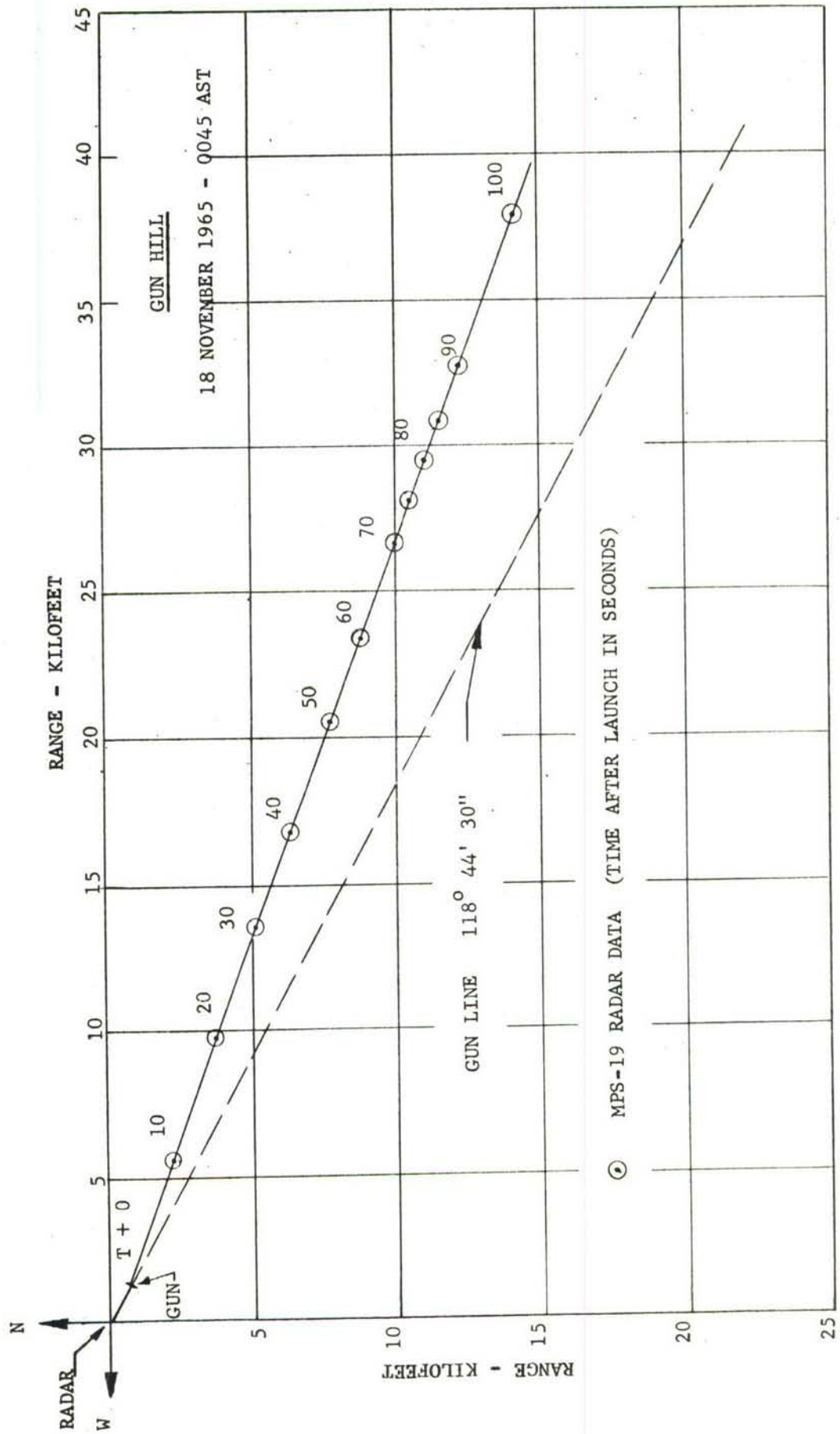
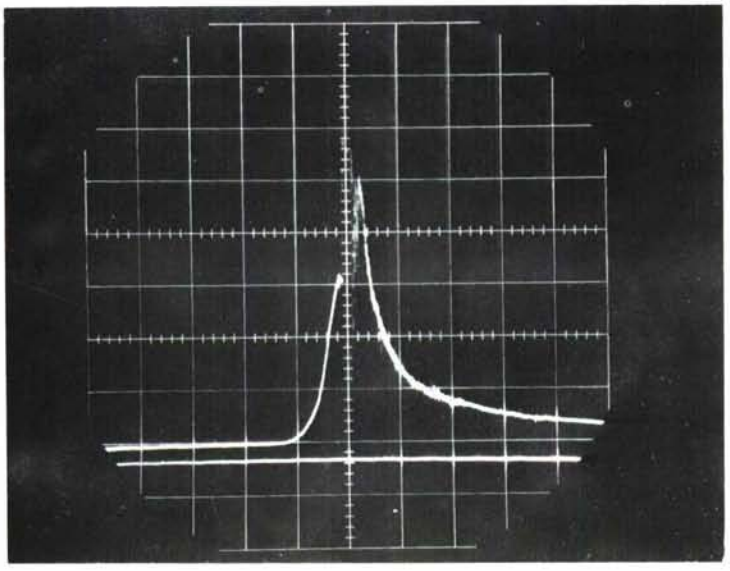


FIG. 2.11b PLAN VIEW OF MARTLET 2C GUN HILL TRAJECTORY

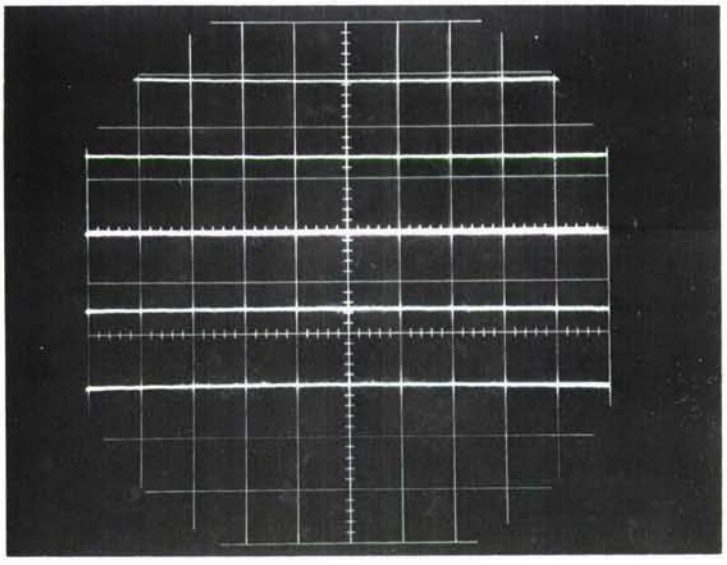
H A S T I N G S

18 NOVEMBER 1965 - 0155 AST

7070 psi/division
BREECH PRESSURE



10,350 psi/ohm
CALIBRATION
3 ohm



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 43,000 psi

Charge: 790 lb M8M.22

FIG. 2.12 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND HASTINGS

H A S T I N G S

18 NOVEMBER 1965 - 0155 AST

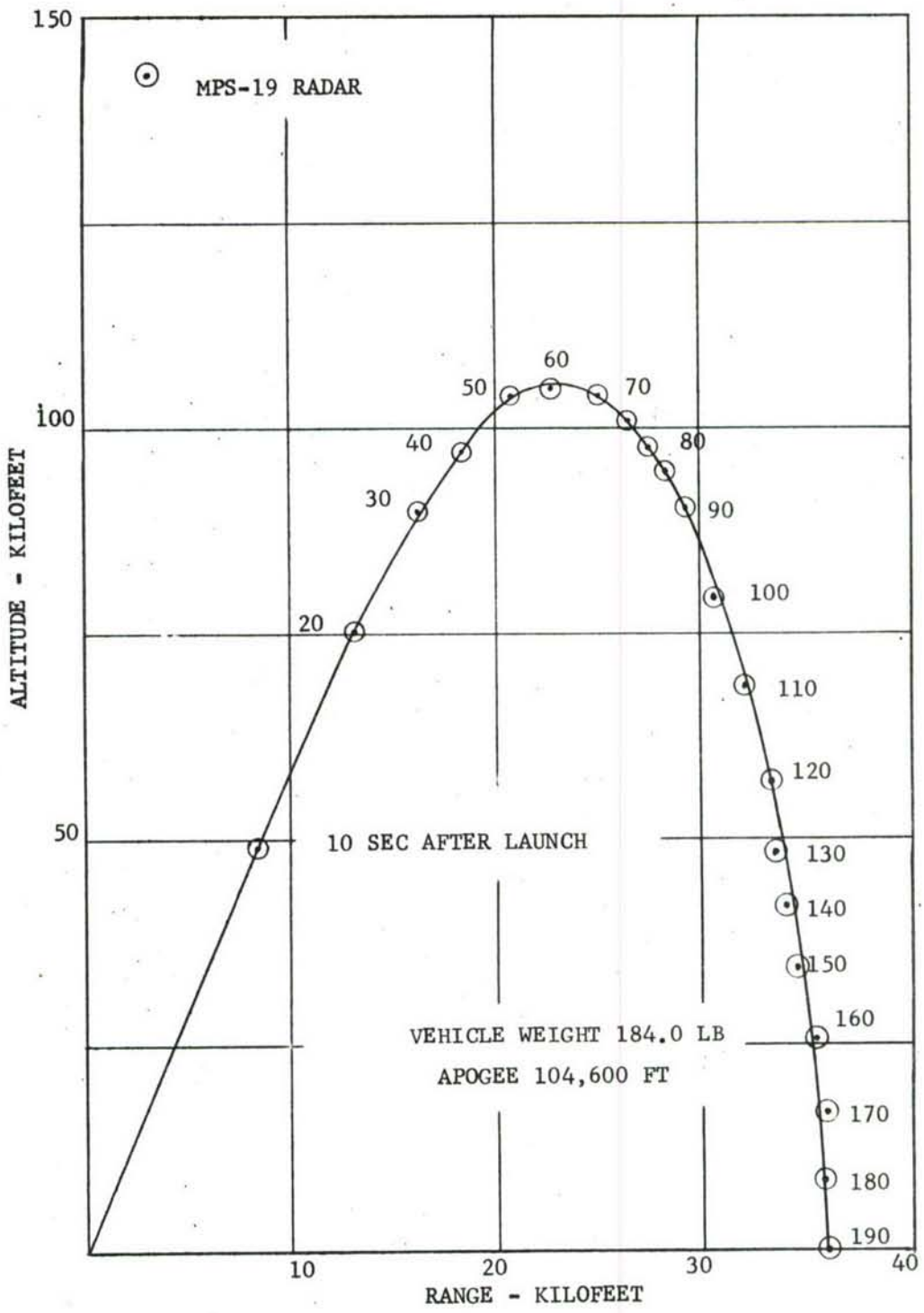


FIG. 2.12a MARTLET 2C HASTINGS
ALTITUDE VS RANGE

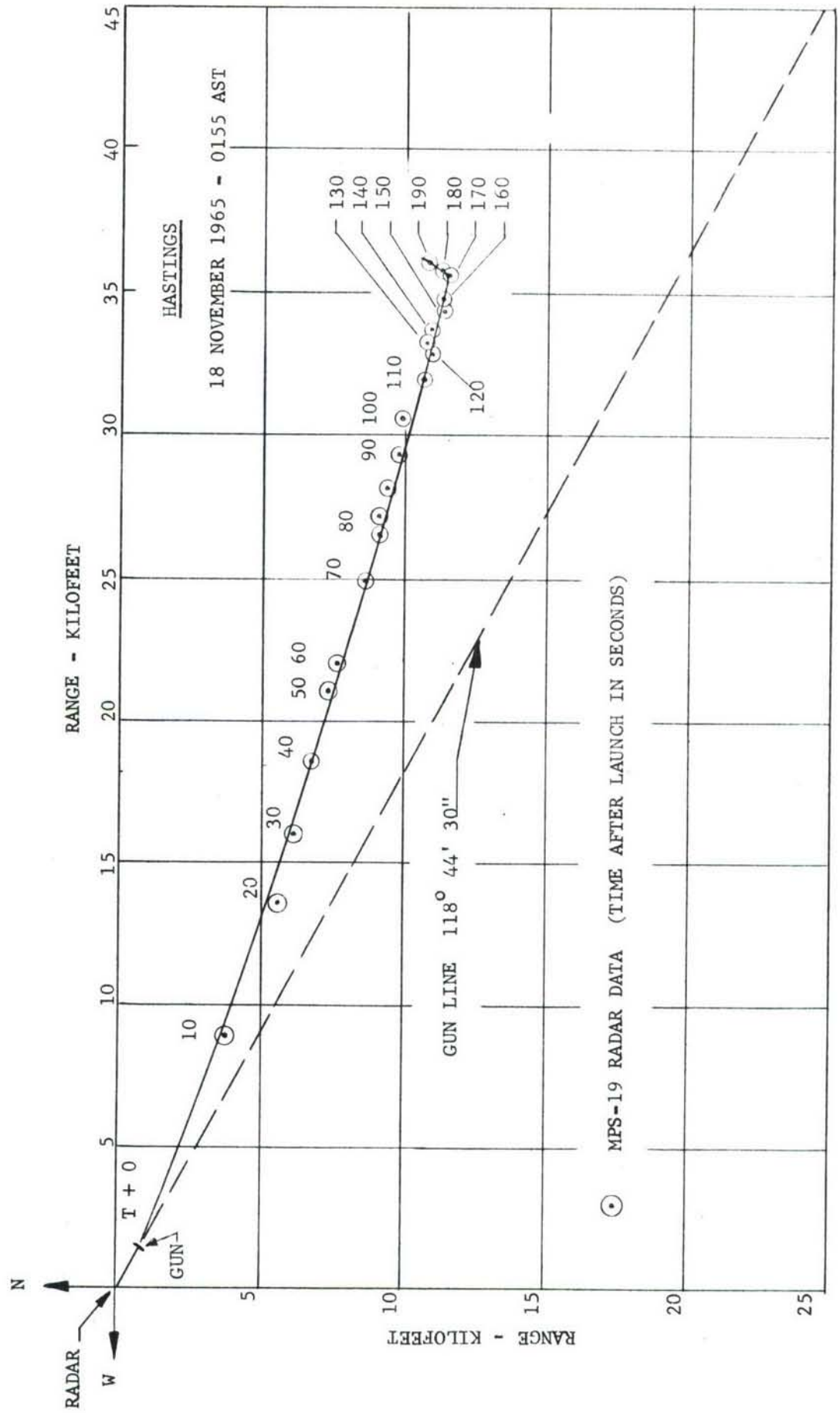


FIG. 2.12b PLAN VIEW OF MARTLET 2C HASTINGS TRAJECTORY

Round No. 166 - INDIAN GROUND

Date: 18 November 1965 - 0330 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	184.0 lb
	Pusher and Obturator	132.0 lb
	Sabot	102.0 lb
	Shot Weight	418.0 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: Evacuated to a vacuum of 27 inches of mercury.

Launch Data:

Charge Weight	750 lb M8M.22 (8 bags) Lot No. CAD 9029
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 3
Ram Distance	196 in
Ram Load	16 tons
Chamber Volume	41,640 in^3
Recoil	38.5 in
Breech Pressure	M11: 42,200 psi Strain: 43,600 psi (Fig. 2.13)
Muzzle Velocity (Probe)	Left: 5950 ft/sec Right: 6000 ft/sec Average: 5980 ft/sec

Camera Records:

No smear and Fastax cameras were used.

Radar Records:

The M-33 radar tracked from T + 10 sec to T + 35 sec.

The MPS-19 radar tracked to T + 110 sec.

TECHNICAL REPORTS SECTION
STINFO BRANCH
BLDG. 305

Trajectory:

The radar data are compared in Fig. 2.13a with standard trajectories for 6000 ft/sec, 85 deg elevation, and 5900 ft/sec, 85.7 deg. The latter curve shows a better agreement, indicating that the elevation was somewhat higher than 85 degrees, and the drag higher than standard. The apogee derived from the radar data was 400,000 ft = 122 km, and the estimated total range 140,000 ft. Fig. 2.13b, giving the plan view of the trajectory, shows an azimuth reading above that of the gun line.

The estimated range was 140,000 ft.

TMA Trail Results:

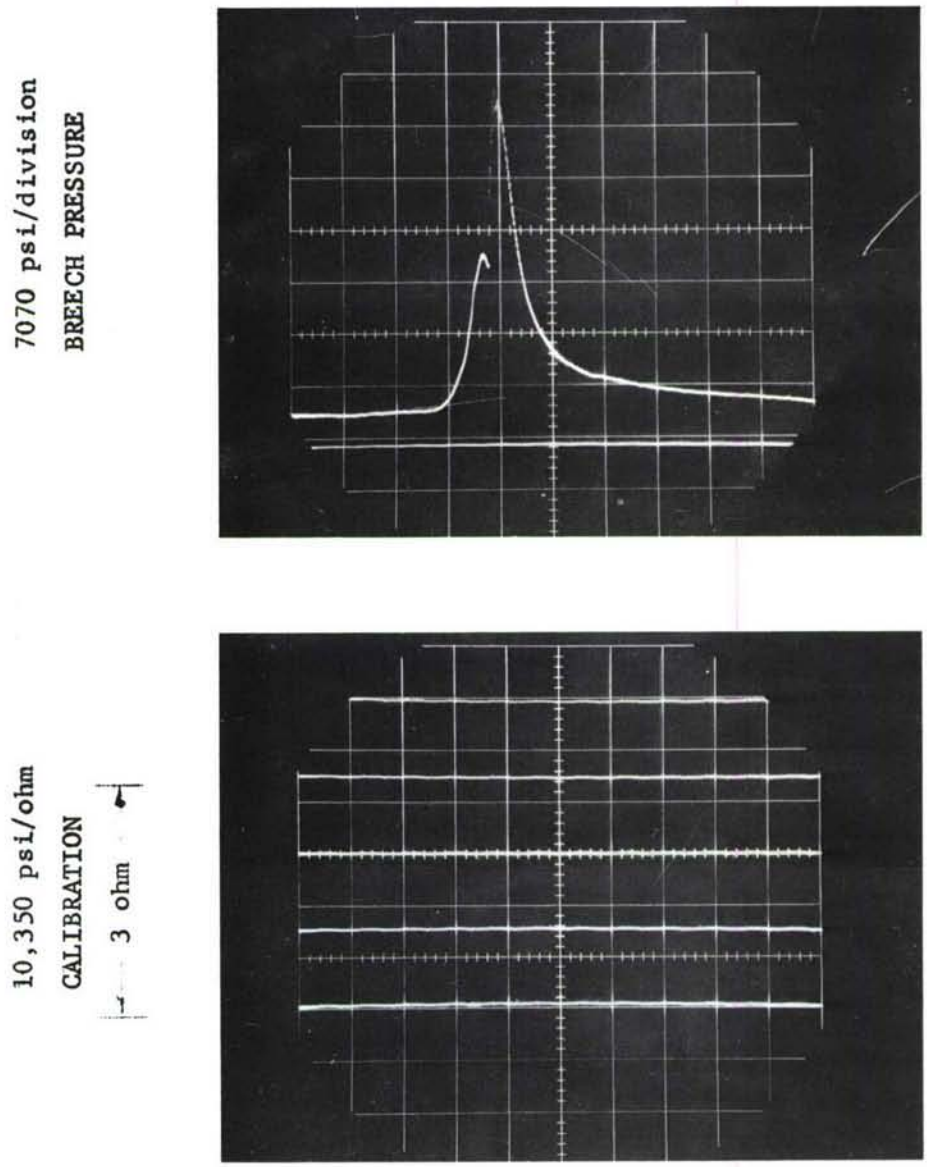
Cameras and the payloads performed satisfactorily. The evaluation of trail photographs gave up-trail data between 98 km and 117 km.

Summary:

The round was successful.

I N D I A N G R O U N D

18 NOVEMBER 1965 - 0330 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 43,600 psi

Charge: 750 lb M8M.22

FIG. 2.13 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND INDIAN GROUND

I N D I A N G R O U N D

18 NOVEMBER 1965 - 0330 AST

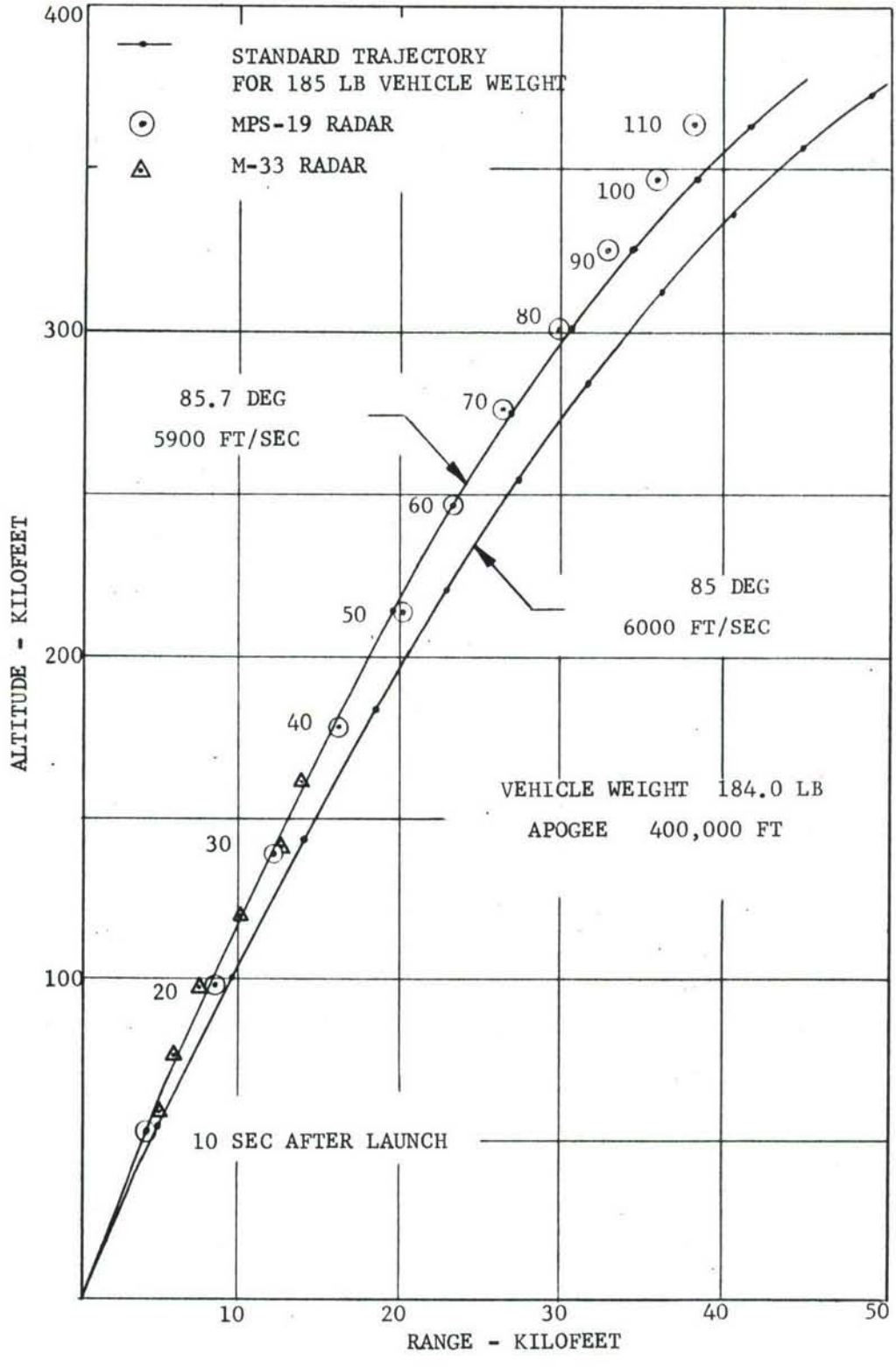


FIG. 2.13a MARTLET 2C INDIAN GROUND
ALTITUDE VS RANGE

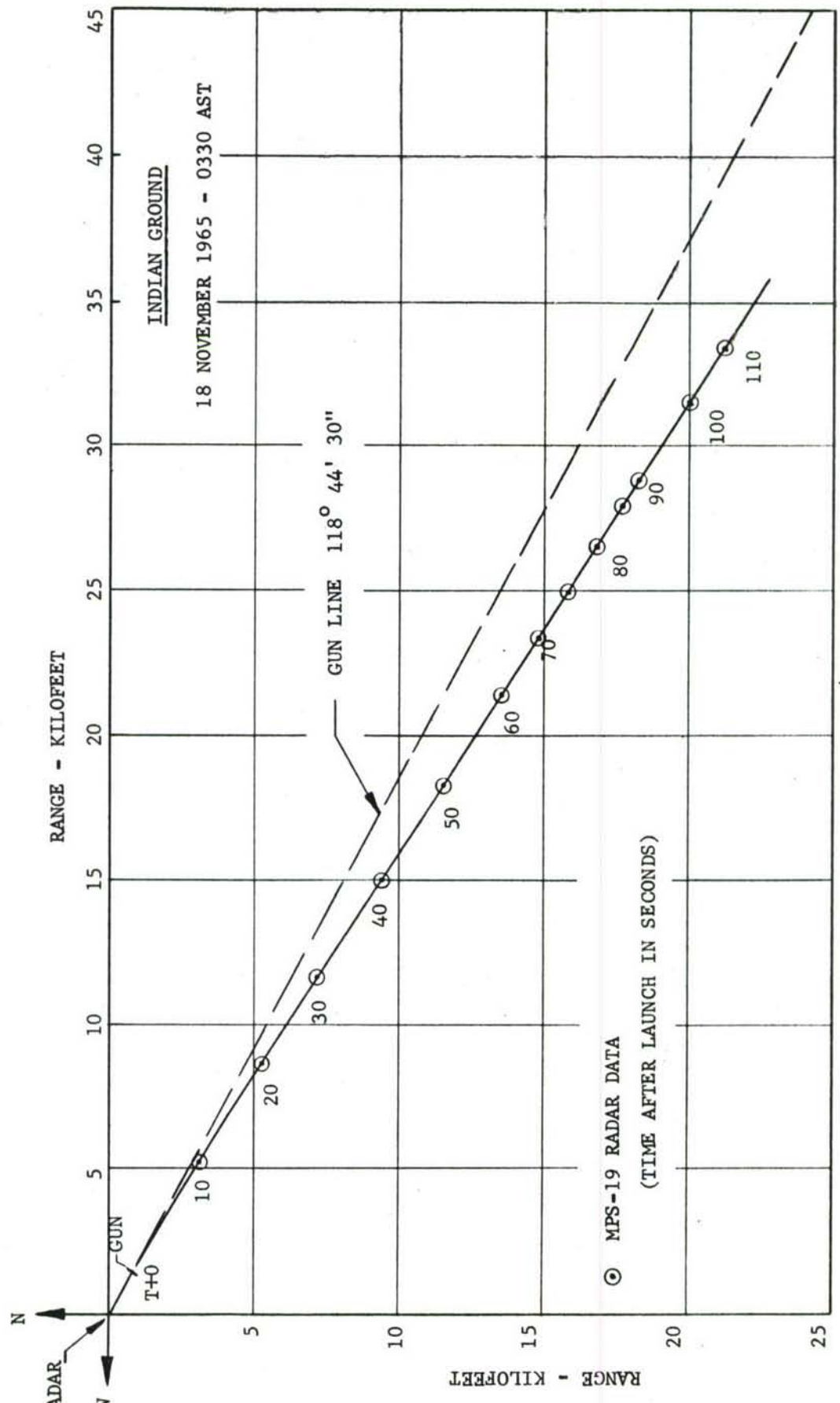


FIG. 2.13b PLAN VIEW OF MARTLET 2C INDIAN GROUND TRAJECTORY

Round No. 167 - JAMESTOWN

Date: 18 November 1965 - 0508 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles. (Sunrise shot)

Weights:		
	Vehicle	184.0 lb
	Pusher and Obturator	130.0 lb
	Sabot	101.0 lb
	Shot Weight	415.0 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	750 lb M8M.22 (8 bags) Lot No. CAD 9029
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 3
Ram Distance	196 in
Ram Load	18 tons
Chamber Volume	41,640 in^3
Recoil	39.0 in
Breech Pressure	M11: 37,900 psi Strain: 38,200 psi (Fig. 2.14)
Muzzle Velocity (Probe)	Left: 5670 ft/sec Right: Not available

Camera Records:

No smear and Fastax cameras were in operation.

Radar Records:

The M-33 radar tracked from T + 6 sec to T + 40 sec.

The MPS-10 radar tracked from T + 10 sec to T + 100 sec.

Trajectory:

The radar data are compared in Figs. 2.14 a,b with a standard drag trajectory for 5700 ft and 85 deg elevation.

The apogee derived from these data is 391,000 ft = 119.0 km which is in agreement with the trail results.

The total range was estimated to be 124,000 ft.

TMA Trail Results:

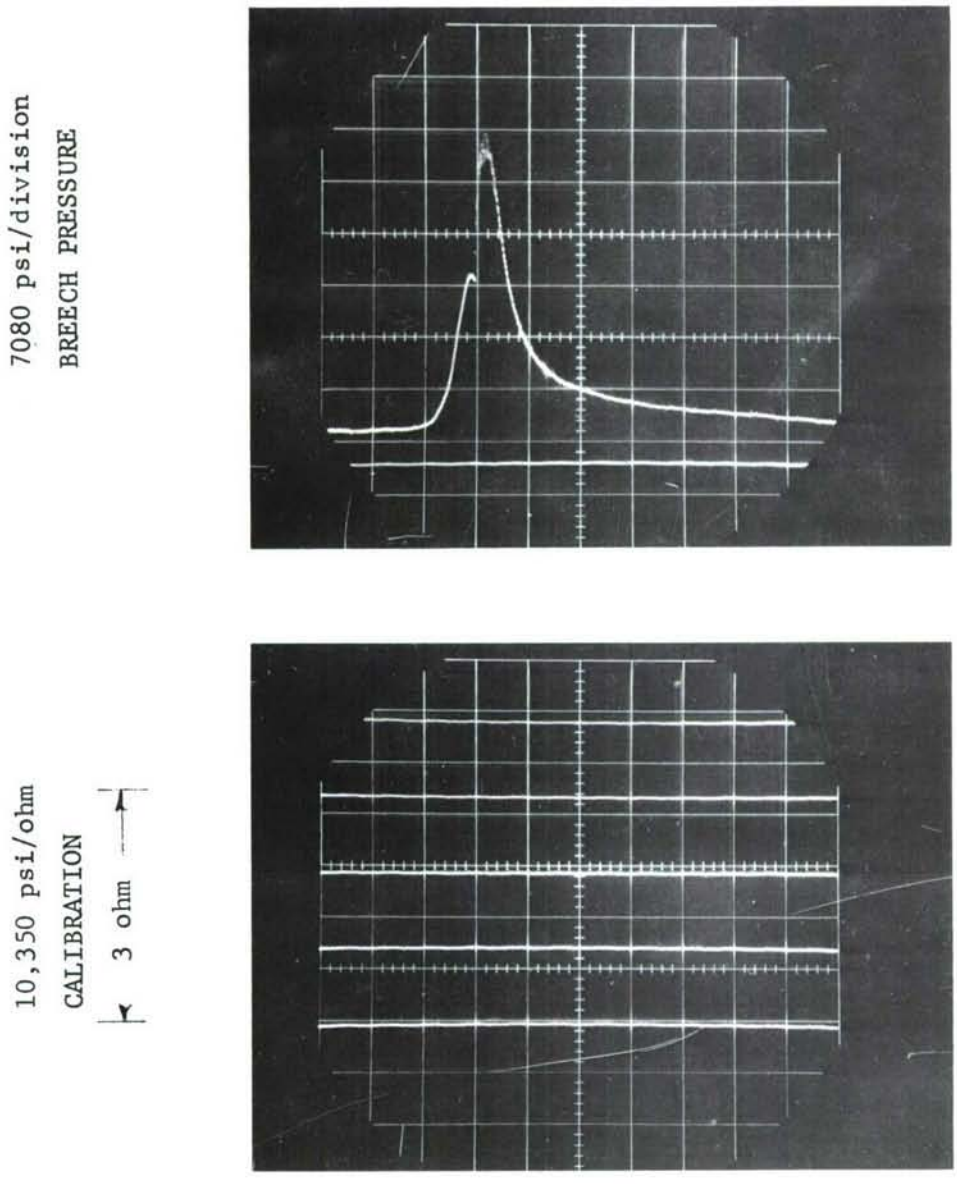
The cameras and the payload performed satisfactorily and a very good trail was obtained. The trace, however, appeared to "blue" very late. The solar horizon was calculated to be 100 km. The evaluation of the trail photographs gave wind data up-trail between 93 km and 119 km.

Summary:

This was a successful shot.

J A M E S T O W N

18 NOVEMBER 1965 - 0508 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 38,200 psi

Charge: 750 lb M8M.22

FIG. 2.14 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND JAMESTOWN

JAMESTOWN

18 NOVEMBER 1965 - 0508 AST

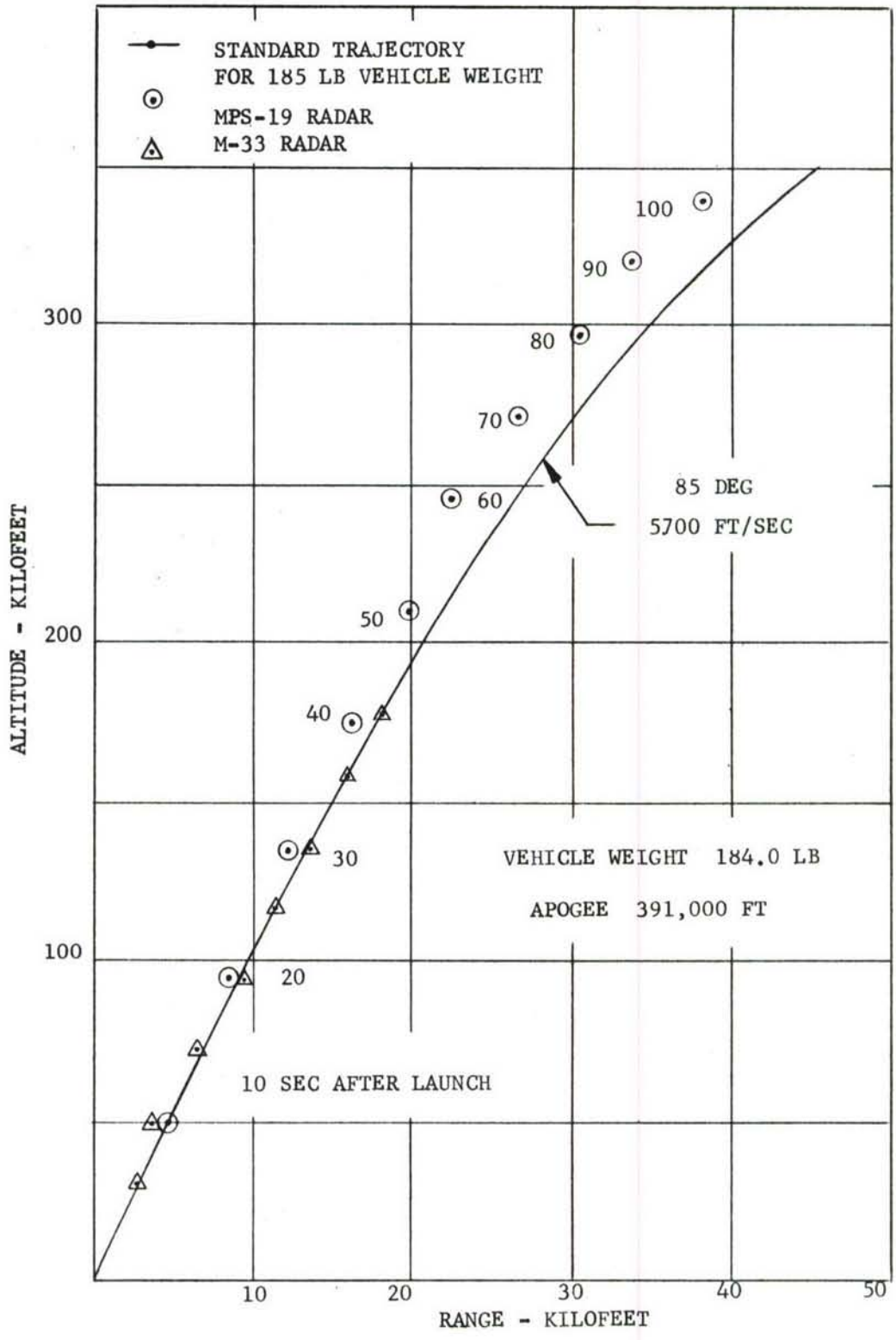


FIG. 2.14a MARTLET 2C JAMESTOWN
ALTITUDE VS RANGE

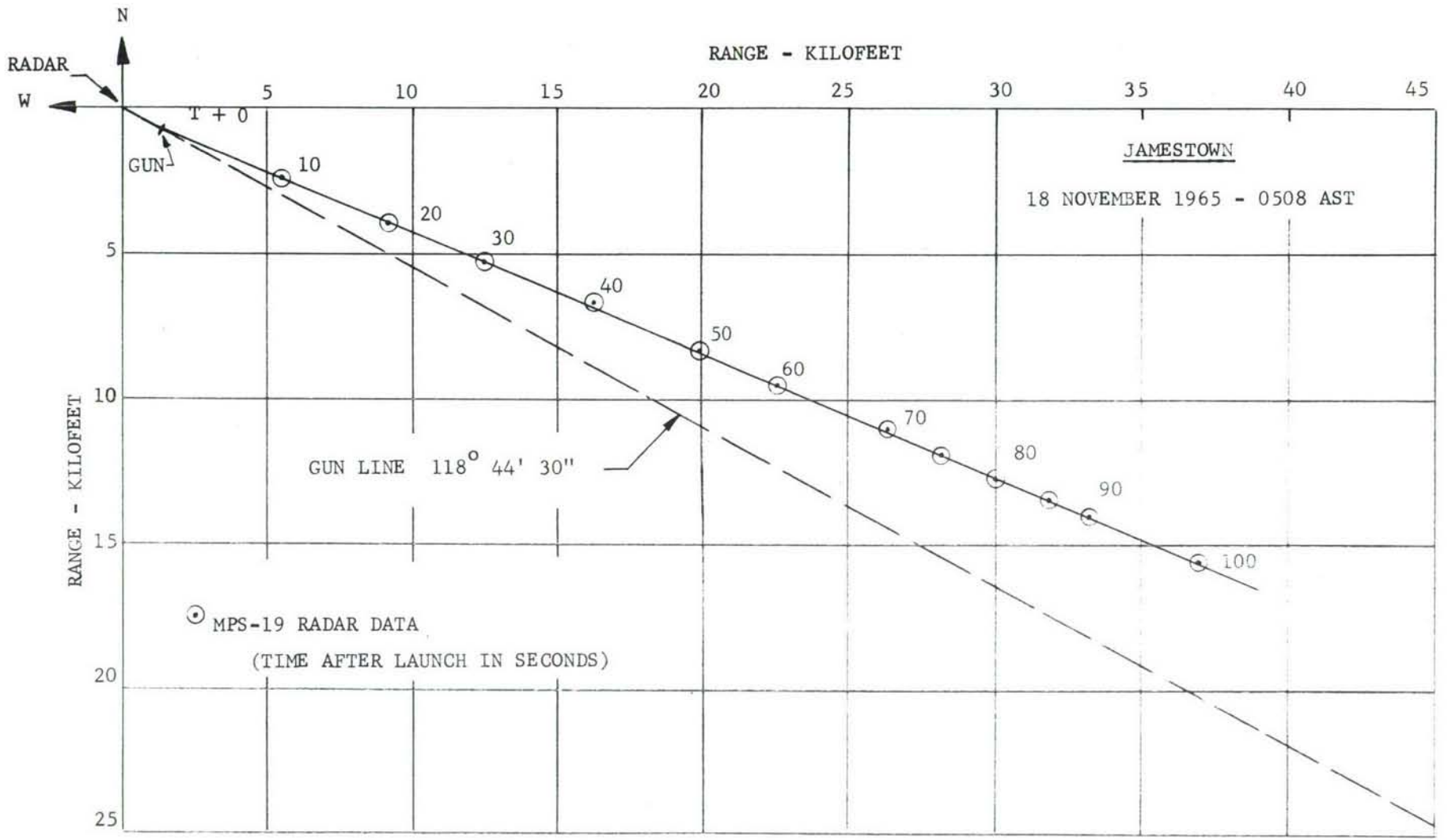


FIG. 2.14b PLAN VIEW OF MARTLET 2C JAMESTOWN TRAJECTORY

Round No. 168 - KENDALL

Date: 19 November 1965 - 1330 AST

Vehicle Description: Martlet 2C (Mod 3) carrying a payload consisting of S-band chaff and a parachute telemetry package with thermistors.

Payload Description:

The 14 ft^2 metallized silk parachute was packed in the upper 14 3/4 in section of a split cylinder 19 - 3/4 in long by 2.85 in. in diameter. The 1750 MHz telemetry unit, 5 3/8 in long, 2½ in. in diameter and weighing 30 ounces, a SOLISTRON production model was attached to the parachute and held in the split cylinder with a retaining ring at the aft end. A combined slot-loop ("sloop") antenna was used, protruding out of the end of the projectile to provide tracking and telemetry data from launch through ejection to impact. Four bead thermistors were attached to the 18 ft shroud.

Purpose of Test:

Measurement of upper atmosphere air temperature and winds, furthermore tests of i) the revised parachute ejection system with tethered ejection slug to prevent parachute damage, ii) the performance of the thermistors on the parachute shroud lines at four different spacings from the telemetry unit, and iii) the performance of the telemetry transmitter, a seven segment BRL subcarrier oscillator, a nickel-cadmium battery pack and the sloop antenna, particularly at low temperatures.

Weights:		
	Vehicle	184.0 lb
	Pusher and Obturator	134.0 lb

Spacer for Pusher Plate	12.0 lb
Sabot	101.0 lb
Shot Weight	431.0 lb

Centre of Gravity: 20.3 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	590 lb WMM.225 (6 bags)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	80 deg
Crusher Gauges	Mk6: 2 M11: 4
Ram Distance	194 in
Ram Load	15 tons
Chamber Volume	41,220 in^3
Recoil	30 in
Breech Pressure	M11: 22,150 psi Mk6: 21,900 psi Average: 22,000 psi Strain: 23,650 psi
Muzzle Velocity (Probe)	4650 ft/sec

Camera Records:

Both Fastax stations were in operation and good films were obtained.

Radar Records:

The MPS-19 radar tracked to T + 75 sec. At T + 130 sec the radar acquired the chaff at an elevation angle which agreed closely with the predicted angle. At T + 274 sec the radar acquired the telemetry package with apparently an unopened parachute, at an elevation of 38 deg. The package was also acquired by the M-33 radar at T + 300 sec and 33 deg elevation. At T + 310 sec, at an altitude of 90,000 ft, a large piece of the parachute was torn away from the telemetry payload, and

both radars tracked this piece for approximately 30 minutes beyond the telemetry splash time. The fall rate of the telemetry package was found to be approximately 1000 ft/sec at T + 230 sec and approximately 300 ft/sec at T + 340 sec.

Trajectory:

The MPS-19 radar data are plotted in Figs. 2.15 a and b comparing well with a standard trajectory for 4700 ft/sec muzzle velocity. The apogee derived from these data was 237,000 ft and the total range was estimated to be 155,000 ft.

Telemetry:

The periods of telemetry reception were from T + 219 sec to 256 sec, 260 sec to 480 sec where the reception was finally lost. The signal strength was very weak. The GMD tracking was good during the signal reception periods. The subcarrier oscillator performed well, although with noisy periods.

Test Results:

i) The payload ejection occurred at T + 110 seconds approximately. The parachute, however, did not open and was later torn away from the telemetry payload.

ii) Temperature data were obtained on the Solistron, but none on the shroud lines.

iii) Wind data were not obtained.

Summary:

The trajectory of the vehicle was satisfactory. The payload ejection system functioned properly but the parachute did not open, and

only partial test results were obtained. The telemetry system did not perform to complete satisfaction.

K E N D A L L

19 NOVEMBER 1965 - 1330 AST

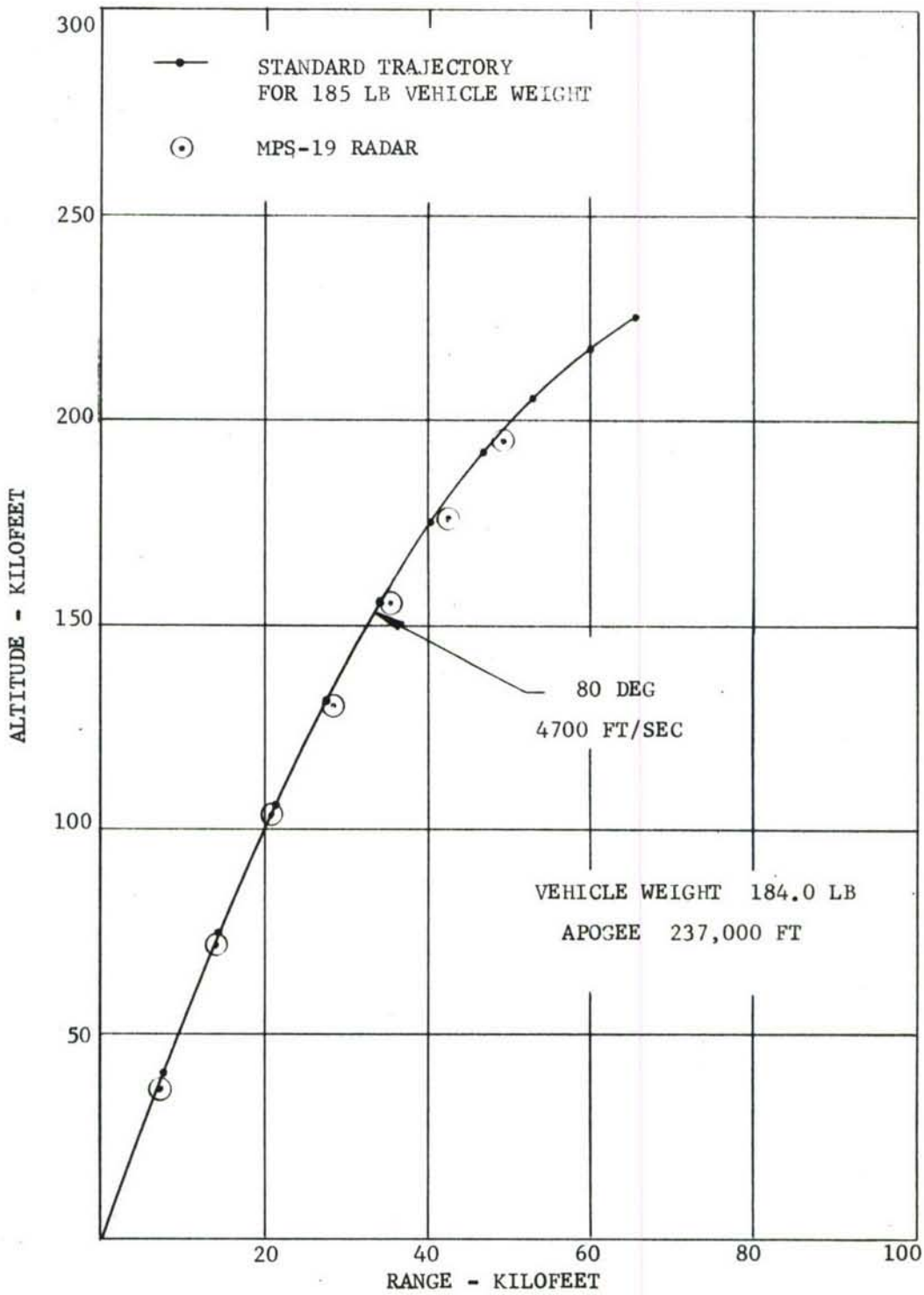


FIG. 2.15a MARTLET 2C (MOD 3) KENDALL

ALTITUDE VS RANGE

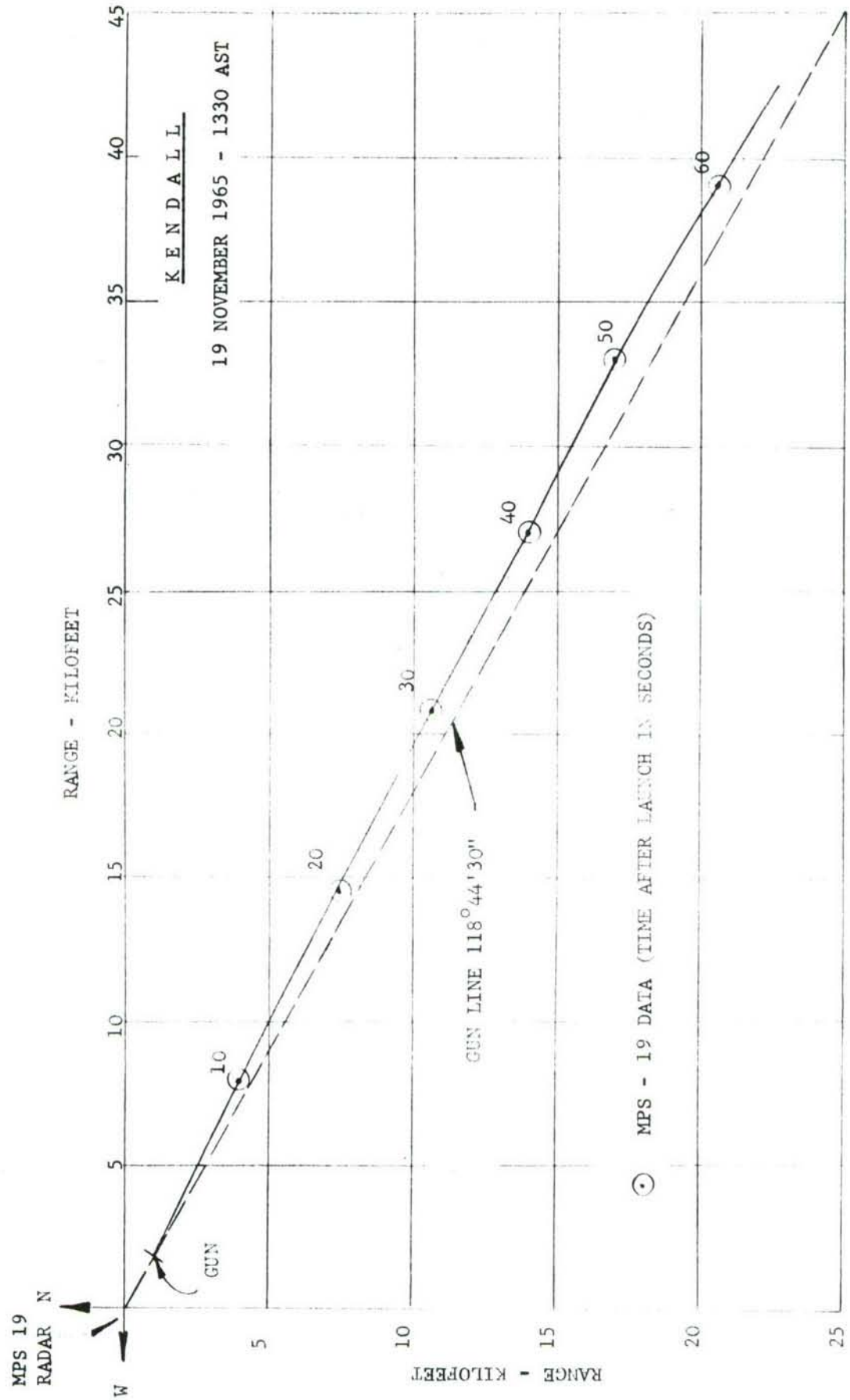


FIG. 2.15b PLAN VIEW OF MARCLET 2C (MOD.3) KENDALL TRAJECTORY

Round No. 169 - TEST SLUG NO. 2

Date: 19 November 1965 - 1550 AST

Vehicle Description: Test Slug

Purpose of Test: Test of slower burning propellant of larger web size.

Weights: Vehicle and Shot Weight 397.5 lb

Gun Evacuation: None

Launch Data:

Charge Weight	750 lb M8M.270 (8 bags) Lot No. CAD 9032
Spacing of Charge	300 S 200 S 250 (2 wooden spacers 30" long). See Note.
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	80 deg
Crusher Gauges	M11: 4 Mk6: 2
Ram Distance	197 in
Ram Load	12 tons
Chamber Volume	41,860 in^3
Recoil	34 in
Breech Pressure	M11: 21,900 psi Mk6: 26,600 psi Average: 24,200 psi Strain: 23,300 psi (Fig. 2.16)
Muzzle Velocity (Probe)	Right: 4780 ft/sec

Note: A new method of loading the charge was used by inserting wooden spacers between the bags so that the propellant was more evenly spaced in the chamber and filled the chamber completely. The purpose was to achieve a more uniform burning of the propellant. The scheme was as follows:

MUZZLE									BREECH
100 LB	100 LB	100 LB	SPACER 30"	100 LB	100 LB	SPACER 30"	100 LB	50 LB	100 LB

Camera Records:

Both Fastax stations were in operation and furnished good films.

Radar Records:

The M-33 radar tracked the slug to impact but only azimuth data during flight and the impact co-ordinates were available. (T + 58 sec, total range 3870 ft azimuth 130.6 deg.)

The MPS-19 also tracked to impact.

Trajectory:

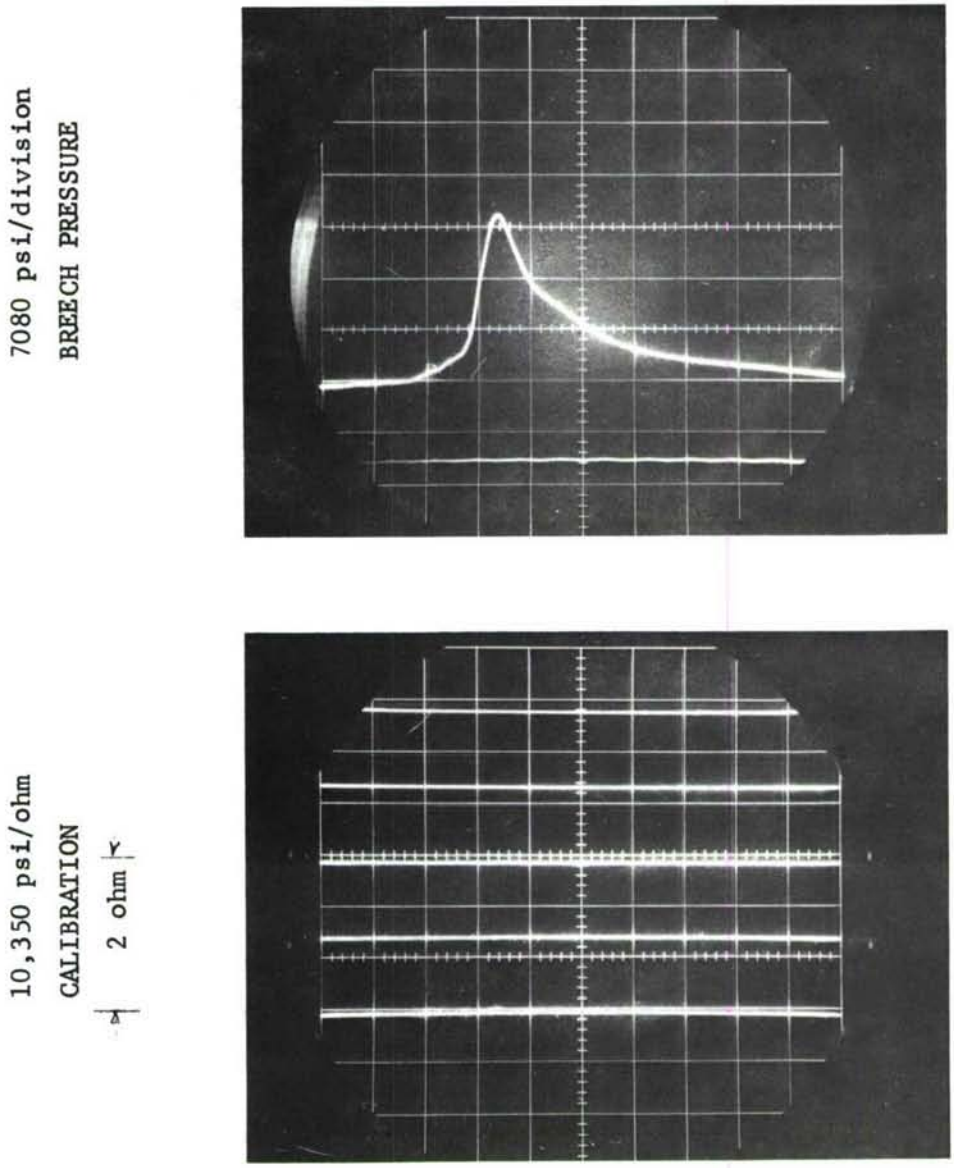
The available radar data are plotted in Fig. 2.16a. The apogee was 12,750 ft, and the total range approximately 4,000 ft.

Summary:

The round was successful. A low breech pressure was recorded, and a very smooth pressure-time plot for the breech was obtained.

T E S T S L U G N O. 2

19 NOVEMBER 1965 - 1550 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 23,300 psi

Charge: 750 lb M8M.270

FIG. 2.16 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND TEST SLUG NO. 2

T E S T S L U G No. 2

19 NOVEMBER 1965 - 1550 AST

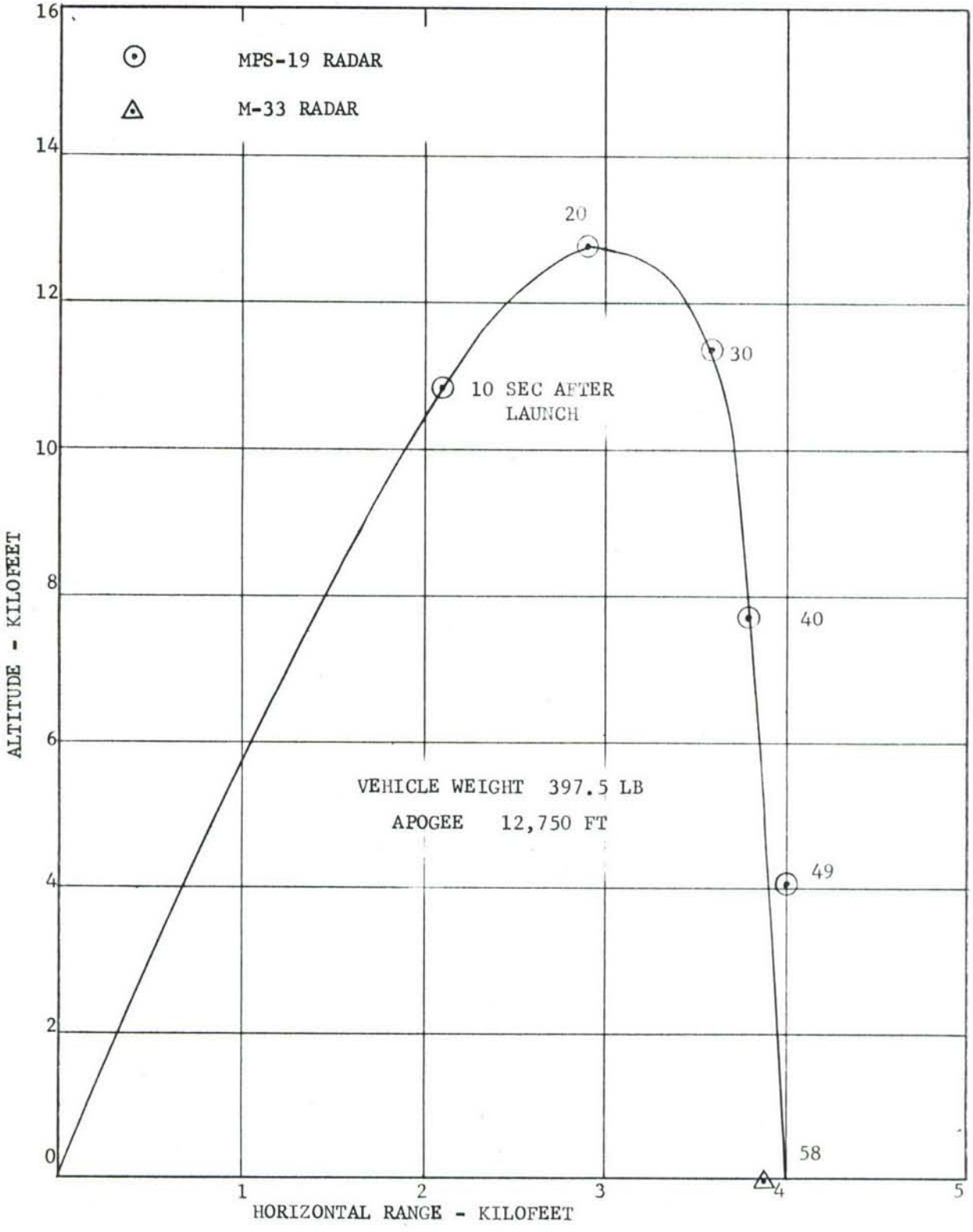


FIG. 2.16a TEST SLUG NO. 2
ALTITUDE VS RANGE

Round No. 170 - WORTHING

Date: 20 November 1965 - 1200 AST

Vehicle Description: Martlet 2C (Mod 2) with a SOFAR impact bomb.

A strengthened aluminum sabot was used.

Purpose of Test: Engineering Test of the SOFAR impact payload.

Weights:		
	Vehicle	180.0 lb
	Pusher and Obturator	115.0 lb
	Sabot	85.0 lb
	Shot Weight	380.0 lb

Centre of Gravity: 20.4 inches from base.

Gun Evacuation: 28 inches of Mercury.

Launch Data:

Charge Weight	850 lb M8M.270 (9 bags) Lot No. CAD 9032
Spacing of Charge	300 S 300 S 250 (two wooden spacers 27" and 21" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	80 deg
Crusher Gauges	M11: 3 Mk6: 2
Ram Distance	196 in
Ram Load	20 tons
Chamber Volume	41,640 in^3
Recoil	38.0 in
Breech Pressure	M11: 31,400 psi Mk6: 31,100 psi Average: 31,300 psi Strain: 32,900 psi (Fig. 2.17)
Muzzle Velocity (Probe)	Left: 5600 ft/sec Right: 5640 ft/sec Average: 5620 ft/sec

Camera Records:

The smear camera records showed that the fins were intact but

the vehicle appeared to have been launched with a 10 deg yaw angle.

The two Fastax stations were also in operation and furnished satisfactory films.

Radar Records:

No track was obtained by the M-33 radar. The MPS-19 radar tracked to T + 60 sec and recorded the impact at T + 315 sec at a range of 247,000 ft. The vehicle appeared to oscillate at 23.5 seconds after launch with increasing amplitude until 30 seconds at which time the oscillation died out; with two small disturbances at T + 33 sec and T + 42 sec. Thereafter the AGC record showed a stable motion.

Trajectory:

The MPS-19 radar data are plotted in Figs. 2.17 a and b and compare well with a standard trajectory for 5600 ft/sec. The apogee calculated from the radar data was 340,000 ft = 104 km, and the total range measured was 247,000 ft.

Payload Performance:

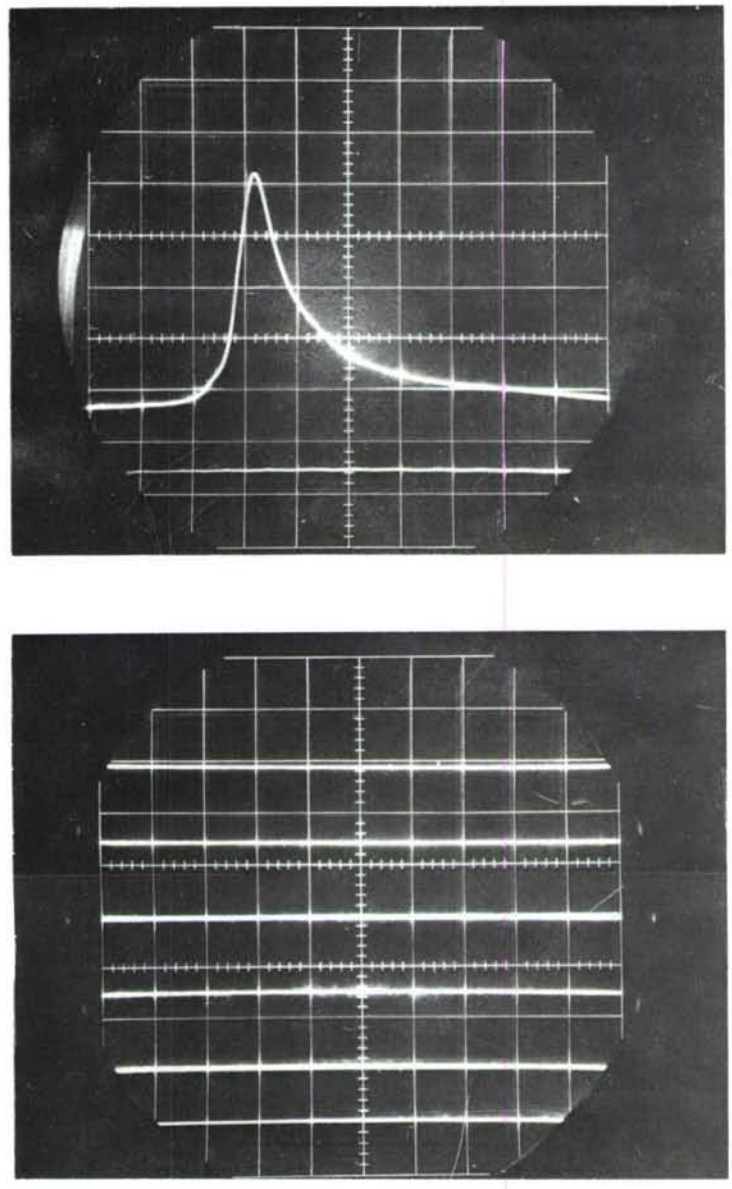
The Navy reported that the SOFAR bomb was successful.

Summary:

The round was successful. The charge loading method with spacers proved again useful, resulting in a smooth pressure-time curve.

W O R T H I N G

20 NOVEMBER 1965 - 1200 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 32,900 psi

Charge: 850 lb M8M.270

FIG. 2.17 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND WORTHING

W O R T H I N G

20 NOVEMBER 1965 - 1200 AST

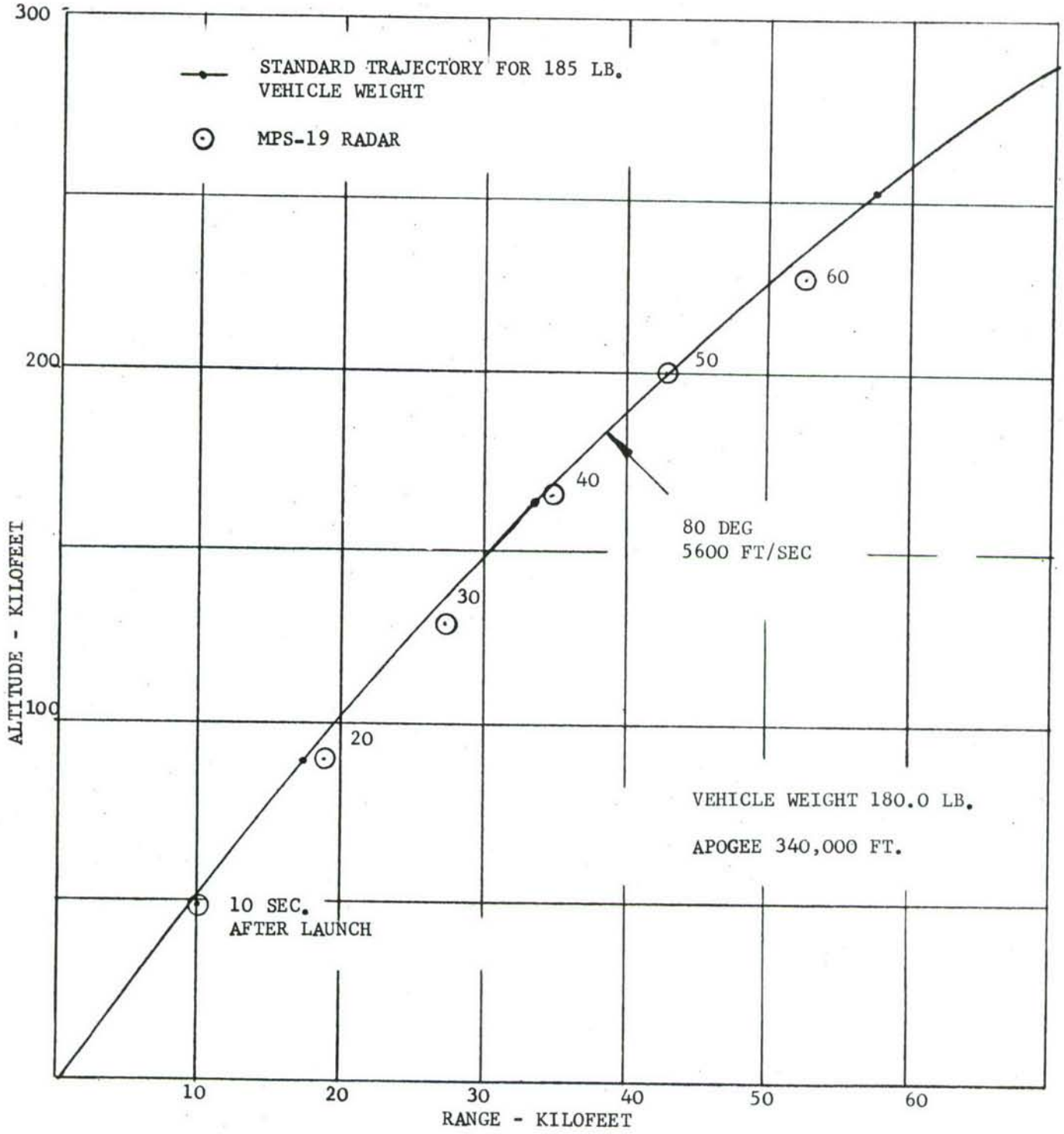


FIG. 2.17a MARTLET 2C WORTHING
ALTITUDE VS. RANGE

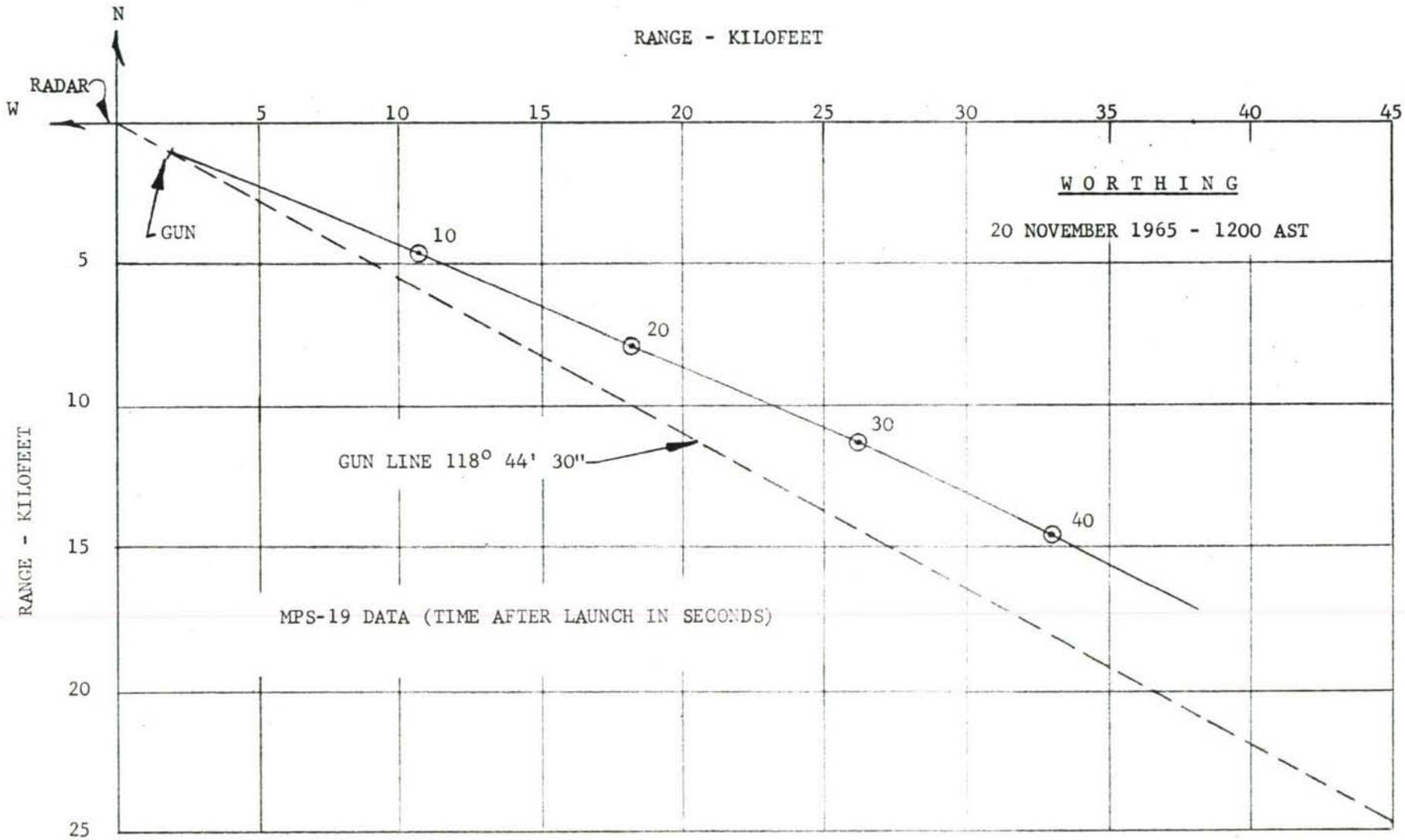


FIG. 2.17b PLAN VIEW OF MARTLET 2C WORTHING TRAJECTORY

Round No. 171 - LANCASTER

Date: 20 November 1965 - 1647 AST

Vehicle Description: Martlet 2C (Mod 3) carrying a payload consisting of S-band chaff and a parachute telemetry package with thermistors.

Payload Description: The 14 ft^2 metallized silk parachute was packed in the upper 14 3/4 in. section of a split cylinder 19 3/4 in. long by 2.85 in. in diameter. The 1750 MHz telemetry unit, 5 3/8 in. long, 2½ in. in diameter, and weighing 30 ounces, a SOLISTRON production model, was attached to the parachute and held in the split cylinder with a retaining ring at the aft end. A combined slot-loop ("sloop") antenna was used, protruding out of the end of the projectile to provide tracking and telemetry data from launch through ejection to impact. Four bead thermistors were attached to the 18 ft shroud.

Purpose of Test: Measurement of upper atmosphere air temperature and winds, furthermore tests of i) the revised parachute ejection system with tethered ejection slug to prevent parachute damage, ii) the performance of the thermistors on the parachute shroud lines at four different spacings from the telemetry unit, and iii) the performance of the telemetry transmitter, a seven segment BRL subcarrier oscillator, a nickel-cadmium battery pack and the sloop antenna, particularly at low temperatures.

Weights:

Vehicle	183.5 lb
Pusher and Obturator	135.0 lb
Sabot	101.0 lb
Pusher Plate Spacer	12.0 lb
Shot Weight	431.5 lb

Centre of Gravity: 20.3 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	580 lb WMM.225 Lot No. CAD 7502
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4 Mk6: 2
Ram Distance	194 in
Ram Load	11 tons
Chamber Volume	41,220 in^3
Recoil	30 in
Breech Pressure	M11/Mk6: Not available Strain: 17,400 psi
Muzzle Velocity (Probe)	Not available

Camera Records:

No smear camera records were available. Both Fastax stations were in operation and furnished satisfactory films.

Radar Records:

The M-33 radar tracked to T + 45 sec. The telemetry package was not observed, nor was ejection, apogee and impact. The MPS-19 radar, however, had a good track, and data on all three targets were obtained. Between 120 and 130 seconds the radar tracked a target rising from 189,500 to 192,300 ft, probably a piece of the parachute. At T + 160 sec it acquired the telemetry unit and tracked two closely spaced targets to T + 210 sec. At this time the radar began to track a slowly falling target at 70,800 ft which dropped to 64,200 ft altitude at T + 240 sec. At T + 250 sec the radar was directed to the telemetry package again and tracked with the GMD to impact.

Trajectory:

The M-33 radar data of the vehicle are plotted in Fig. 2.18a and compared with a standard trajectory for 4250 ft/sec muzzle velocity. The MPS-19 data were not available. The apogee was estimated to be approximately 190,000 ft = 58 km, and the total range 63,000 ft.

Telemetry:

The telemetry signal was first acquired at T + 75 sec at 1738 MHz and was lost at T + 446 sec (impact). The carrier signal was strong. Due to temperature change a frequency shift occurred throughout the flight from -3 MHz to +1 MHz. The vehicle roll rate was 8 rps until ejection at T + 89 sec; between 89 and 111 sec the telemetry and GMD records show an unstable motion of the vehicle changing to a stable spinning motion of 5 rps. The subcarrier oscillator failed at launch. The GMD tracking was satisfactory.

Summary:

The round was successful. The payload was ejected and the fall rates could be determined. The telemetry and GMD tracking worked properly, with the exception of the subcarrier oscillator which failed at launch.

LANCASTER

20 NOVEMBER 1965 - 1647 AST

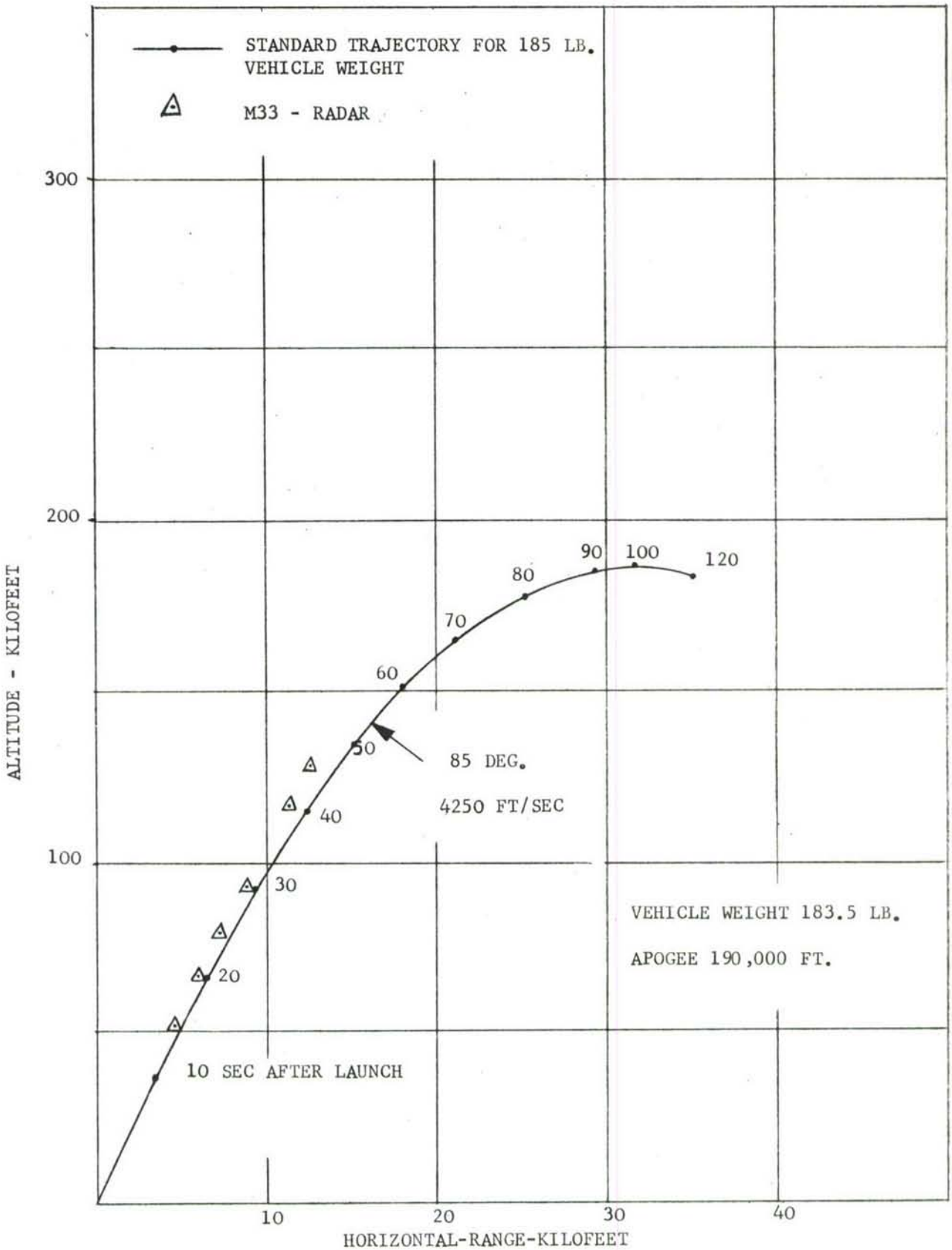


FIG. 2.18a MARTLET 2C (MOD.3) LANCASTER
ALTITUDE VS. RANGE

Round No. 172 - VAUXHALL

Date: 21 November 1965 - 1210 AST

Vehicle Description: Martlet 2C (Mod 2) carrying telemetry with two subcarrier oscillators at 40 KHz and 70 KHz. The antenna was a flush mounted quadraloop.

Purpose of Test:

i) To measure temperature in the electronics section, and

ii) To determine the feasibility of utilizing a high gain differential amplifier to measure low-level signals.

Weights:		
	Vehicle	183.0 lb
	Pusher and Obturator	115.0 lb
	Sabot	85.0 lb
	Shot Weight	383.0 lb

Centre of Gravity: 22.4 inches from base.

Gun Evacuation: 28 inches of Mercury.

Launch Data:

Charge Weight	780 lb M8M.22 (8 bags) Lot No. CAD 9030
Spacing of Charge	300 S 180 S 300 (2 wooden spacers 23" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	80 deg
Crusher Gauges	M11: 4
Ram Distance	196 in
Ram Load	18 tons
Chamber Volume	41,640 in^3
Recoil	37.5 in
Breech Pressure	M11: 39,800 psi Strain: 39,000 psi (Fig. 2.19)
Muzzle Velocity (Probe)	Left: 6130 ft/sec Right: 6140 ft/sec Average: 6140 ft/sec

Camera Records:

Two smear cameras were in operation.

Radar Records:

The M-33 radar tracked to T + 10 sec, and the MPS-19 radar to T + 96 sec, with a normal AGC trace.

Trajectory:

The radar data are plotted in Figs. 2.19 a and b, and agree well with a standard trajectory for a muzzle velocity of 6100 ft/sec. The apogee derived from these data is 418,000 ft = 128 km. The total range was estimated to be 287,000 ft.

Telemetry:

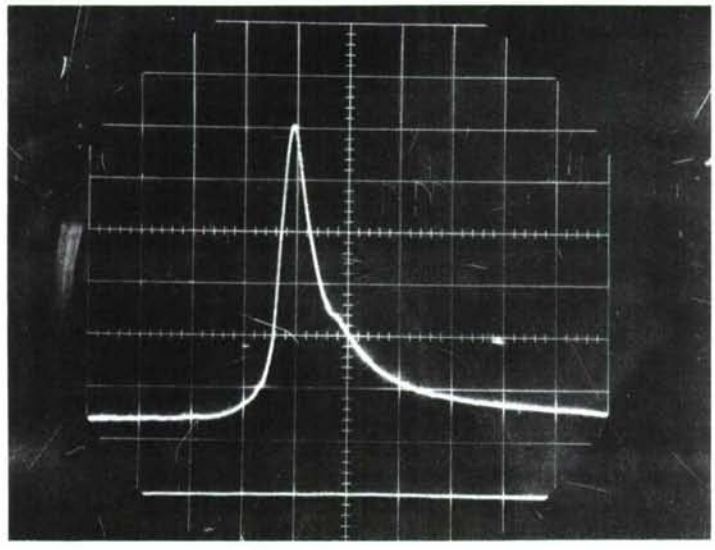
The RF signal was received at launch at the predicted frequency of 240 MHz for 4 seconds, at a level of -90 dbm at its maximum. A vehicle spin rate of 4 revolutions per seconds was indicated. The 70 KHz subcarrier oscillator worked on the predicted frequency but no information was available on the 40 KHz subcarrier oscillator and no temperature data were obtained.

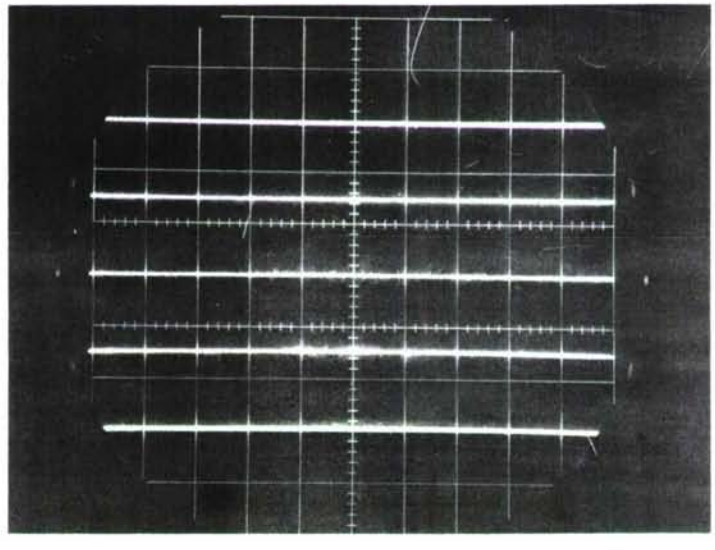
Summary:

The round was successful regarding the flight trajectory but the telemetry performance was not completely satisfactory. The quadra-loop antenna appeared to have been broken.

V A U X H A L L

21 NOVEMBER 1965 - 1210 AST





TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 39,000 psi

Charge: 780 lb M8M.220

FIG. 2.19 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND VAUXHALL

V A U X H A L L

21 NOVEMBER 1965 - 1210 AST

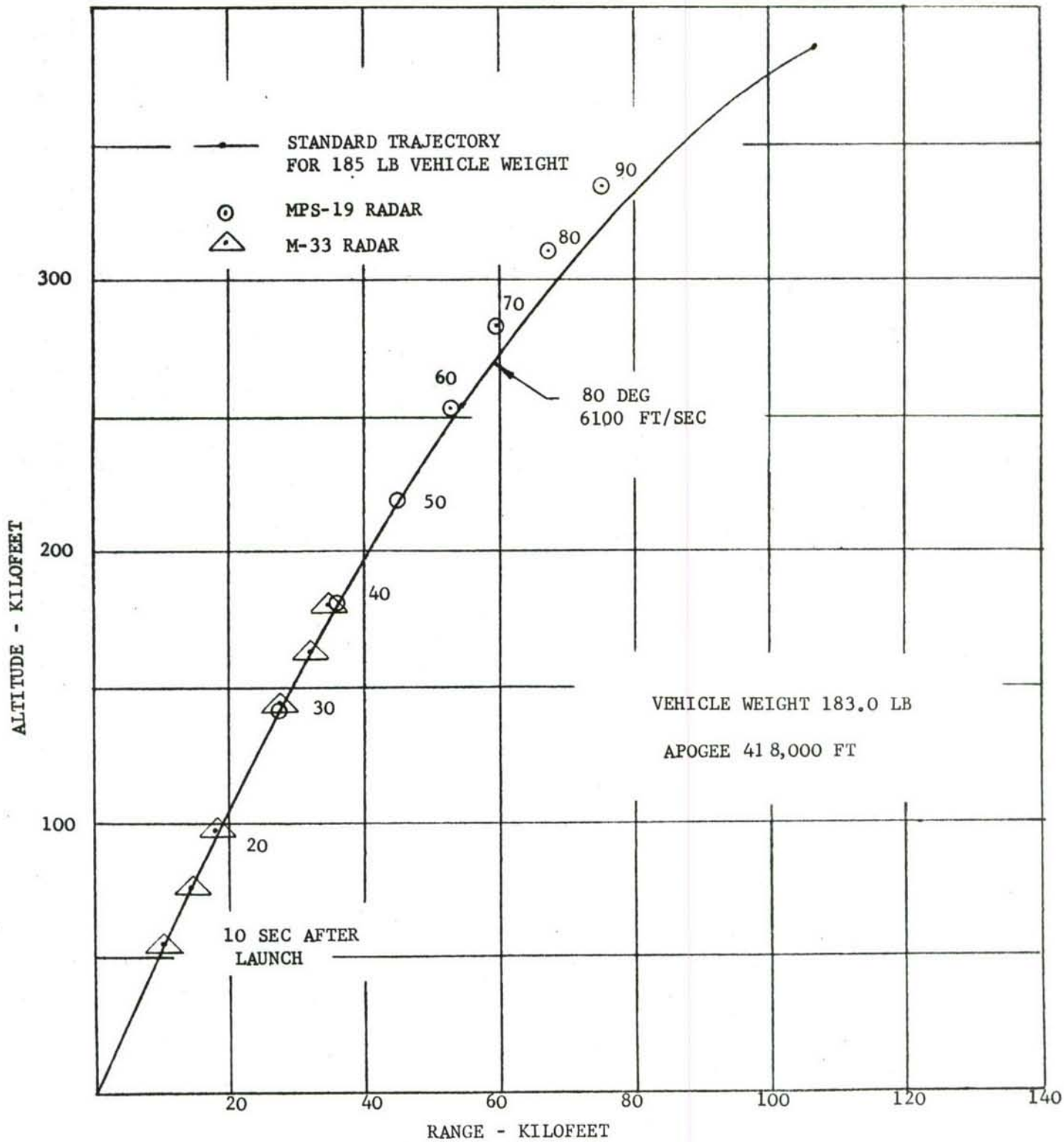


FIG. 2.19a MARTLET 2C VAUXHALL
ALTITUDE VS RANGE

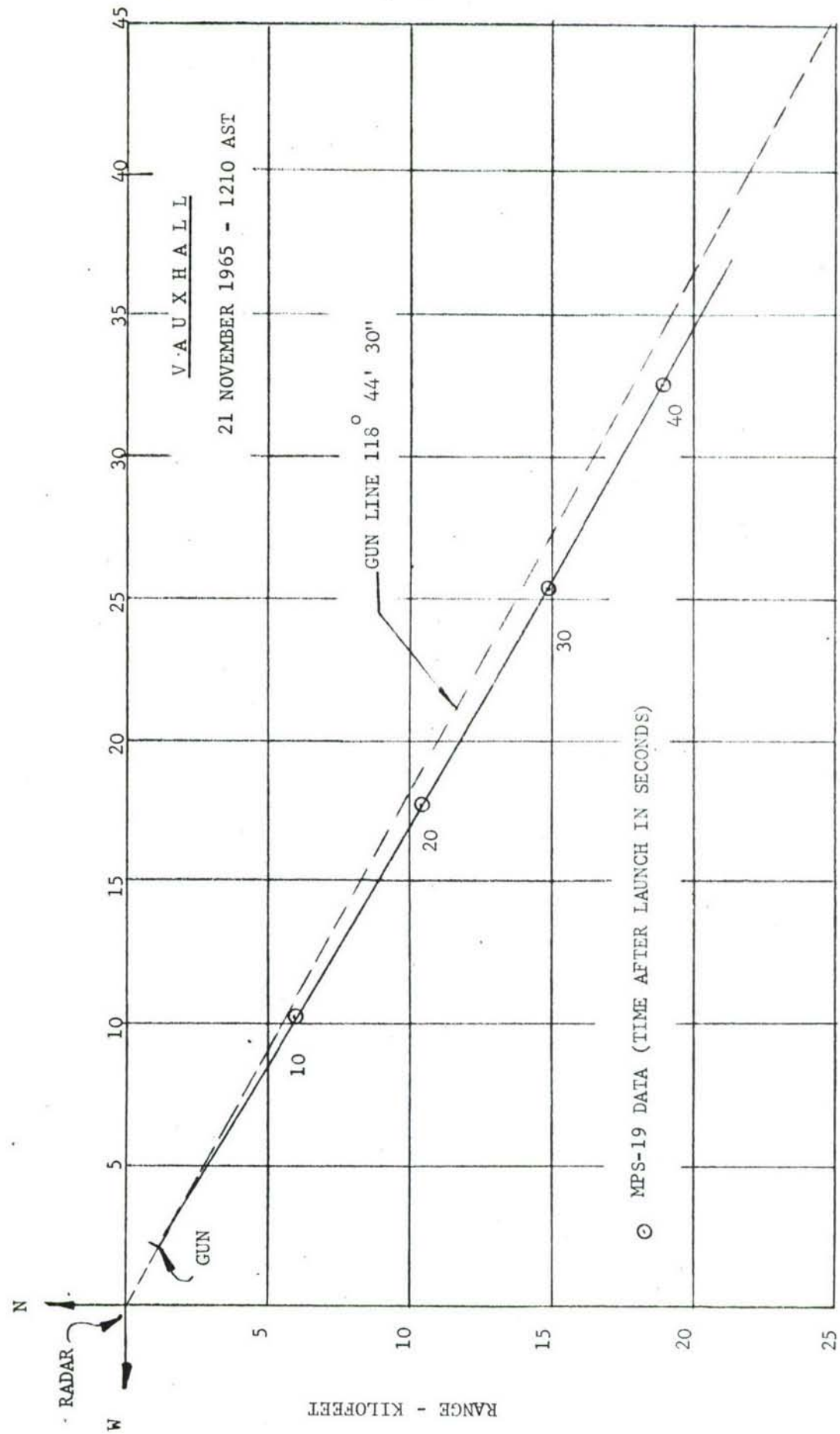


FIG. 2.19b PLAN VIEW OF MARTLET 2C VAUXHALL TRAJECTORY

Round No. 173 - MAXWELL

Date: 22 November 1965 - 1809 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism. A strengthened sabot was used.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	181.0 lb
	Pusher and Obturator	114.8 lb
	Sabot	85.0 lb
	Shot Weight	380.8 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	915 lb M8M.27 (10 bags) Lot No. CAD 9032
Spacing of Charge	300 S 300 S 315 (wooden spacers 20" and 7" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	185 in
Ram Load	100 tons
Chamber Volume	39,300 in^3
Recoil	41.5 in
Breech Pressure	M11: 49,500 psi Strain: 49,200 psi (Fig. 2.20)
Muzzle Velocity (Probe)	Not available owing to electrical power failure.

Note: A large section of the vehicle loading quill jammed in the bore during loading of the vehicle. The shot was fired with the quill in the bore.

Camera Records:

No smear and Fastax cameras were in operation.

Radar Records:

The M-33 radar tracked from T + 6 sec to T + 40 sec and the MPS-19 radar from T + 10 sec to T + 110 sec.

Trajectory:

The radar data are compared in Figs. 2.20 a and b with a standard drag trajectory of 6300 ft/sec and 85 degree elevation.

The apogee derived from these data is 466,500 ft = 142 km, and the estimated total range is 156,000 ft.

TMA Trail Results:

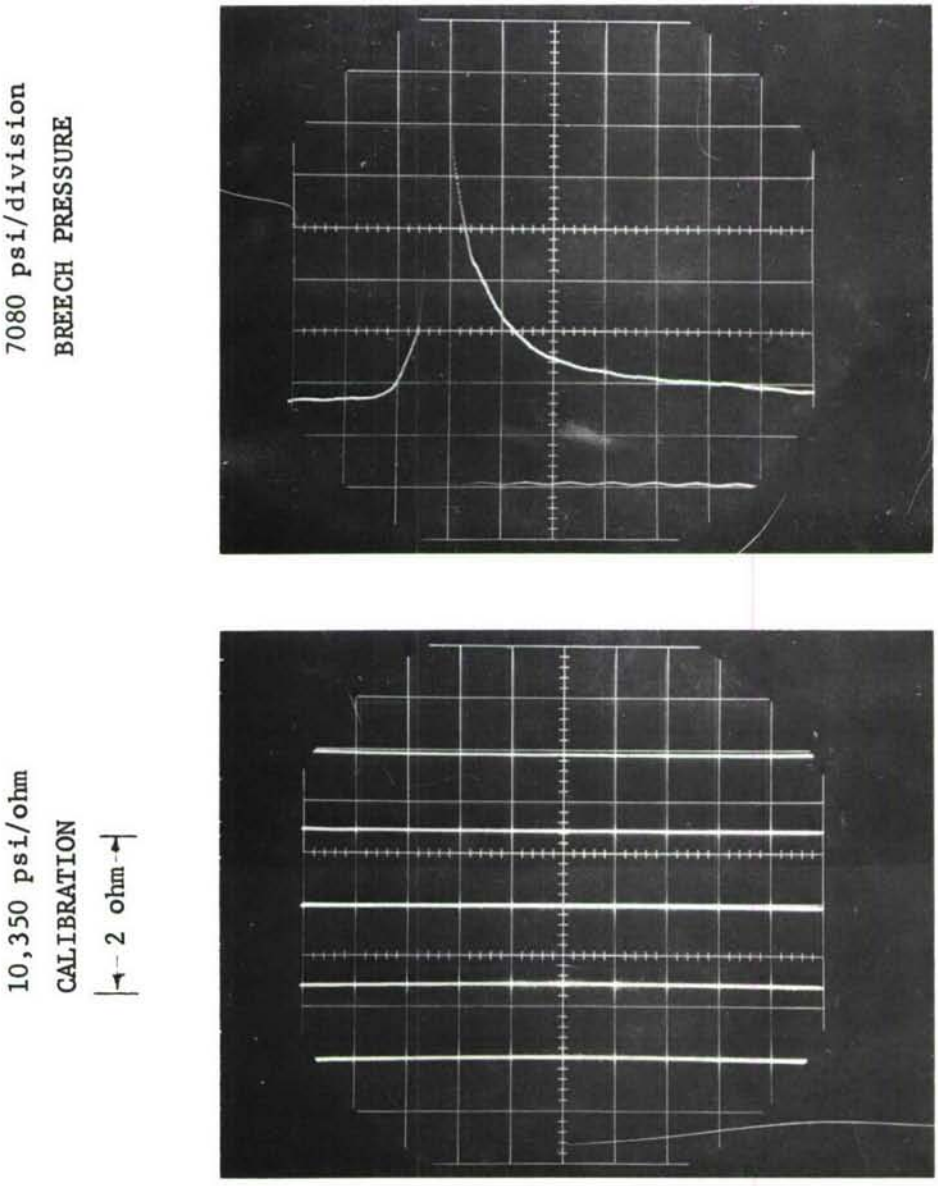
The cameras and the TMA payload performed satisfactorily. Evaluation of the trail photographs gave wind data up-trail between 94 km and 120 km.

Summary:

This was a successful shot regarding trajectory and payload.

M A X W E L L

22 NOVEMBER 1965 - 1809 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 49,200 psi

Charge: 915 lb M8M.27

FIG. 2.20 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND MAXWELL

M A X W E L L

22 NOVEMBER 1965 - 1809 AST

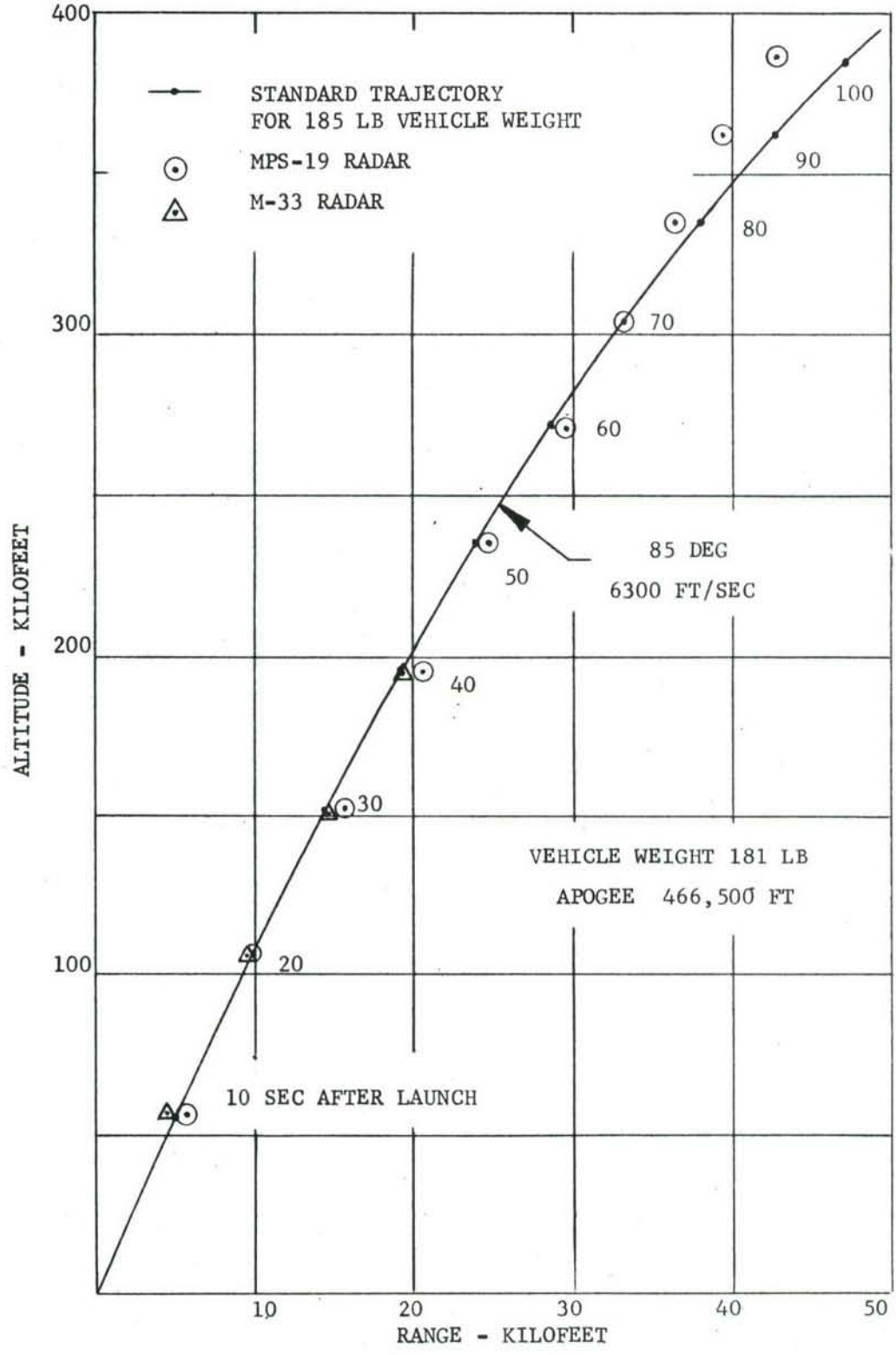


FIG. 2.20a MARTLET 2C MAXWELL TRAJECTORY

ALTITUDE VS RANGE

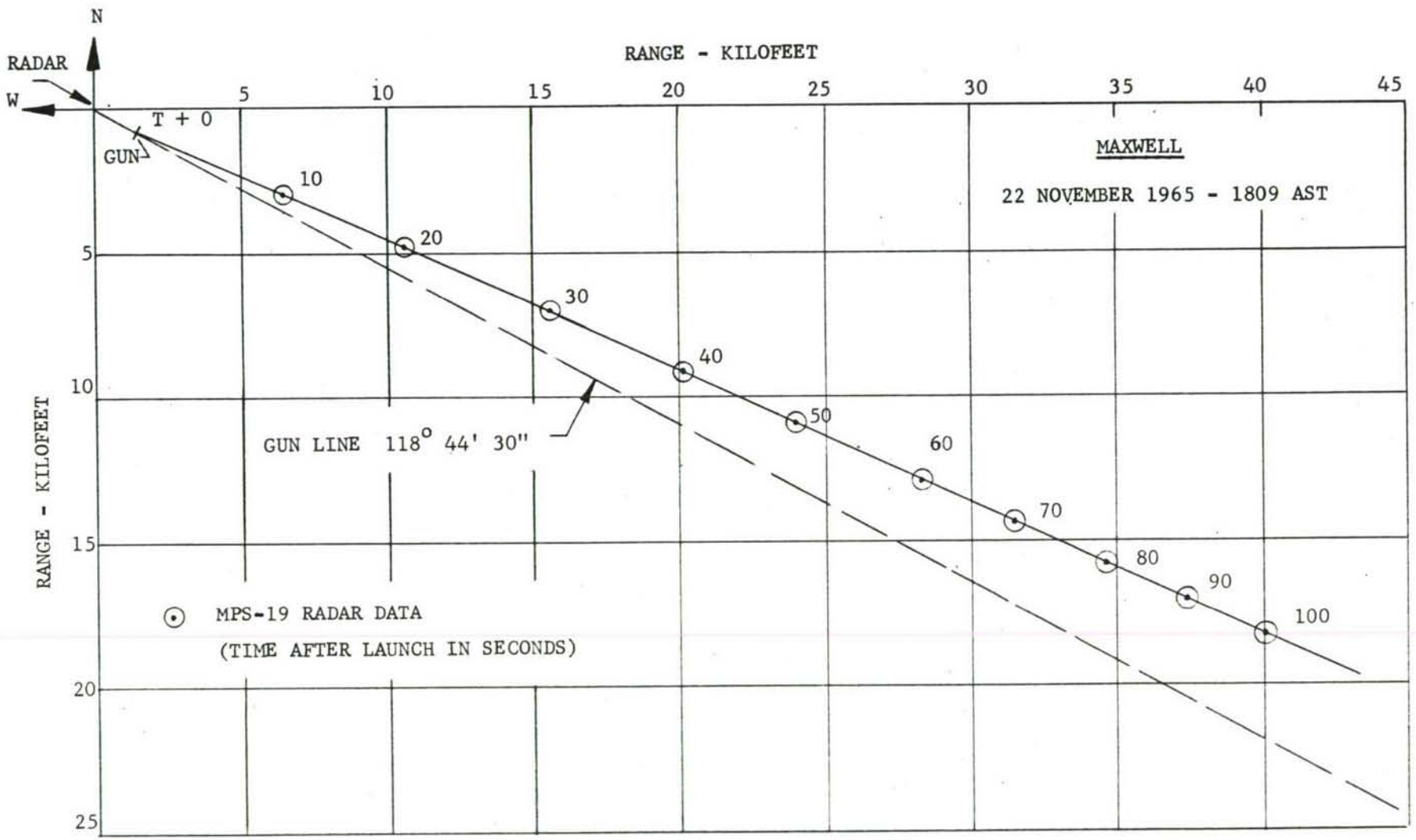


FIG. 2.20b PLAN VIEW OF MARTLET 2C MAXWELL TRAJECTORY

Round No. 174 - NEEDHAM'S POINT

Date: 22 November 1965 - 1930 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism, and a telemetry package in the nose cone, consisting of a 231 MHz transmitter, with two subcarrier oscillators.

Purpose of Test: Synoptic measurements of wind profiles, measurements of time pulses and temperature and test of a high gain differential amplifier.

Weights:

Vehicle	183.5 lb
Pusher and Obturator	119.0 lb
Sabot	85.0 lb
Shot Weight	387.5 lb

Centre of Gravity: 21.3 inches from base.

Gun Evacuation: Evacuated to a vacuum of 29 inches of Mercury.

Launch Data:

Charge Weight	930 lb M8M.27 (10 bags) Lot No. CAD 9032
Spacing of Charge	300 S 300 S 330 (wooden spacers 20" and 13" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	196 in
Ram Load	17 tons
Chamber Volume	41,640 in^3
Recoil	41.5 in
Breech Pressure	M11: 42,800 psi Strain: 42,200 psi (Fig. 2.21)
Muzzle Velocity (Probe)	Left: 6,090 ft/sec Right: 6,080 ft/sec Average: 6,090 ft/sec

Camera Records:

No smear or Fastax cameras were in operation.

Radar Records:

The M-33 radar tracked from T + 7 sec to T + 20 sec. The signal was much weaker than in the previous shot and faded earlier. The MPS-19 tracked to T + 100 sec. The AGC trace indicated a yawing and pitching movement from T + 30 to T + 80 seconds, which was more severe than normal.

Trajectory:

The radar data are plotted in Figs. 2.21 a and b. Good agreement is found with a standard trajectory for a muzzle velocity of 6100 ft/sec. The apogee as determined from the radar data was 435,000 ft = 133 km, and the estimated total range was 145,000 ft.

TMA Trail Results:

The TMA payload and the cameras performed satisfactorily, and wind data were obtained up-trail between 93 and 134 km.

Telemetry Records:

The pre-test data indicated good performance for both sub-carrier oscillators and the transmitter but the unit was not received at T + 0 at the predicted frequency on either of the two receiving stations, and there was no indication of an RF signal. Thus a failure of either the power supply or the transmitter must be assumed.

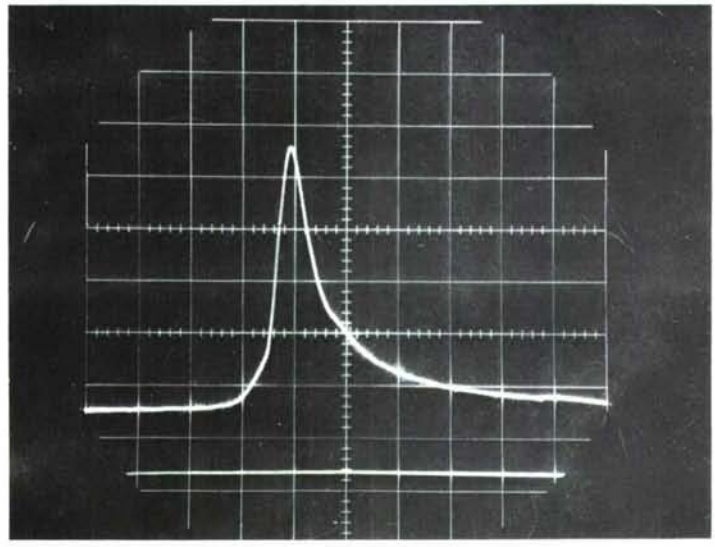
Summary:

The round was successful regarding the TMA payload but the telemetry failed.

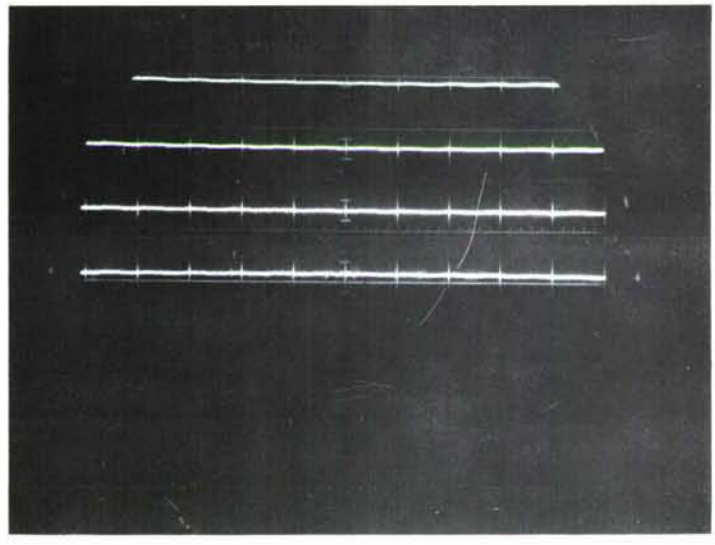
N E E D H A M ' S P O I N T

22 NOVEMBER 1965 - 1930 AST

8280 psi/division
BREECH PRESSURE



10,350 psi/ohm
CALIBRATION
2 ohm



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 42,200 psi

Charge: 930 lb M8M.270

FIG. 2.21 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND NEEDHAM'S POINT

N E E D H A M'S P O I N T
22 NOVEMBER 1965-1930 AST

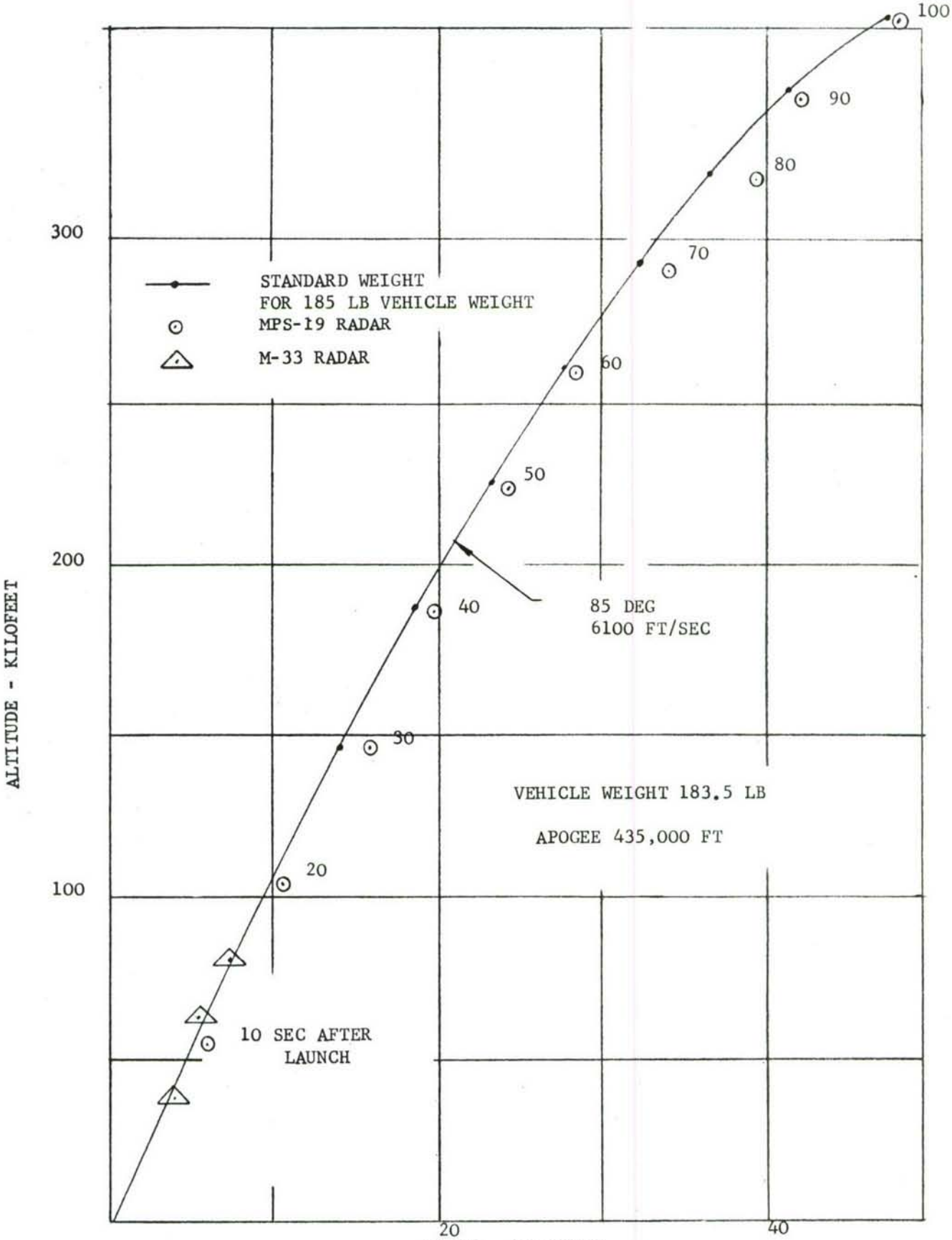


FIG. 2.21a MARTLET 2C NEEDHAM'S POINT
ALTITUDE VS RANGE

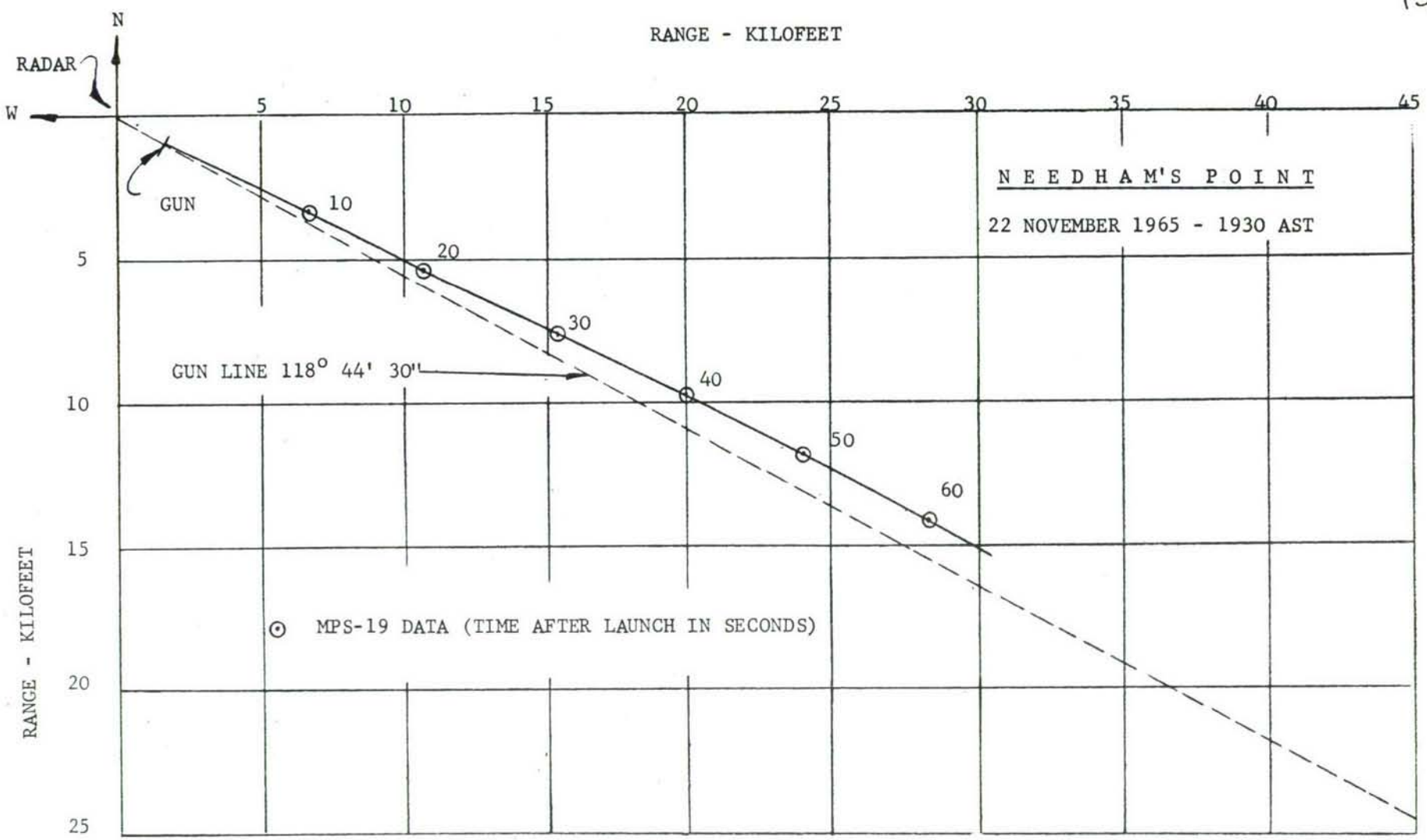


FIG. 2.21b PLAN VIEW OF MARTLET 2C NEEDHAM'S POINT TRAJECTORY

Round No. 175 - OLDBURY

Date: 22 November 1965 - 2055 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	185.5 lb
	Pusher and Obturator	120.5 lb
	Sabot	85.0 lb
	Shot Weight	391.0 lb

Centre of Gravity: 22.1 inches from base.

Gun Evacuation: Evacuated to 29 inches of mercury.

Launch Data:

Charge Weight	975 lb M8M.27 (10 bags), Lot No. CAD 9032
Spacing of Charge	300 S 300 S 375 (two wooden spacers 16" and 12" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	196 in
Ram Load	12 tons
Chamber Volume	41,640 in^3
Recoil	41.8 in
Breech Pressure	M11: 49,100 psi Strain: 47,400 psi (Fig. 2.22)
Muzzle Velocity (Probe)	Left: Not available Right: 6420 ft/sec

Camera Records:

No smear and Fastax cameras were in operation.

Radar Records:

The M-33 radar tracked to T + 35 seconds; the signal fluctuated so badly that the radar could not stay on the target beyond that time. The MPS-19 radar tracked the target to impact. The AGC data indicated that the vehicle flew in a disturbed condition until 30 seconds after launch, then had a reasonably smooth flight until T + 110 sec, and from that time on became progressively unstable.

Trajectory:

The vehicle slowed down rapidly and reached an apogee of 102,000 ft = 31 km at approximately 70 seconds after launch. The total range at T + 154 sec was 10,000 ft. The vehicle flew off-course, from an azimuth angle of 116.5 deg at T + 10 sec to 121.5 deg at T + 110 sec, 110 deg at T + 120 sec, and 114 deg at impact.

Comments:

Some sabot parts were located on the Seawell runway and revealed that the vertical supports placed in the quarter sabot shells to prevent buckling had failed under acceleration.

TMA Trail Results:

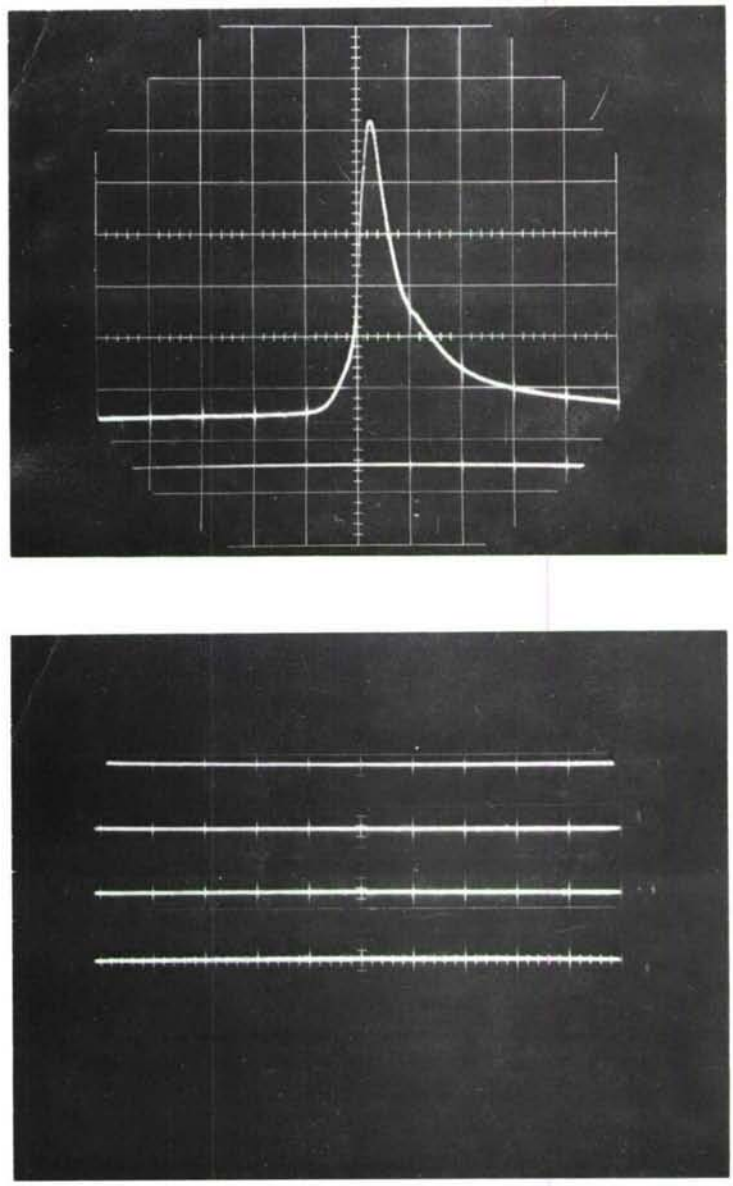
No trails obtained.

Summary:

The round was not successful, probably due to sabot failure causing subsequent vehicle damage.

O L D B U R Y

22 NOVEMBER 1965 - 2055 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 47,400 psi

Charge: 975 lb M8M.270

FIG. 2.22 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND OLDBURY

Round No. 176 - PARAGON

Date: 22 November 1965 - 2259 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	185.5 lb
	Pusher and Obturator	120.5 lb
	Sabot	85.0 lb
	Shot Weight	391.0 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: 24 inches of Mercury.

Launch Data:

Charge Weight	930 lb M8M.27 (10 bags), Lot No. CAD 9032
Spacing of Charge	300 S 300 S 330 (two wooden spacers, 20" and 16" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 3
Ram Distance	200 in
Ram Load	10 tons
Chamber Volume	42,500 in^3
Recoil	39.5 in
Breech Pressure	M11: 45,100 psi Strain: 43,900 psi (Fig. 2.23)
Muzzle Velocity (Probe)	Left: 6240 ft/sec Right: 6240 ft/sec Average: 6240 ft/sec

Camera Records:

No smear and Fastax cameras were used.

Radar Records:

The M-33 radar tracked to T + 24 sec, and the MPS-19 to

T + 100 sec.

Trajectory:

The radar data are plotted in Figs. 2.23a and b and compare well with a standard trajectory of 6150 ft/sec. The apogee as evaluated from the radar data was 442,000 ft = 135 km, and the total range was estimated as 148,000 ft.

TMA Trail Results:

Cameras and payload functioned properly, and up-trail wind data were obtained from 99 to 120 km.

Summary:

The round was successful.

P A R A G O N

22 NOVEMBER 1965 - 2259 AST

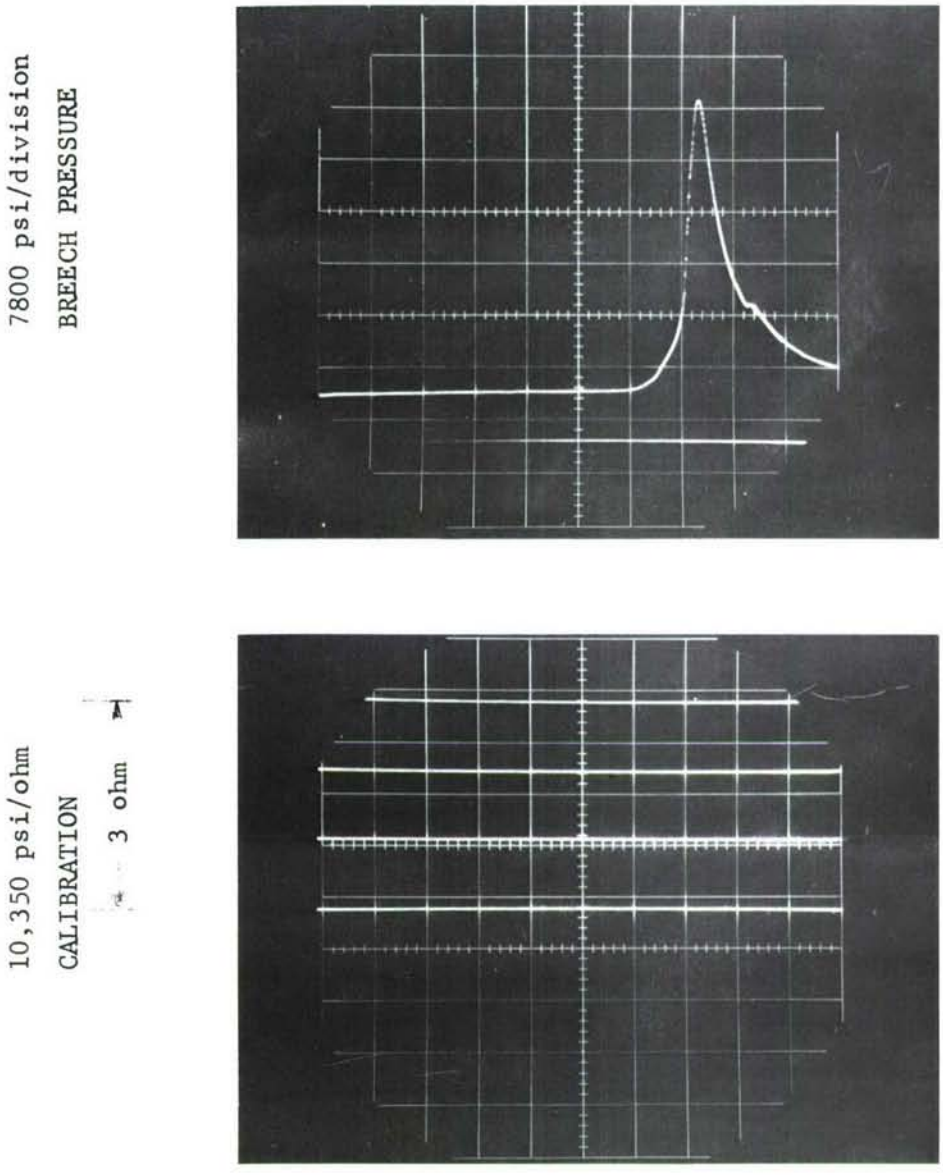


FIG. 2.23 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND PARAGON

PARAGON
22 NOVEMBER 1965 - 2259 AST

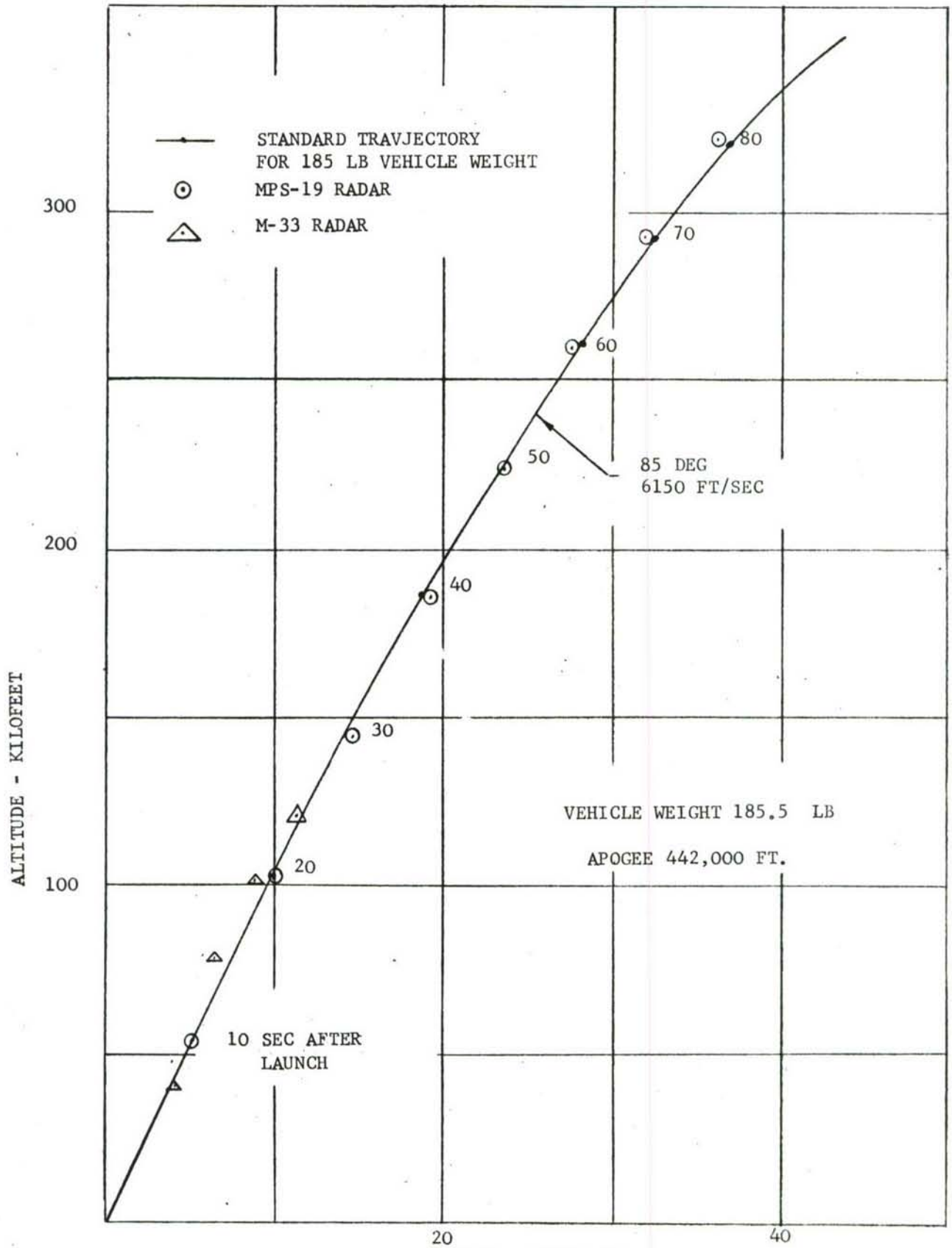


FIG. 2.23a MARTLET 2C PARAGON
ALTITUDE VS RANGE

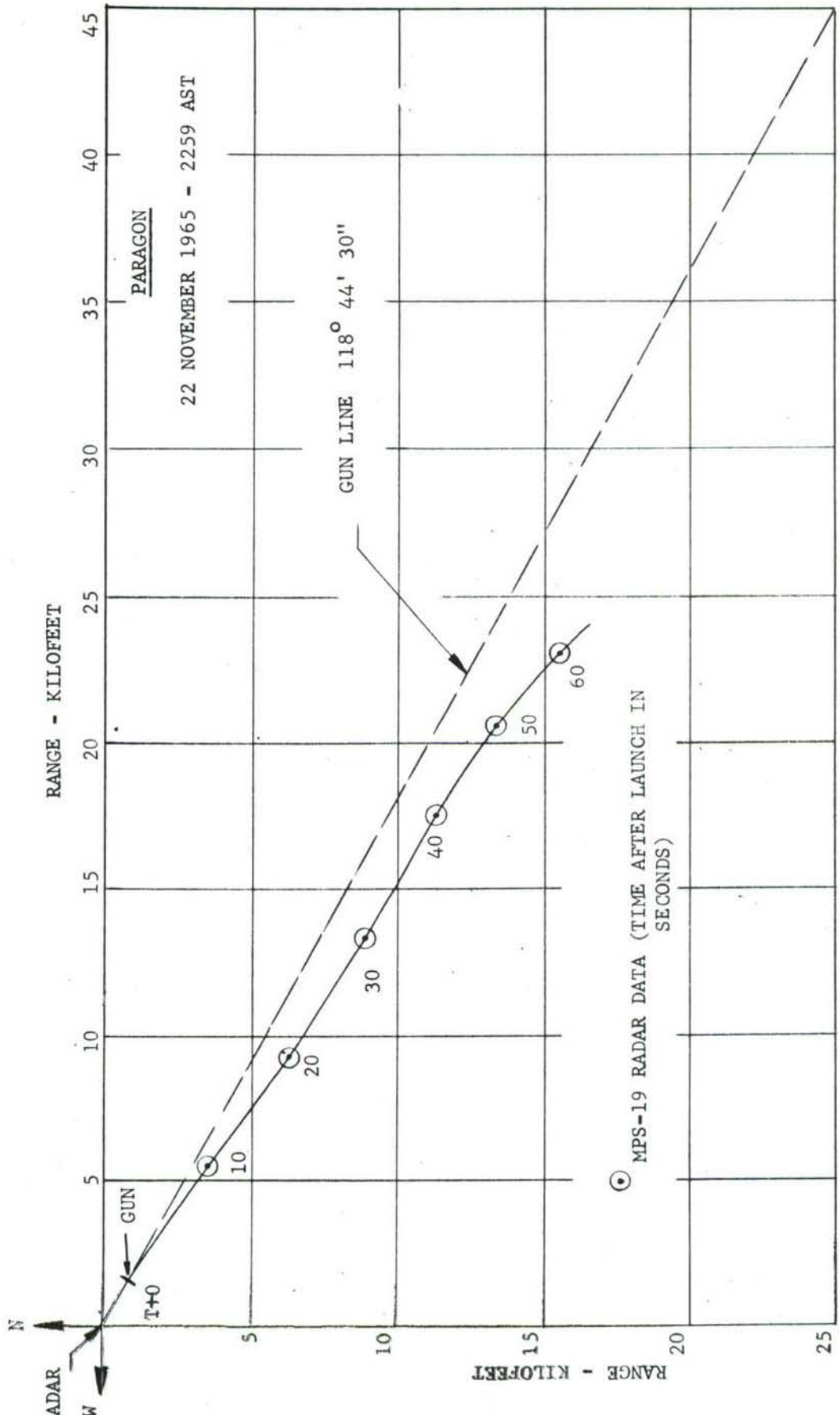


FIG. 2.23b PLAN VIEW OF MARTLET 2C PARAGON TRAJECTORY

Round No. 177 - QUEEN'S FORT

Date: 23 November 1965 - 0131 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	184.0 lb
	Pusher and Obturator	119.0 lb
	Sabot	85.0 lb
	Shot Weight	388.0 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	930 lb M8M.27 (10 bags) Lot No. CAD 9032
Spacing of Charge	300 S 300 S 330
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 3
Ram Distance	200 in
Ram Load	10 tons
Chamber Volume	42,500 in^3
Recoil	Not available
Breech Pressure	M11: 42,400 psi Strain: 42,300 psi (Fig. 2.24)
Muzzle Velocity (Probe)	Left: 6090 ft/sec Right: 6090 ft/sec Average: 6090 ft/sec

Camera Records:

No smear and Fastax cameras were used.

Radar Records:

The M-33 radar tracked to T + 36 sec, and the MPS-19 radar

to T + 90 sec. A normal AGC trace was obtained.

Trajectory:

The radar data are plotted in Figs. 2.24 a and b and compare well with a standard trajectory of 6100 ft/sec. The apogee as calculated from the radar data was 436,000 ft = 133 km, in agreement with the trail results. The estimated range was 148,000 ft.

TMA Trail Result

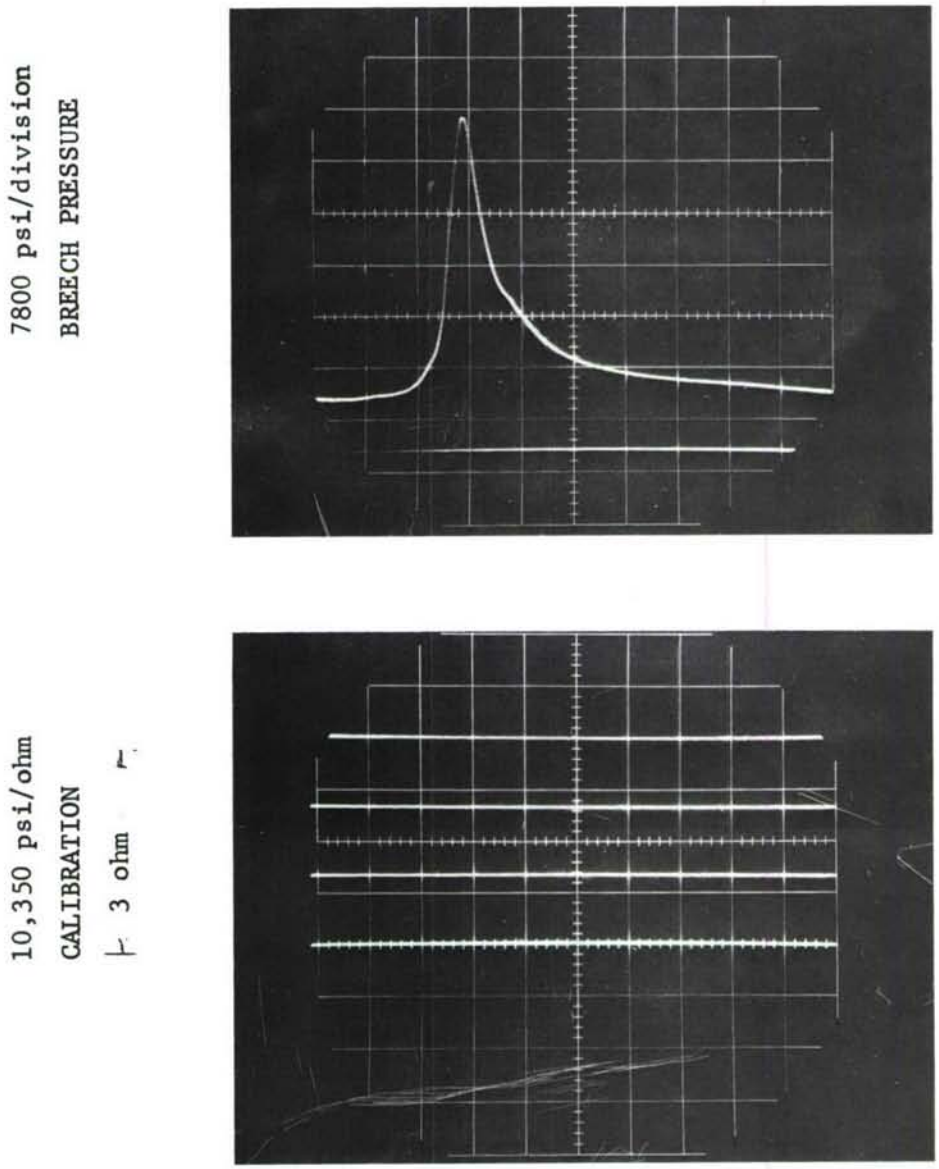
Cameras and payload performed satisfactorily, and a bright trail was obtained. The evaluation of the trail photograph furnished up-trail wind data from 100 to 133 km.

Summary:

This was a successful round.

Q U E E N S F O R T

23 NOVEMBER 1965 - 0131 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 42,300 psi

Charge: 930 lb M8M.270

FIG. 2.24 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND QUEENSFORT

Q U E E N S F O R T

23 NOVEMBER 1965 - 0131 AST

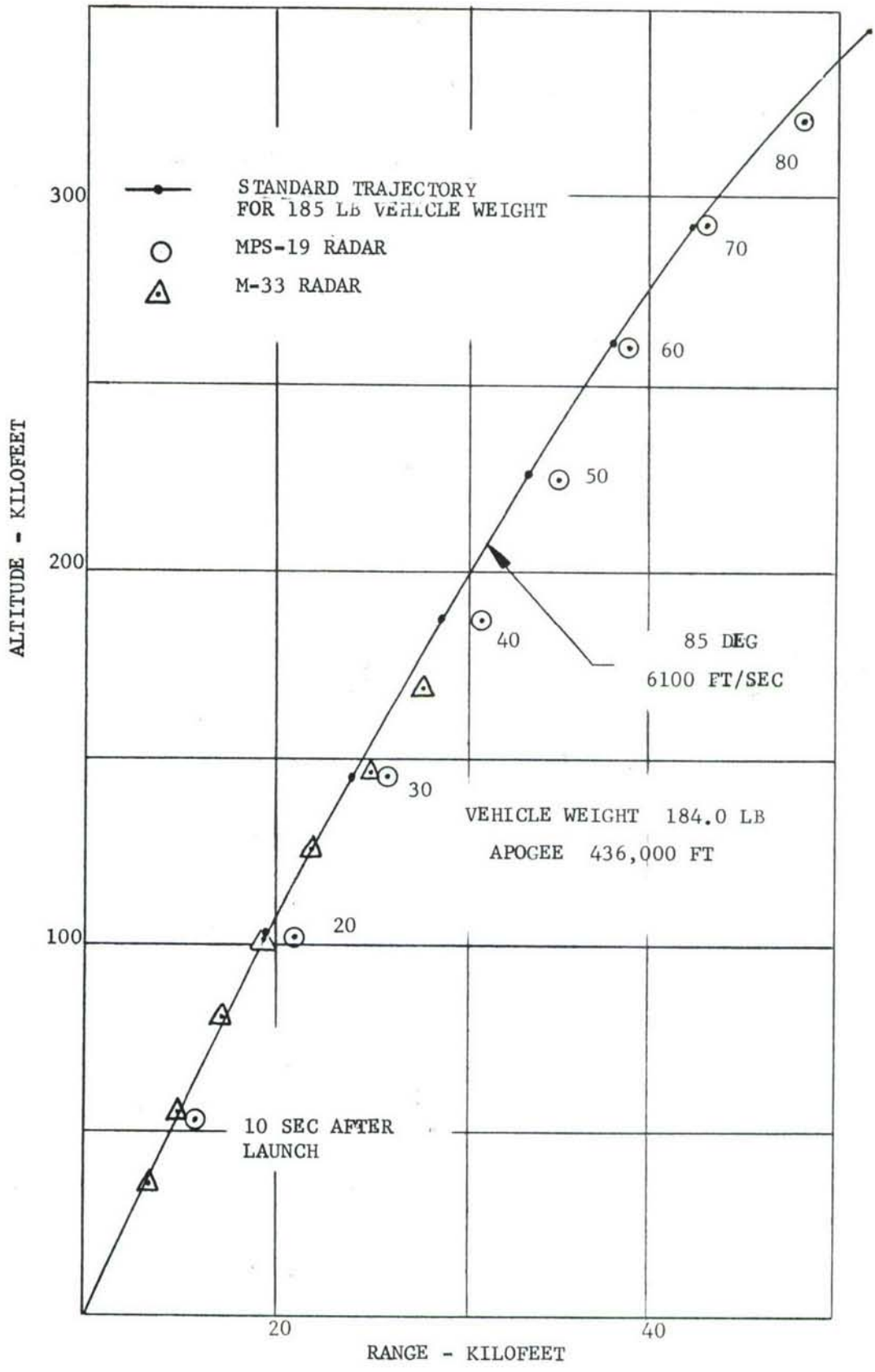


FIG. 2.24a MARTLET 2C QUEENSFORT
ALTITUDE VS RANGE

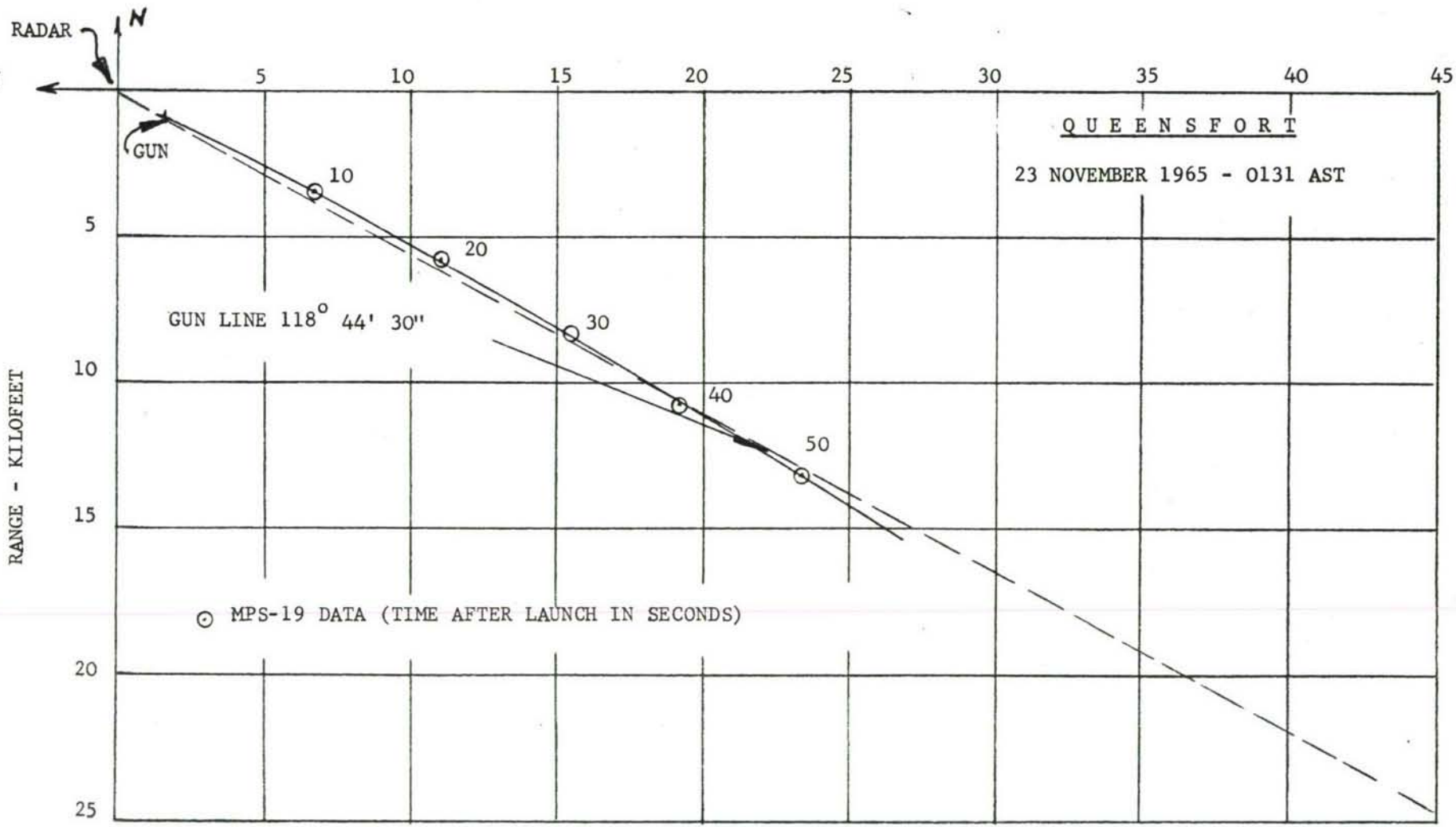


FIG. 2.24b PLAN VIEW OF MARTLET 2C QUEENSFORT TRAJECTORY

Round No. 178 - ROCKLEY

Date: 23 November 1965 - 0328 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism. A strengthened aluminum sabot was used.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	184.3 lb
	Pusher and Obturator	111.8 lb
	Sabot	85.0 lb
	Shot Weight	381.1 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: 21 inches of mercury.

Launch Data:

Charge Weight	950 lb M8M.27 (10 bags), Lot No. CAD 9032
Spacing of Charge	300 S 300 S 350 (two wooden spacers, 20" and 16" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 3
Ram Distance	200 in
Ram Load	10 tons
Chamber Volume	42,500 in^3
Recoil	41.5 in
Breech Pressure	M11: 45,000 psi Strain: 43,800 psi (Fig. 2.25)
Muzzle Velocity (Probe)	Left: 6200 ft/sec Right: 6220 ft/sec Average: 6210 ft/sec

Camera Records:

No smear and Fastax cameras were used.

Radar Records:

The M-33 radar tracked to T + 40 sec, and the MPS-19 radar to T + 100 sec, with a normal AGC trace.

Trajectory:

The radar data are plotted in Figs. 2.25a and b. They compare well with a standard trajectory for a muzzle velocity of 6300 ft/sec, which is higher than the measured velocity of 6210 ft/sec, indicating a lower drag than "standard". The apogee as calculated from the radar data was 470,000 ft = 143 km, and the total range was estimated as 159,000 ft.

TMA Trail Results:

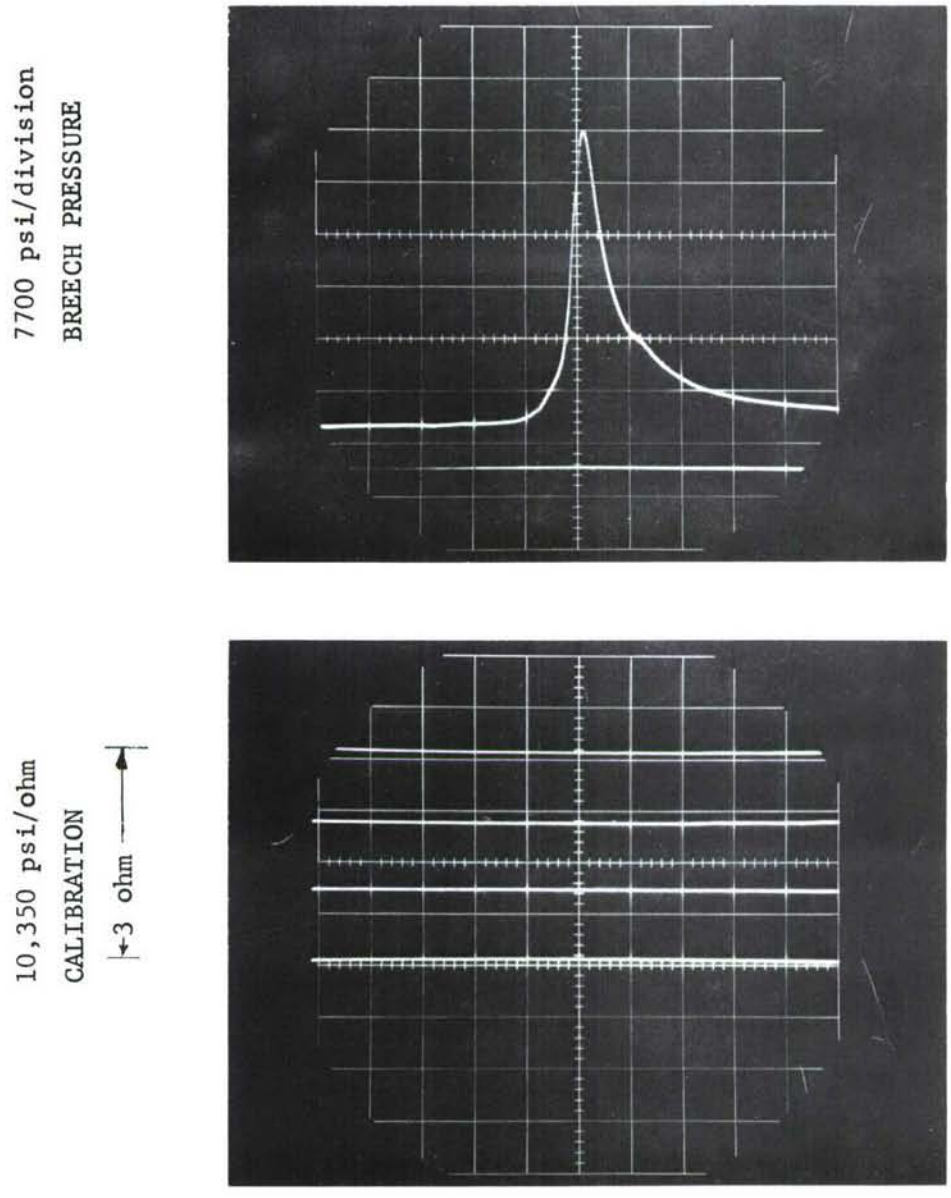
Cameras and TMA payload performed properly, and wind data were obtained in the altitude range from 95 km to 138 km.

Summary:

The round was successful.

R O C K L E Y

23 NOVEMBER 1965 - 0328 AST



TIME

20 milliseconds/division

Maximum Breech Pressure: P_{max} = 43,800 psi

Charge: 950 lb M8M.270

FIG. 2.25 STRAIN GAUGE RECORD OF BREECH PRESSURE ROUND ROCKLEY

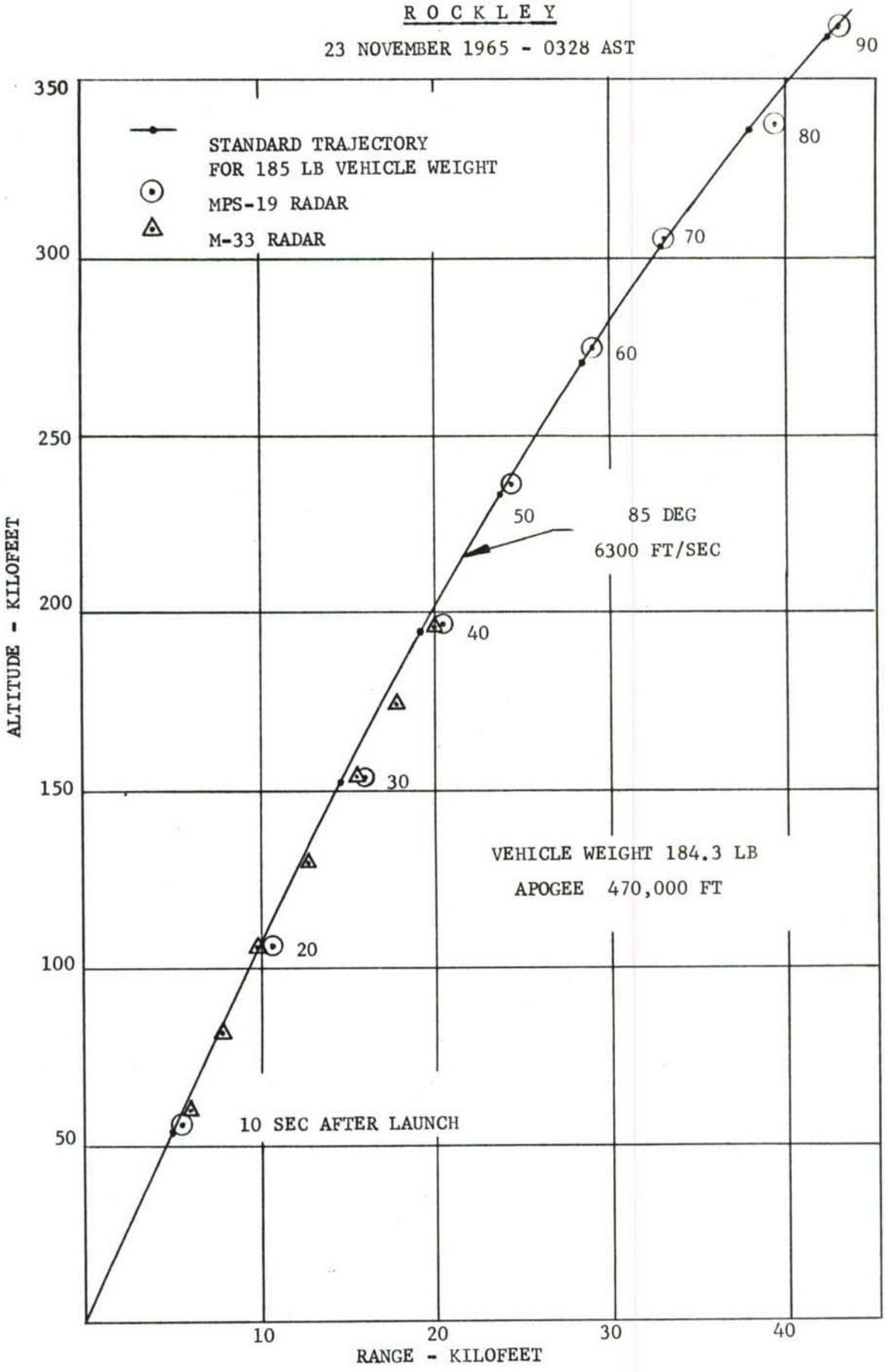


FIG. 2.25a MARTLET 2C ROCKLEY

ALTITUDE VS RANGE

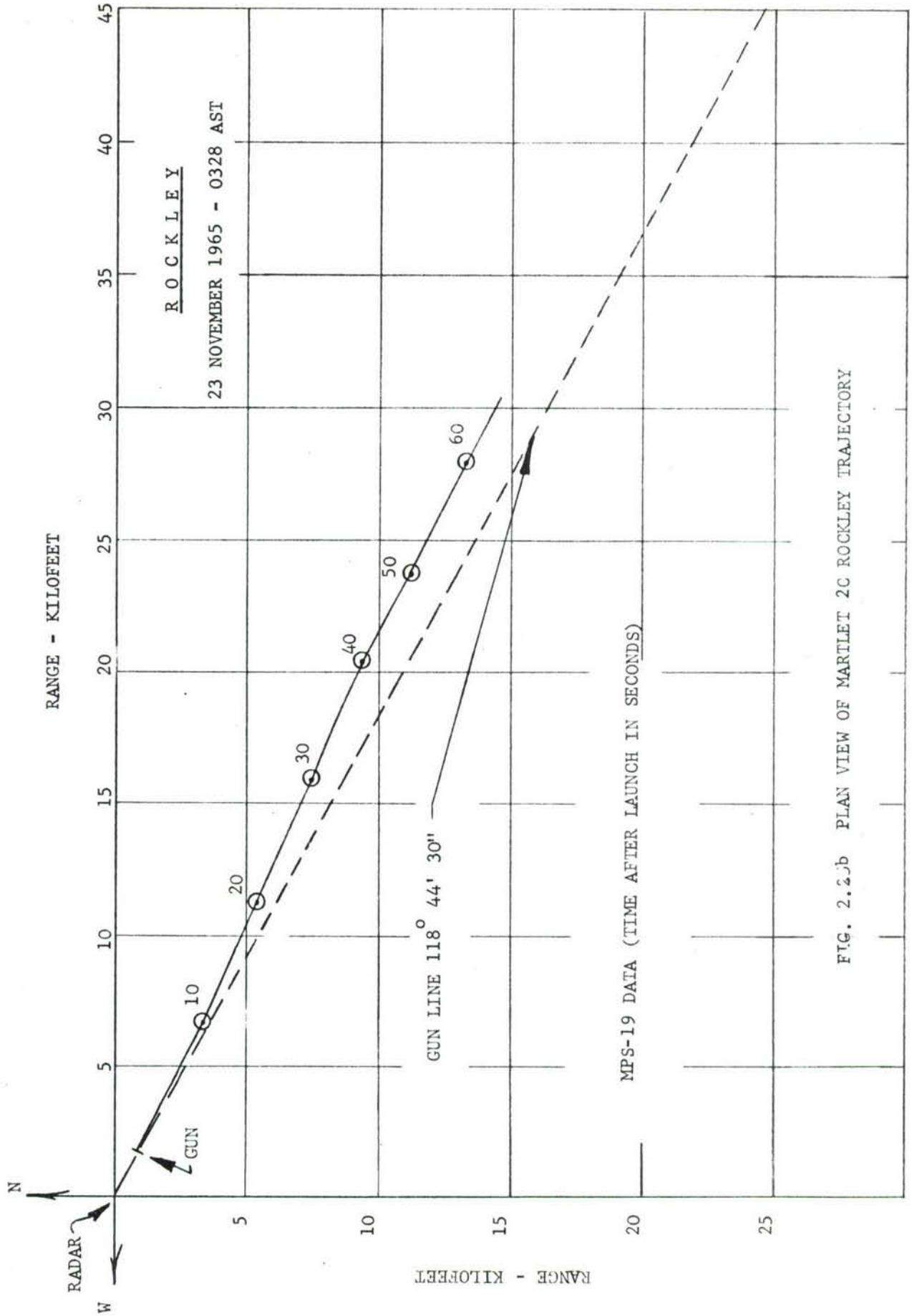


FIG. 2.4.3b PLAN VIEW OF MARTLET 2C ROCKLEY TRAJECTORY

Round No. 179 - SEAWELL

Date: 23 November 1965 - 0516 AST

Vehicle Description: Martlet 2C carrying a 5.5 lb payload of TMA with delay release mechanism.

Purpose of Test: Synoptic measurements of wind profiles.

Weights:		
	Vehicle	183.0 lb
	Pusher and Obturator	120.5 lb
	Sabot	85.0 lb
	Shot Weight	388.5 lb

Centre of Gravity: 21.5 inches from base.

Gun Evacuation: None

Launch Data:

Charge Weight	975 lb M8M.27 (10 bags) Lot No. CAD 9032
Spacing of Charge	300 S 300 S 375 (two wooden spacers 20" and 18" long)
Swedish Additive	15 sheets
Igniter	500 grams/bag
Gun Elevation	85 deg
Crusher Gauges	M11: 4
Ram Distance	203 in
Ram Load	10 tons
Chamber Volume	43,100 in^3
Recoil	42.0 in
Breech Pressure	M11: 46,200 psi Strain: 46,000 psi (Fig. 2.26)
Muzzle Velocity (Probe)	Left: 6220 ft/sec Right: 6240 ft/sec Average: 6230 ft/sec

Cameras Records:

Smear and Fastax cameras were not used.

Radar Records:

The M-33 radar tracked to T + 38 sec and the MPS-19 to T + 100 sec with normal AGC trace.

Trajectory:

The radar data are plotted in Figs. 2.26 a and b and compare well with a standard trajectory for 6300 ft/sec muzzle velocity. The apogee as calculated from the radar data was 464,000 ft = 141 km and the total range was estimated as 156,000 ft.

TMA Trail Results:

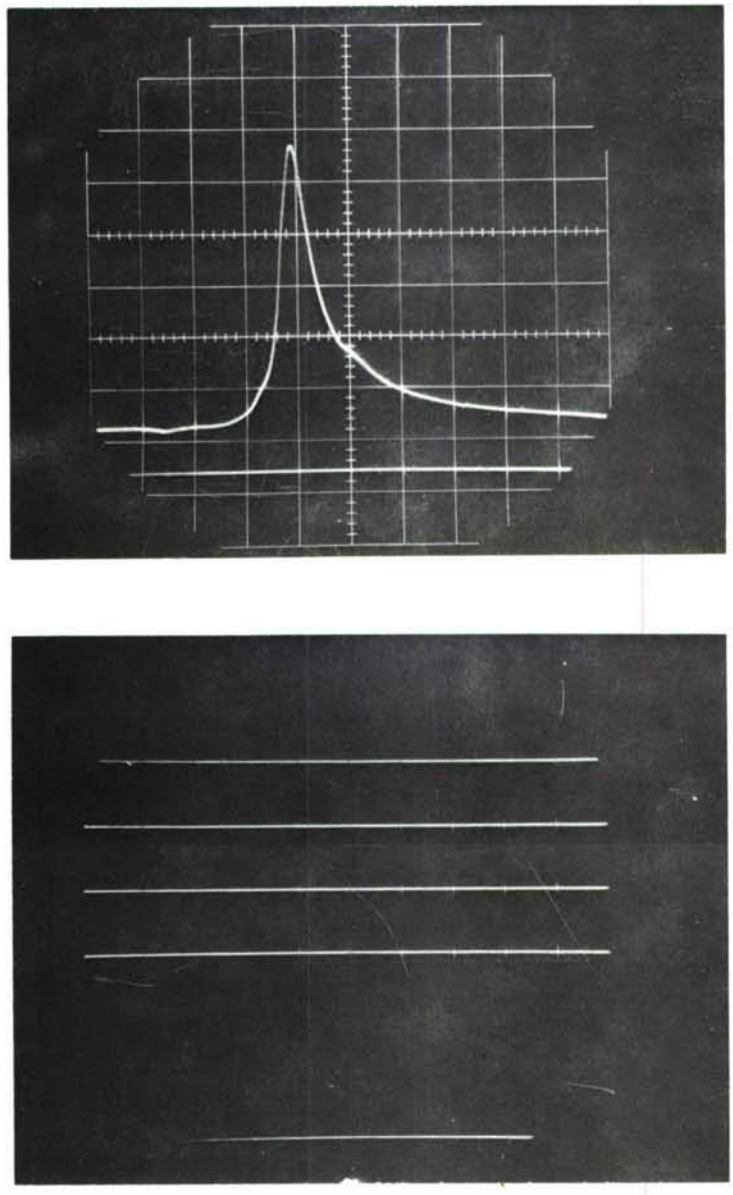
Cameras and TMA payload functioned properly, and wind data were obtained in the altitude range from 91 km to 130 km.

Summary:

The round was successful.

S E A W E L L

23 NOVEMBER 1965 - 0516 AST



20 milliseconds/division

Maximum Breech Pressure: P_{max} = 46,000 psi

Charge: 975 1b M8M.270

FIG. 2.26 STRAIN GAUGE RECORD OF BREECH PRESSURE
ROUND SEAWELL

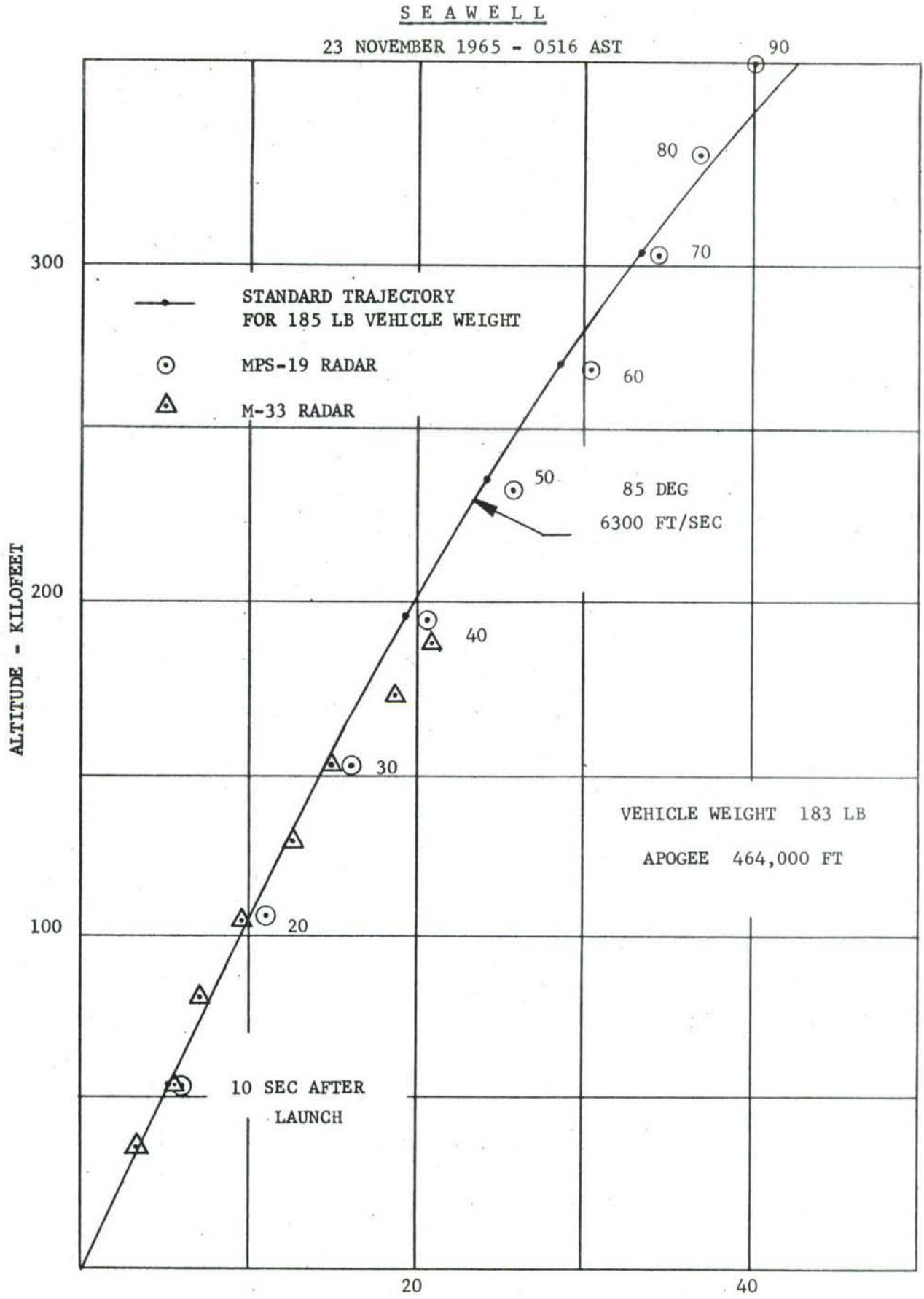


FIG. 2.26a MARTLET 2C SEAWELL
ALTITUDE VS RANGE

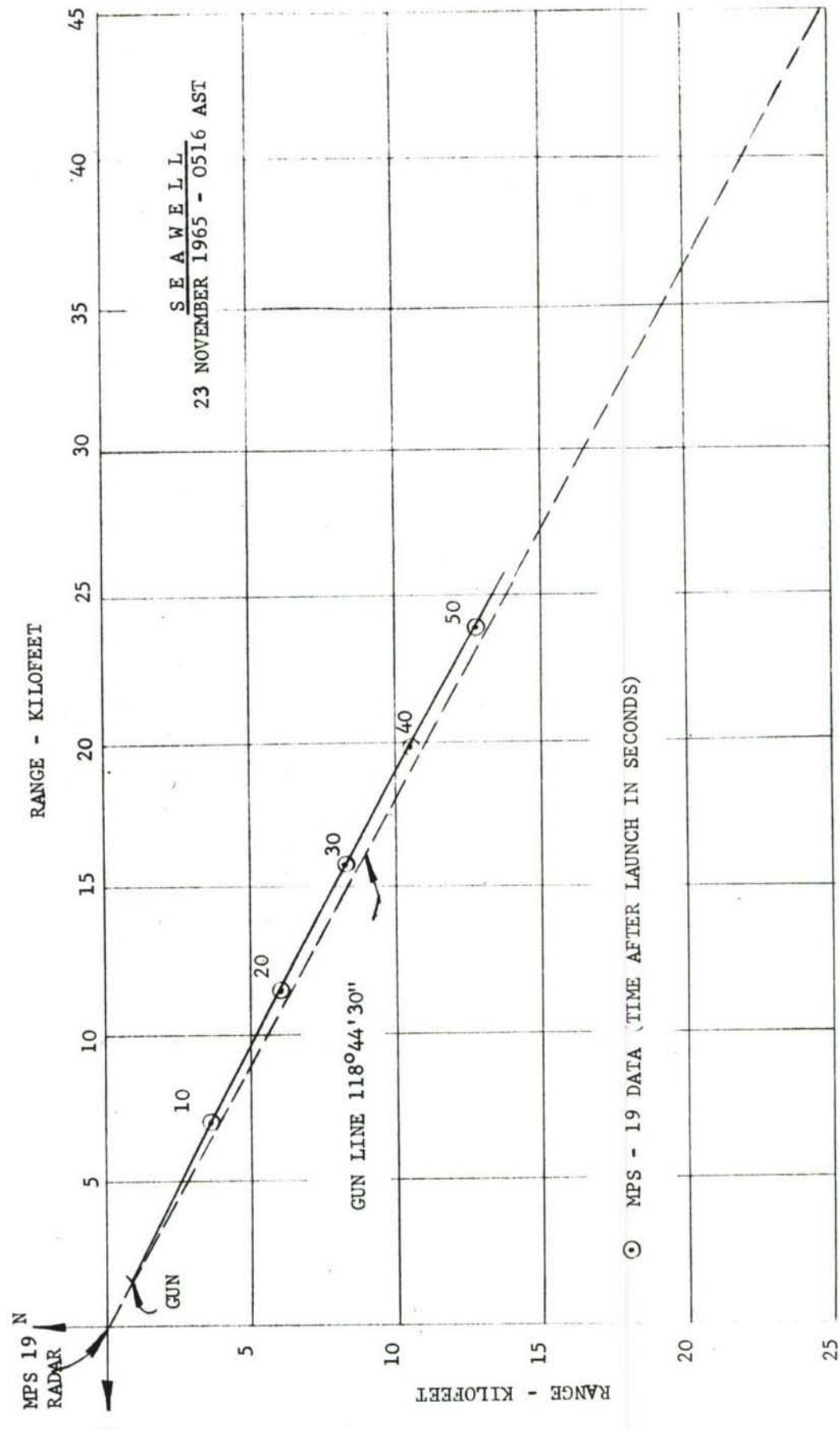


FIG. 2.26b PLAN VIEW OF MARTLET 2C SEAWELL-TRAJECTORY

PART III

TABLE OF RADAR DATA

Round No.	Name	Radar MPS-19	Radar M-33	Comments
153	Test Slug 1			
154	FOAM	X	X	
155	GOOSE			
156	ZENMAC	X	X	
157	YORKSHIRE	X	X	
158	HAHA	X		
159	BRIDGETOWN	X	X	
160	CHRISTCHURCH		X	
161	DOVER	X	X	
162	ENTERPRISE	X	X	
163	FOUL BAY	X	X	Synoptic Series
164	GUN HILL	X	X	
165	HASTINGS	X		
166	INDIAN GROUND	X	X	
167	JAMESTOWN	X	X	
168	KENDALL	X		
169	Test Slug 2	X		
170	WORTHING	X		
171	LANCASTER		X	
172	VAUXHALL	X	X	
173	MAXWELL	X	X	
174	NEEDHAM'S POINT	X	X	
175	OLDBURY	X	X	Synoptic Series
176	PARAGON	X	X	
177	QUEEN'S FORT	X	X	
178	ROCKLEY	X	X	
179	SEAWELL	X	X	

Round 153 and 155: No results available from both radars

NOVEMBER TEST SERIES - RADAR DATA

154 — FOAM						156-ZENMACK					
	MPS - 19			M - 33			MPS - 19			M - 33	
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude	Range
5	17,500	5,200	15	33,400	9,750	10	49,200	10,050	6	42,550	7,440
10	30,900	9,000	20	35,000	10,350	20	91,950	19,050	11	58,600	11,000
20	35,700	11,000	98	17,800	4,390	30	131,250	27,650	16	76,000	14,900
25	36,000	12,000				40	168,000	36,750	21	95,600	19,200
50	29,250	15,000				50	199,650	46,200	26	115,000	23,500
70	19,200	16,200				60	229,800	53,100			
90	5,600	16,900									
100		17,000									

157-YORKSHIRE						158-HAHA				
	MPS-19			M-33			MPS-19			M-33
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude Range
10	51,000	4,500	10	45,050	3,520	10	25,000	7,500		not available
20	96,000	9,000	15	79,350	6,600	20	34,100	11,000		
30	137,700	12,750	20	102,000	8,700	30	38,000	13,750		
40	175,500	16,800	25	118,900	10,500	40	38,600	16,300		
50	210,750	20,700	30	138,100	12,500	50	36,000	18,900		
60	242,700	24,300	40	174,800	16,350	60	30,750	21,000		
70	271,500	29,700				70	23,900	22,900		
80	297,000	34,800				80	16,300	24,250		
90	319,200	41,400				90	8,800	25,100		
						100	1,700	25,600		

RADAR DATA CONT'D

159-BRIDGETOWN						160-CHRISTCHURCH					
	MPS-19			M-33			MPS-19			M-33	
Time	Altitutde	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude	Range
10	43,500	4,000	5	36,350	2,080		Not available		6	37,800	2,960
20	81,000	7,500	10	48,400	4,040				10	54,400	3,430
30	--	--	15	68,250	5,600				15	72,600	4,740
40	147,000	15,000	20	86,800	7,270				20	95,000	6,800
50	174,000	18,500	25	102,600	9,000				25	117,900	8,900
60	198,000	22,000	30	117,750	10,500				30	138,000	10,800
80	273,000	29,000	42	155,000	14,550				35	157,900	12,620
90	253,000	32,000									
100	264,000	36,000									

161- DOVER						162-ENTERPRISE					
	MPS-19			M-33			MPS-19			M-33	
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude	Range
10	51,000	5,250	5	25,800	2,080	10	46,200	4,500	6	29,950	2,900
20	96,300	9,600	10	52,800	4,450	20	80,100	7,500	10	47,350	4,300
30	138,000	13,950	15	74,750	6,750	30	110,100	10,500			
40	176,700	18,150	20	96,000	8,400	40	136,200	13,500			
50	211,800	22,700	25	119,450	10,950	50	159,000	16,200			
60	244,500	27,000	30	140,400	13,200	60	178,800	18,600			
70	273,600	30,300	35	157,900	15,100	70	195,750	20,700			
						80	208,500	24,000			
						90	218,700	27,000			
						100	225,750	29,500			

RADAR DATA CONT'D

163 – FOUL BAY						164 – GUN HILL					
	MPS-19			M-33			MPS-19			M-33	
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude	Range
10	52,000	5,250	15	78,700	8,000	10	54,000	4,500	10	53,900	4,600
20	97,500	10,200	20	99,200	9,600	20	99,750	8,850	15	77,650	6,150
30	139,500	15,000	25	122,000	12,300	30	142,500	12,750	20	98,650	8,000
40	178,500	19,450	30	141,000	14,500	40	182,250	16,800	25	121,200	10,500
50	214,500	24,000				50	218,700	20,700	30	143,900	12,830
60	247,200	28,500				60	252,300	23,700			
70	276,600	32,400				70	282,300	27,000			
80	303,000	37,200				80	309,750	30,000			
90	326,700	40,500				90	333,750	33,300			
100	346,800	44,100				100	354,300	39,600			

165 – HASTINGS						166 – INDIAN GROUND					
	MPS-19			M-33			MPS-19			M-33	
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude	Range
10	50,100	8,700		Not available		10	52,500	4,500	10	58,500	5,050
20	76,500	13,200				20	97,500	8,400	15	76,550	5,900
30	89,700	15,750				30	139,500	12,300	20	98,200	8,100
40	97,800	18,300				40	178,500	16,500	25	120,550	9,800
50	102,600	20,700				50	214,200	20,250	30	140,250	11,750
60	104,100	23,100				60	246,750	23,700	35	161,000	13,800
70	102,600	25,200				70	276,300	26,100			
80	98,400	27,000				80	302,700	29,700			
90	90,500	29,100				90	325,800	32,700			
100	80,250	30,750				100	345,900	36,000			
120	57,900	33,000				110	363,000	37,800			
150	34,500	34,600									
190	0	36,200									

RADAR DATA CONT'D

167 — JAMESTOWN						168-KENDALL				
	MPS-19			M-33			MPS-19			M-33
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude Range
10	51,750	4,500	6	31,800	2,600	10	36,000	7,000		Not available
20	96,900	8,400	10	51,550	3,875	20	71,000	14,500		
30	138,300	12,300	15	75,400	6,600	30	102,000	21,600		
40	176,700	16,500	20	96,800	9,000	40	130,000	28,700		
50	211,800	19,950	25	117,850	11,400	50	154,200	35,600		
60	244,200	23,100	30	137,700	13,700	60	126,000	42,700		
70	273,000	27,000	35	158,300	16,000	70	194,100	49,500		
80	298,800	30,900	40	177,000	18,150	75	202,300	53,000		
90	321,750	34,500								
100	341,250	38,550								

169 – Test Slug #2					170-WORTHINGS				
	MPS-19			M-33		MPS-19			M-33
Time	Altitude	Range	T	Altitude Range	T	Altitude	Range	T	Altitude Range
10	10,900	3,100		Not available	10	49,500	9,750		Not available
20	12,750	2,900			20	91,800	18,300		
30	11,400	3,600			30	130,800	27,000		
40	7,700	3,800			40	166,800	34,500		
49	4,100	4,000			50	199,500	42,750		
					60	227,700	51,000		

RADAR DATA CONT'D

171 – LANCASTER					172 – VAUXHALL			
	MPS-19		M-33			MPS-19		M-33
Time	Altitude Range	T	Altitude Range		T	Altitude Range	T	Altitude Range
	Not available	6	25,300	2,280	10	52,500 9,900	10	55,000 9,500
		15	52,300	4,400	20	99,000 18,750	15	75,450 13,750
		20	66,900	5,850	30	141,900 27,600	20	97,750 17,800
		25	81,000	7,200	40	181,500 36,000	30	143,600 27,200
		30	93,750	8,650	50	218,500 45,000	35	163,400 31,250
		35	117,100	11,350	60	252,000 53,100	40	182,800 35,200
		40	117,500	11,400	70	282,600 60,000		
		45	128,500	12,600	80	310,500 67,500		
					90	334,800 75,300		

173-MAXWELL					174 – NEEDHAM'S POINT			
	MPS-19		M-33			MPS - 19		M-33
Time	Altitude Range	T	Altitude Range		T	Altitude Range	T	Altitude Range
10	56,700 5,700	6	38,000	3,800	10	54,300 5,700	7	38,000 3,950
20	106,200 10,200	10	56,760	4,650	20	102,000 10,500	11	62,200 5,300
30	151,800 15,600	15	80,780	7,200	30	146,250 15,750	15	79,200 7,300
40	194,700 20,400	20	105,500	9,650	40	187,500 19,800	20	101,650 9,600
50	234,300 24,900	25	128,400	12,200	50	225,000 24,300		
60	270,900 29,700	30	151,100	14,700	60	259,800 28,500		
70	304,500 33,000	35	174,300	17,250	70	291,300 34,200		
80	335,000 36,600	40	191,600	19,150	80	319,500 39,300		
90	362,700 39,900				90	345,750 42,300		
100	387,000 42,750				100	367,500 46,200		
					110	379,800 47,700		

RADAR DATA CONT'D

175 – OLDBURY						176 – PARAGON					
	MPS-19			M-33			MPS-19			M-33	
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude	Range
10	37,500	3,000	12	38,000	3,300	10	54,000	5,000	15	77,900	6,500
20	60,900	5,100	15	41,000	3,600	20	102,000	10,000	20	102,000	9,000
30	78,900	6,600	20	53,900	3,850	30	146,200	14,400	25	121,800	11,200
40	90,000	7,500	25	65,500	5,100	40	188,000	19,000			
50	97,500	7,500	30	76,300	5,600	50	226,000	23,200			
60	101,700	9,000	35	86,000	7,000	60	260,800	27,200			
70	102,000	8,000				70	293,000	32,000			
80	99,300	9,000				80	322,000	36,000			
90	93,900	9,000				90	348,000	38,000			
100	85,200	9,300				100	370,800	40,000			
110	74,400	9,900									
120	64,800	10,000									

177-QUEEN'S FORT						178-ROCKLEY					
	MPS-19			M-33			MPS-19			M-33	
Time	Altitude	Range	T	Altitude	Range	T	Altitude	Range	T	Altitude	Range
10	53,600	5,600	5	34,100	3,500	10	56,400	5,600	10	61,750	5,900
20	101,600	10,800	10	54,800	4,730	20	106,000	10,800	15	83,600	7,500
30	146,000	15,600	15	80,800	7,000	30	152,800	16,000	20	106,300	10,100
40	187,200	20,400	20	102,000	9,430	40	196,000	20,800	25	130,000	12,800
50	225,600	24,800	25	125,200	12,000	50	236,000	24,600	30	153,000	15,450
60	260,600	28,800	30	146,250	15,450	60	273,500	29,000	35	175,750	18,000
70	292,400	32,800	35	168,500	18,000	70	307,500	33,500	40	195,800	20,300
80	321,800	38,000				80	338,000	38,500			
90	347,000	44,000				90	365,800	43,000			
						100	386,000	46,000			

RADAR DATA CONT'D

179—SEAWELL

Time	MPS-19 Altitude	Range	T	M-33 Altitude	Range
10	56,000	6,000	6	35,500	3,600
20	106,000	11,200	10	56,350	5,500
30	151,800	16,000	15	82,200	7,000
40	194,500	20,800	20	104,930	9,600
50	234,000	25,600	25	128,500	12,600
60	270,600	30,600	30	150,300	15,100
70	304,000	34,400	35	173,000	18,900
80	335,000	37,000	38	188,500	21,150
90	362,500	40,000			
100	386,400	44,500			

PART IV

TABLES AND GRAPHS OF WIND DATA*

Trail No.	Round No.	Name	Time	Page
30	157	YORKSHIRE	16 Nov. 65	
31	160	CHRISTCHURCH	17/18 Nov. 65	
32	161	DOVER		
33	163	FOUL BAY		
34	164	GUN HILL		
35	166	INDIAN GROUND		
36	167	JAMESTOWN		
37	173	MAXWELL	22/23 Nov. 65	
38	174	NEEDHAM'S POINT		
39	176	PARAGON		
40	177	QUEEN'S FORT		
41	178	ROCKLEY		
42	179	SEAWELL		

For each of these rounds, a data table and graphs are given. The wind speed plot shows the speed of the wind vector in meters per second as a function of altitude in kilometers above sea level. For the wind direction plot the wind vector is considered to point in the direction towards which the wind is moving, and the direction is given in degrees clockwise from North, over East, South, West, to North. The wind components plots give the North/South, and East/West velocities, with direction towards North and East positive. The components are plotted in meters per second versus altitude in kilometers.

The wind direction and components as given in the plots are referenced to true North. Components relative to magnetic North have also been calculated for comparison with other ionospheric phenomena. These components are not plotted, but are listed in the data tables.

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* Taken from Reference

In round YORKSHIRE Cesium was released at 101 km as a point rather than a trail, and remained visible for about 100 seconds. The release showed a considerable vertical motion of approximately 38 m/sec up to above 105 km, before it faded from view. The horizontal wind data are given for the average height of 103 km.

Up-trail and down-trail data were usually the same or differed within the margin of the possible accuracy so that in most cases only one curve was drawn. Only where a significant difference resulted, between up and down results, two curves were shown.

In the case of near zero wind, the wind direction has little meaning, and the calculation may give large errors. An example is Trail No. 41, Round ROCKLEY, where the points of altitude 129 and 130 km do not fit the curve well. A calm wind at 110 km in Round SEAWELL (Trail 42) also caused poor direction results. It must be noted that this round produced poor film data; in particular the data from 104 to 110 km may have considerable errors, and therefore dotted curves were drawn in this altitude band.

TRAIL NO. 30 YORKSHIRE

BARBADOS 16 NOVEMBER 1965 18:15:00

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
103.0	337.7	92.4	85.5	-35.1	90.8	-17.1

NO PLOTS ARE SHOWN FOR THIS RELEASE

TRAIL NO. 31 CHRIST CHURCH

BARBADOS 17 NOVEMBER 1965 18-15-00 AST
UP TRAIL

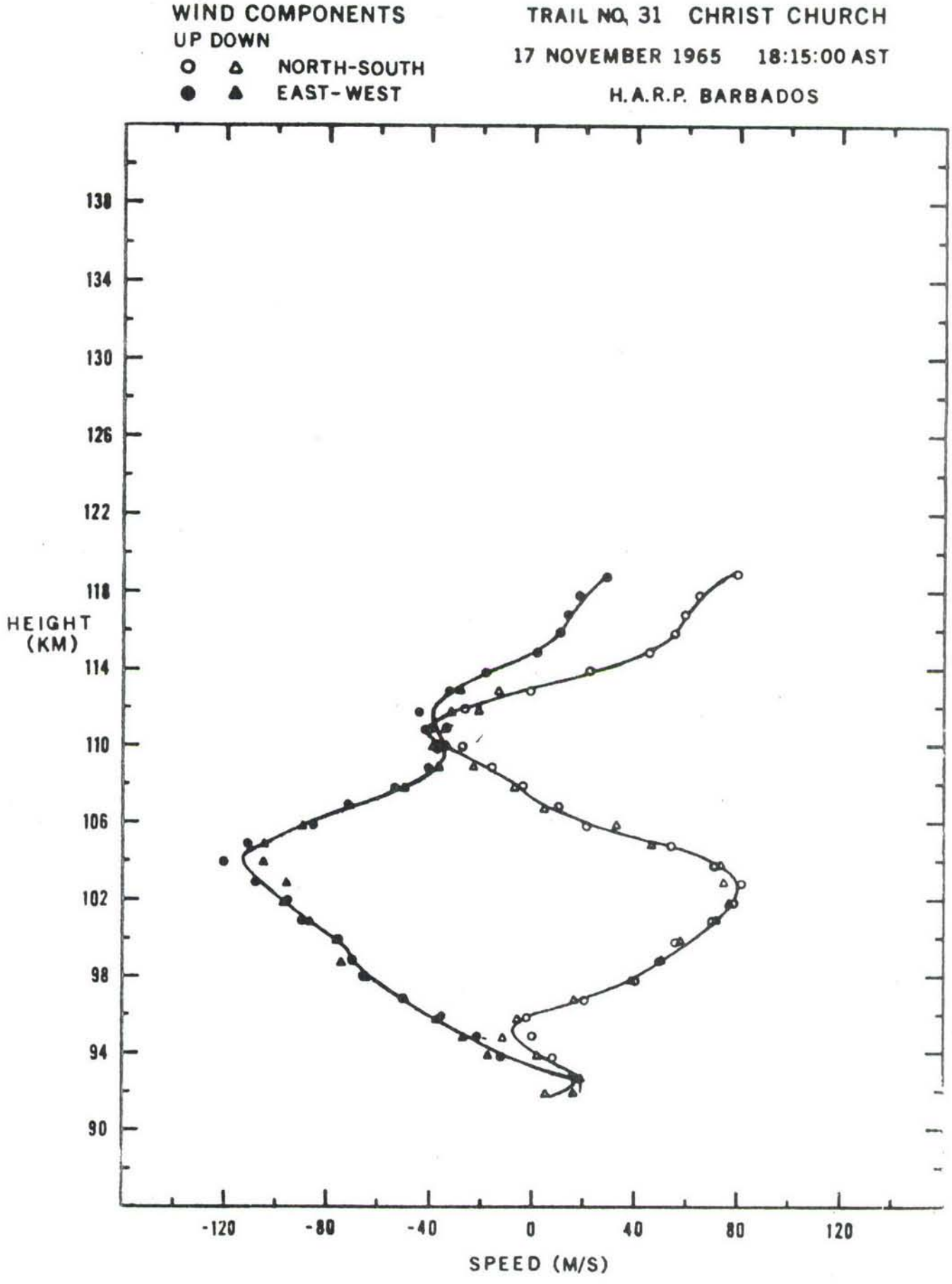
ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
93.0	45.7	27.4	19.1	19.6	14.7	23.1
94.0	303.6	14.9	8.3	-12.5	10.7	-10.6
95.0	271.4	22.1	0.6	-22.1	5.1	-21.5
96.0	268.1	36.7	-1.2	-36.7	6.2	-36.2
97.0	291.2	55.7	20.2	-51.9	30.3	-46.7
98.0	301.2	77.6	40.2	-66.4	52.8	-56.9
99.0	304.6	85.8	48.7	-70.6	62.0	-59.3
100.0	307.0	94.3	56.8	-75.3	70.9	-62.3
101.0	307.6	114.8	70.1	-90.9	87.0	-74.8
102.0	308.8	124.9	78.3	-97.3	96.4	-79.5
103.0	307.3	136.3	82.6	-108.3	102.8	-89.4
104.0	300.4	141.4	71.6	-121.9	94.8	-104.9
105.0	296.1	124.4	54.8	-111.7	76.3	-98.3
106.0	284.1	88.4	21.6	-85.7	38.5	-79.6
107.0	278.5	71.7	10.6	-70.9	24.7	-67.3
108.0	266.5	52.9	-3.2	-52.8	7.5	-52.4
109.0	247.9	44.1	-16.6	-40.9	-8.0	-43.4
110.0	238.2	46.5	-29.7	-35.7	-21.9	-41.0
111.0	223.8	58.5	-42.2	-40.4	-33.2	-48.1
112.0	238.4	50.6	-26.5	-43.1	-17.2	-47.6
113.0	268.8	32.1	-0.7	-32.1	5.8	-31.6
114.0	321.9	28.8	22.6	-17.7	25.7	-12.8
115.0	3.1	45.8	45.7	2.5	44.3	11.7
116.0	10.7	56.5	55.5	10.5	52.2	21.5
117.0	13.4	61.0	59.4	14.1	55.3	25.8
118.0	15.5	67.7	65.2	18.1	60.2	30.9
119.0	19.4	85.0	80.2	28.2	72.8	43.8

TRAIL NO. 31 CHRIST CHURCH

BARBADOS
DOWN TRAIL

17 NOVEMBER 1965 18-15-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
92.0	69.1	18.0	6.4	16.8	2.9	17.7
93.0	44.3	26.9	19.3	18.8	15.1	22.3
94.0	279.1	15.4	2.4	-15.2	5.4	-14.4
95.0	247.2	28.1	-10.9	-25.9	-5.4	-27.6
96.0	261.4	36.8	-5.5	-36.4	2.0	-36.8
97.0	289.8	50.4	17.1	-47.4	26.3	-43.0
98.0	301.7	74.3	39.0	-63.3	51.0	-54.1
99.0	304.7	88.4	50.4	-72.7	64.1	-61.0
100.0	307.9	95.6	58.7	-75.5	72.8	-62.1
101.0	310.3	112.8	72.9	-86.0	88.8	-69.5
102.0	308.5	125.0	77.8	-97.8	96.0	-80.0
103.0	308.2	123.5	76.3	-97.1	94.4	-79.7
104.0	305.4	128.2	74.3	-104.5	93.9	-87.3
105.0	294.3	114.1	46.9	-104.0	67.0	-92.4
106.0	290.8	93.4	33.2	-87.3	50.2	-78.8
107.0	273.9	70.1	4.7	-70.0	18.8	-67.6
108.0	262.6	48.8	-6.3	-48.4	3.6	-48.7
109.0	238.7	41.8	-21.7	-35.7	-14.0	-39.4
110.0	221.8	51.2	-38.1	-34.2	-30.4	-41.2
111.0	219.3	54.0	-41.8	-34.2	-34.0	-41.9
112.0	236.7	37.3	-20.5	-31.2	-13.8	-34.7
113.0	248.0	31.9	-12.0	-29.6	-5.8	-31.4


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 31 CHRIST CHURCH
17 NOVEMBER 1965 18:15:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

WIND SPEED

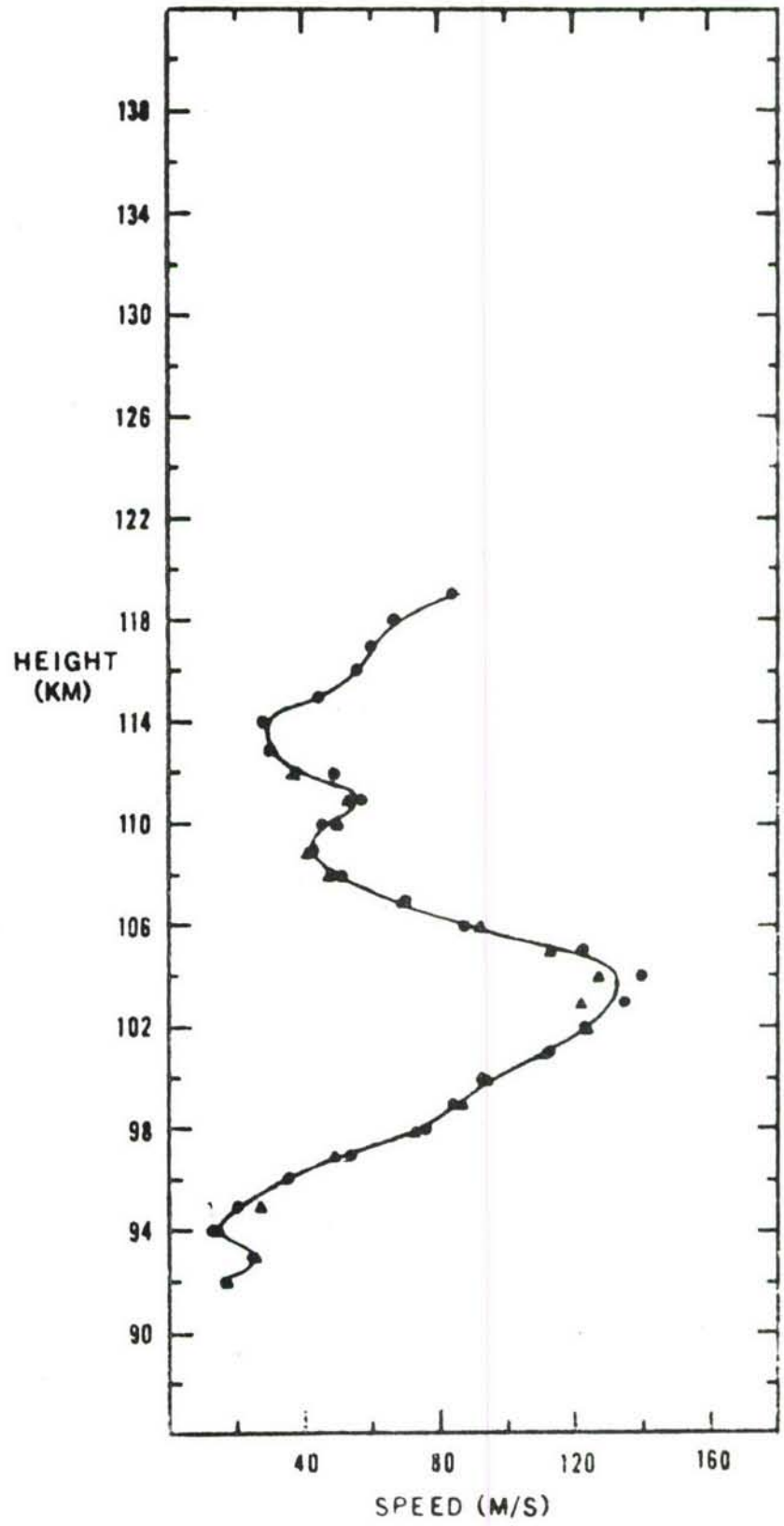
TRAIL NO. 31 CHRIST CHURCH

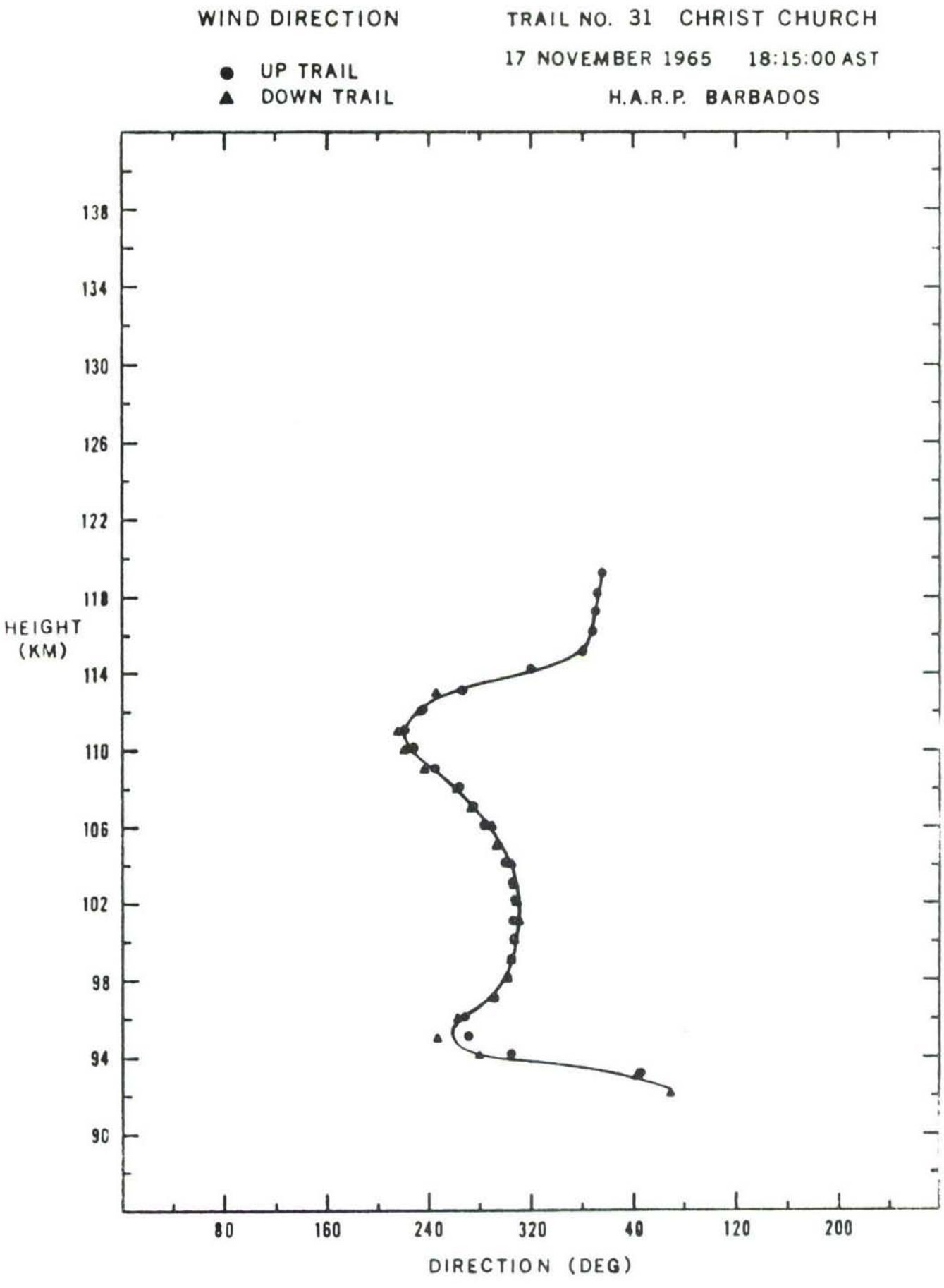
17 NOVEMBER 1965 18.15:00 AST

H.A.R.P. BARBADOS

● UP TRAIL

▲ DOWN TRAIL




WIND DIRECTION
TRAIL NO. 31 CHRIST CHURCH
17 NOVEMBER 1965 18:15:00 AST
H.A.R.P. BARBADOS
UP TRAIL
DOWN TRAIL
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
80
160
240
320
40
120
200
DIRECTION (DEG)

TRAIL NO. 32 DOVER

BARBADOS
UP TRAIL

17 NOVEMBER 1965 19-34-00 AST

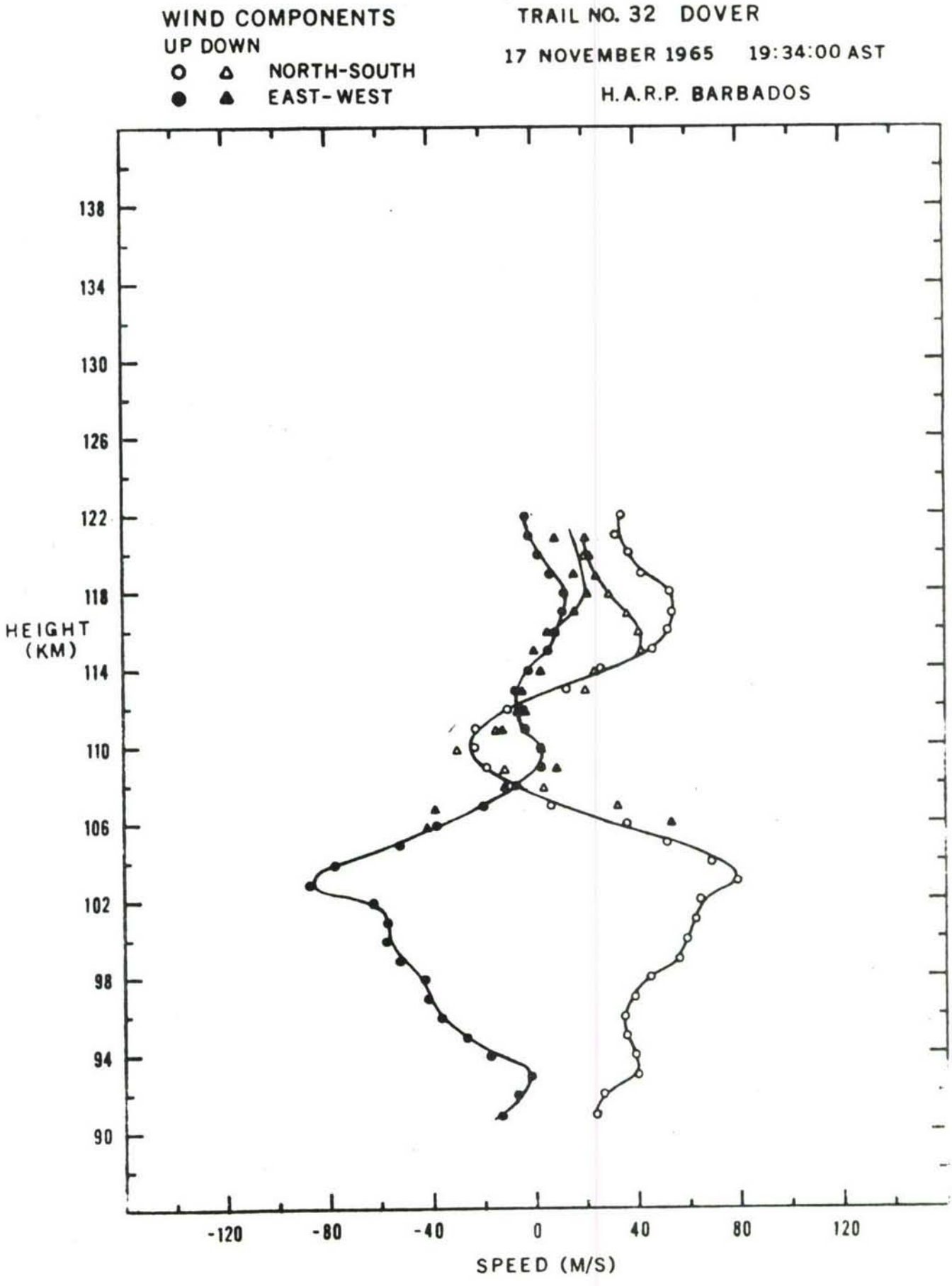
ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
91.0	328.9	27.4	23.5	-14.1	25.9	-9.1
92.0	344.8	27.5	26.5	-7.2	27.4	-1.7
93.0	356.9	39.0	39.0	-2.1	38.6	5.8
94.0	334.9	42.3	38.3	-17.9	41.1	-9.8
95.0	323.2	44.6	35.7	-26.7	40.4	-18.9
96.0	313.5	50.6	34.8	-36.7	41.5	-28.9
97.0	312.8	56.9	38.7	-41.8	46.4	-33.1
98.0	316.1	62.5	45.1	-43.3	52.9	-33.3
99.0	317.0	77.4	56.5	-52.8	66.0	-40.3
100.0	315.9	82.5	59.2	-57.5	69.6	-44.3
101.0	317.9	84.9	62.9	-56.9	73.1	-43.0
102.0	315.9	90.4	64.9	-62.9	76.3	-48.5
103.0	312.3	117.7	79.2	-87.1	95.2	-69.3
104.0	311.8	103.7	69.1	-77.3	83.3	-61.7
105.0	314.4	73.7	51.6	-52.7	61.2	-41.2
106.0	312.7	53.0	36.0	-38.9	43.1	-30.8
107.0	288.7	20.7	6.6	-19.6	10.4	-17.9
108.0	216.0	10.5	-8.5	-6.2	-7.1	-7.8
109.0	171.0	19.0	-18.8	3.0	-19.0	-0.9
110.0	172.6	22.7	-22.5	2.9	-22.6	-1.7
111.0	188.5	22.0	-21.8	-3.3	-20.7	-7.6
112.0	203.3	10.5	-9.7	-4.2	-8.7	-6.1
113.0	334.6	15.7	14.1	-6.7	15.2	-3.7
114.0	356.9	27.1	27.0	-1.4	26.7	4.1
115.0	7.3	47.1	46.7	6.0	44.5	13.3
116.0	9.7	54.2	53.4	9.1	50.5	15.7
117.0	12.2	56.1	54.9	11.9	51.4	22.9
118.0	13.9	55.8	54.2	13.4	50.4	24.1
119.0	9.3	44.3	43.7	7.1	41.4	15.8
120.0	4.3	38.2	38.1	2.9	36.7	13.5
121.0	358.7	33.6	33.6	-0.8	33.1	6.1
122.0	356.4	35.9	35.8	-2.2	35.5	5.1

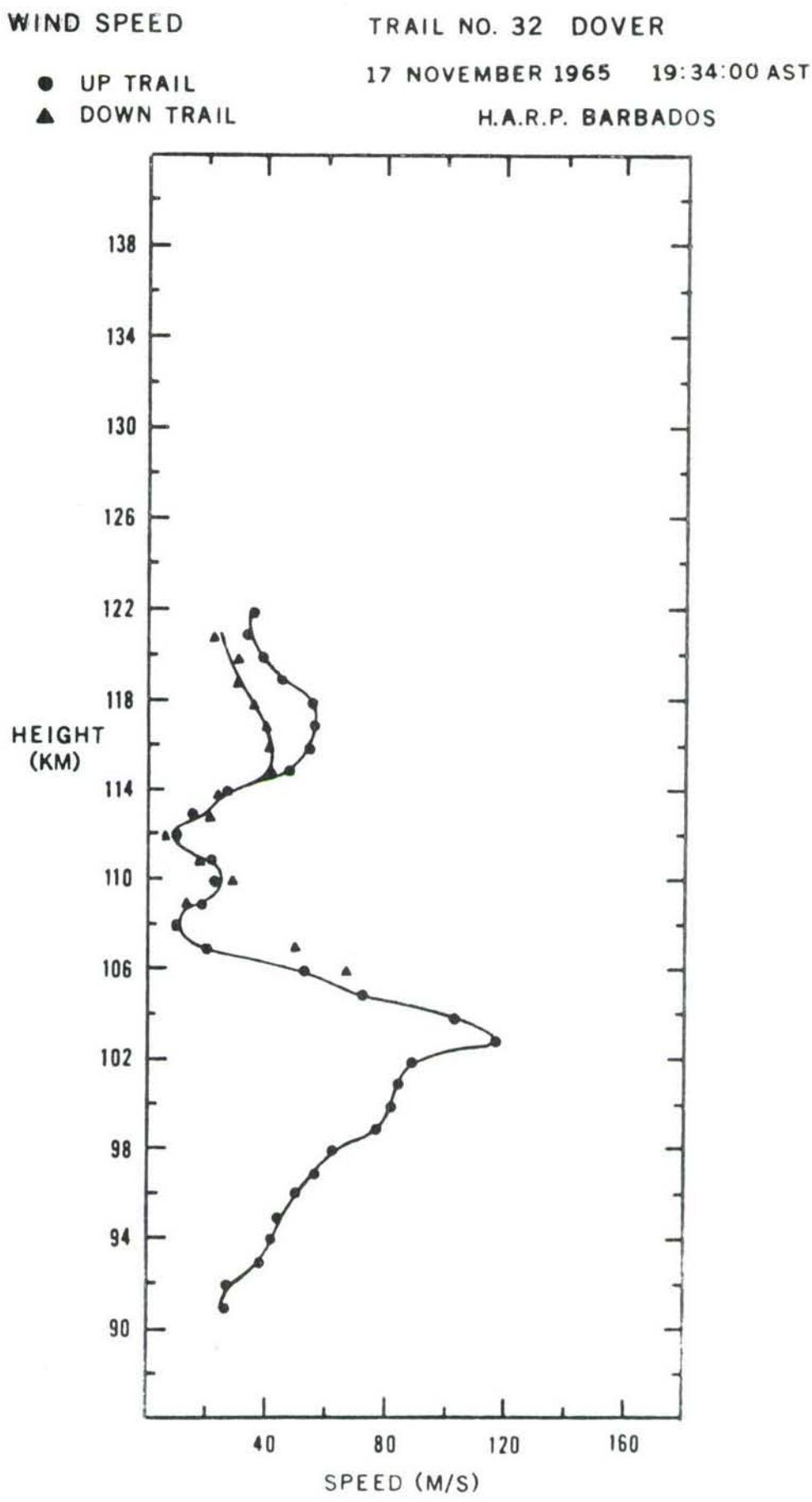
TRAIL NO. 32 DOVER

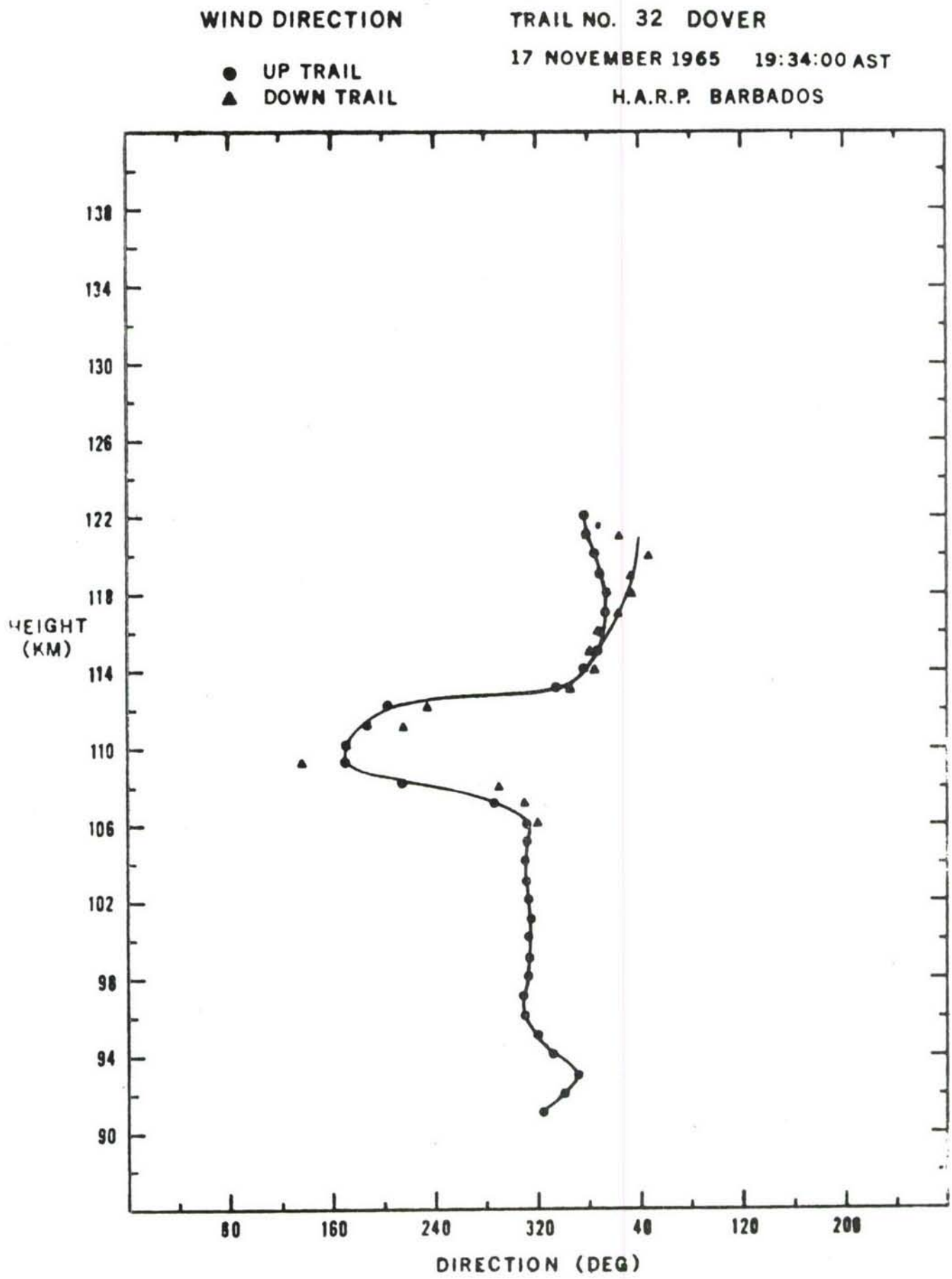
BARBADOS
DOWN TRAIL

17 NOVEMBER 1965 19-34-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
106.0	322.5	67.5	53.6	-41.1	60.8	-29.4
107.0	310.8	50.1	32.7	-37.9	39.7	-30.5
108.0	290.9	11.2	4.0	-10.4	6.0	-9.4
109.0	138.9	14.0	-10.5	9.2	-12.1	6.9
110.0	172.2	29.9	-29.6	4.0	-29.8	-2.1
111.0	218.1	18.7	-14.7	-11.6	-12.1	-14.3
112.0	236.3	6.3	-3.5	-5.2	-2.4	-5.8
113.0	347.4	21.3	20.8	-4.7	21.3	-0.4
114.0	7.4	24.5	24.3	3.1	23.2	7.9
115.0	1.3	42.5	42.5	0.9	41.4	9.5
116.0	8.3	41.6	41.2	6.0	39.1	14.2
117.0	24.1	40.9	37.3	16.7	33.2	23.9
118.0	35.2	36.8	30.1	21.2	25.2	26.8
119.0	32.9	30.2	25.4	16.4	21.6	21.2
120.0	48.2	30.7	20.5	22.9	15.4	26.6
121.0	23.8	23.3	21.3	9.4	19.0	13.5


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 32 DOVER
17 NOVEMBER 1965 19:34:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)


WIND SPEED
TRAIL NO. 32 DOVER
17 NOVEMBER 1965 19:34:00 AST
H.A.R.P. BARBADOS
UP TRAIL
DOWN TRAIL
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
40
80
120
160
SPEED (M/S)


WIND DIRECTION
TRAIL NO. 32 DOVER
17 NOVEMBER 1965 19:34:00 AST
● UP TRAIL
▲ DOWN TRAIL
H.A.R.P. BARBADOS
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
80
160
240
320
40
120
200
DIRECTION (DEG)

TRAIL NO. 33 FOUL BAY

BARBADOS
UP TRAIL

17 NOVEMBER 1965 23-15-00 AST

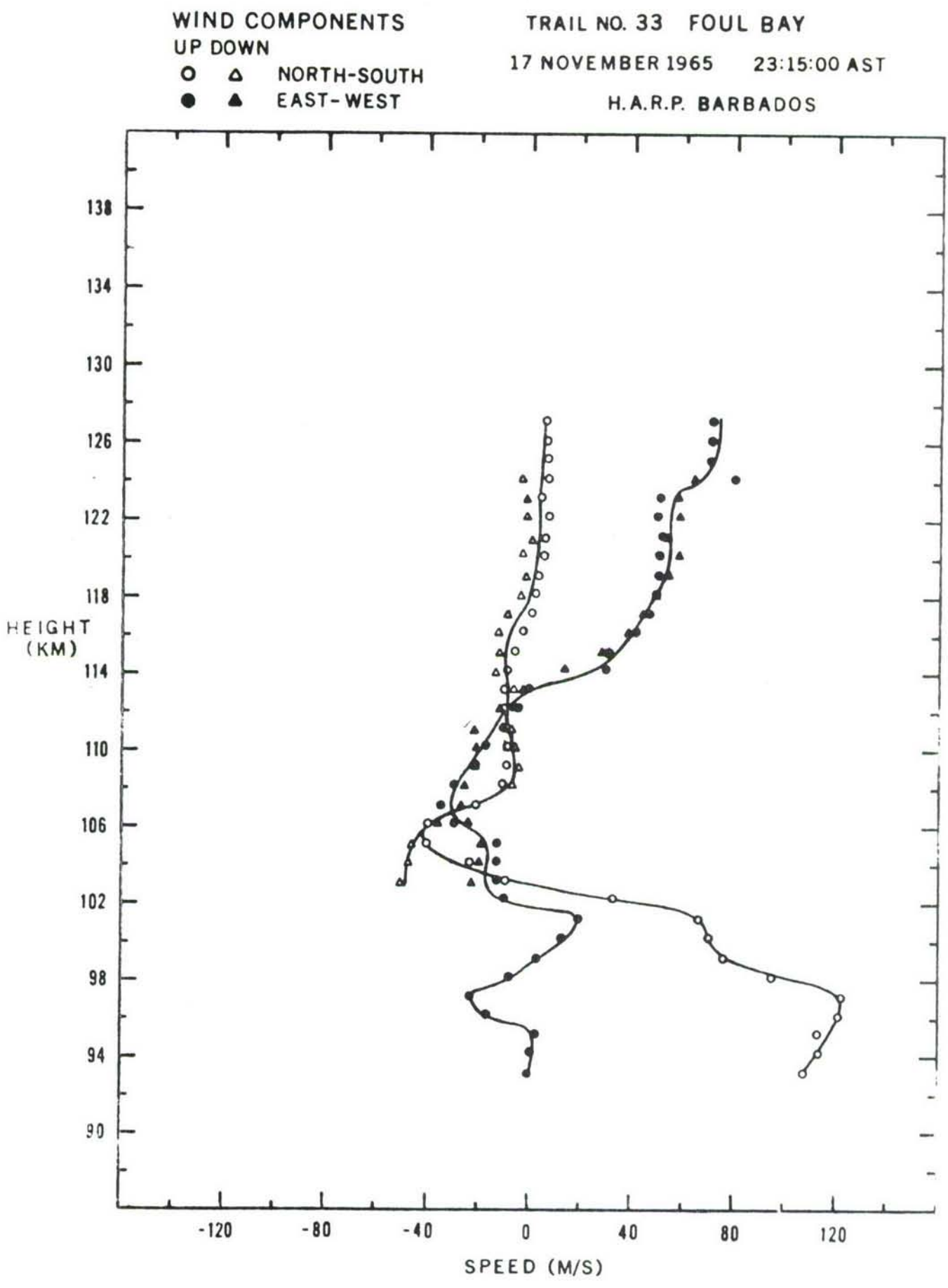
ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
93.0	359.4	108.0	108.0	-1.1	106.0	20.8
94.0	0.6	114.7	114.7	1.3	112.1	24.5
95.0	1.5	113.7	113.6	2.9	110.7	25.8
96.0	352.1	122.7	121.6	-16.9	122.5	8.0
97.0	349.2	125.2	123.0	-23.5	125.2	1.9
98.0	355.4	95.4	95.1	-7.6	94.7	11.8
99.0	2.4	76.6	76.5	3.2	74.3	18.6
100.0	9.8	71.4	70.3	12.2	66.4	26.2
101.0	16.1	69.5	66.8	19.3	61.5	32.4
102.0	341.9	35.2	33.5	-10.9	35.0	-3.9
103.0	235.4	16.3	-9.3	-13.4	-6.4	-15.0
104.0	209.4	26.9	-23.4	-13.2	-20.2	-17.7
105.0	197.6	42.6	-40.6	-12.9	-37.2	-20.8
106.0	216.4	49.3	-39.6	-29.2	-32.9	-36.6
107.0	238.8	40.0	-20.7	-34.2	-13.4	-37.7
108.0	250.2	31.6	-10.7	-29.7	-4.5	-31.3
109.0	249.2	23.4	-8.3	-21.9	-3.7	-23.1
110.0	243.6	19.6	-8.7	-17.6	-5.0	-19.0
111.0	214.7	16.2	-8.6	-9.6	-6.5	-11.1
112.0	203.1	10.6	-9.8	-4.2	-8.7	-6.1
113.0	178.3	10.0	-10.0	0.4	-9.9	-1.6
114.0	105.5	31.9	-8.5	30.7	-14.5	28.3
115.0	101.0	31.5	-6.0	31.0	-12.1	29.1
116.0	93.3	41.7	-2.4	41.7	-10.8	40.4
117.0	89.9	46.7	0.1	46.7	-9.3	45.8
118.0	87.5	49.8	2.2	49.7	-7.9	49.1
119.0	85.7	50.6	3.8	50.5	-6.5	50.2
120.0	83.1	50.4	6.0	50.1	-4.3	50.3
121.0	83.0	51.5	6.2	51.1	-4.3	51.3
122.0	81.5	50.1	7.4	49.6	-2.8	50.1
123.0	84.8	50.7	4.6	50.5	-5.7	50.4
124.0	84.8	80.1	7.3	79.8	-9.0	79.6
125.0	84.4	71.1	7.0	70.7	-7.4	70.7
126.0	84.7	70.9	6.6	70.6	-7.8	70.5
127.0	86.4	72.0	4.5	71.8	-10.1	71.2

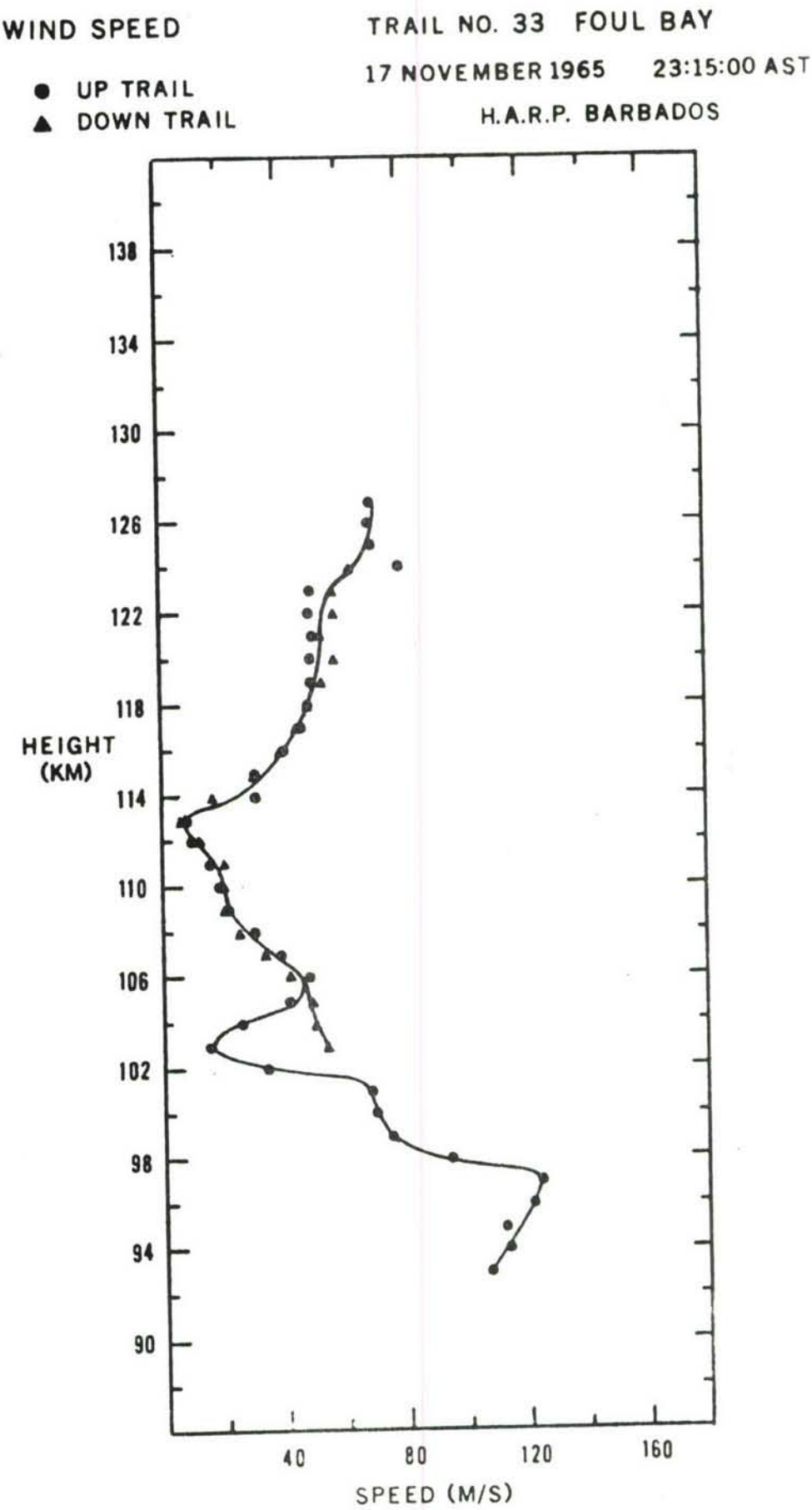
TRAIL NO. 33 FOUL BAY

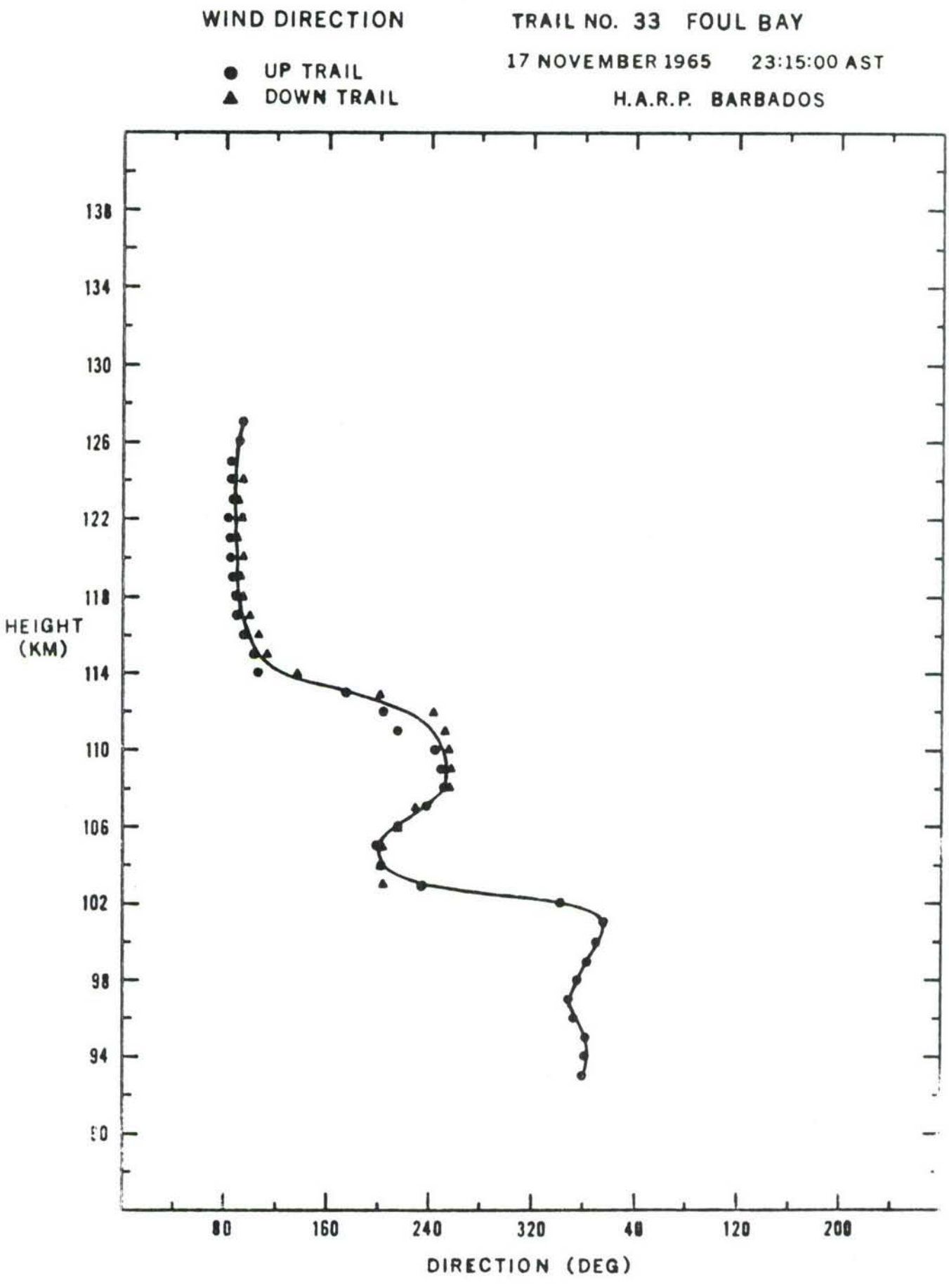
BARBADOS 17 NOVEMBER 1965 23-15-00 AST

DOWN TRAIL

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
103.0	203.7	55.1	-50.4	-22.2	-44.9	-31.9
104.0	202.7	51.3	-47.3	-19.8	-42.3	-29.0
105.0	202.1	50.1	-46.4	-18.9	-41.6	-27.9
106.0	214.6	43.2	-35.6	-24.5	-29.9	-31.2
107.0	229.8	34.9	-22.5	-26.7	-16.6	-30.7
108.0	256.0	26.5	-6.4	-25.7	-1.1	-26.5
109.0	258.4	22.0	-4.4	-21.5	0.0	-21.9
110.0	255.2	22.1	-5.7	-21.4	-1.3	-22.1
111.0	251.4	22.3	-7.1	-21.1	-2.7	-22.1
112.0	242.1	14.0	-6.6	-12.4	-4.0	-13.5
113.0	201.0	7.2	-6.7	-2.6	-6.0	-3.9
114.0	137.5	18.4	-13.6	12.4	-15.8	9.4
115.0	112.8	31.0	-12.0	28.6	-17.5	25.6
116.0	107.8	40.1	-12.3	38.2	-19.8	34.9
117.0	100.5	45.7	-8.4	44.9	-17.3	42.3
118.0	94.6	49.9	-4.0	49.7	-14.0	47.9
119.0	91.1	54.8	-1.1	54.8	-12.2	53.4
120.0	92.4	58.3	-2.5	58.2	-14.2	56.5
121.0	89.9	54.0	0.1	54.0	-10.8	52.9
122.0	91.4	58.7	-1.4	58.6	-13.2	57.1
123.0	90.6	58.2	-0.6	58.2	-12.4	56.9
124.0	93.0	64.7	-3.3	64.6	-16.3	62.6


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 33 FOUL BAY
17 NOVEMBER 1965 23:15:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

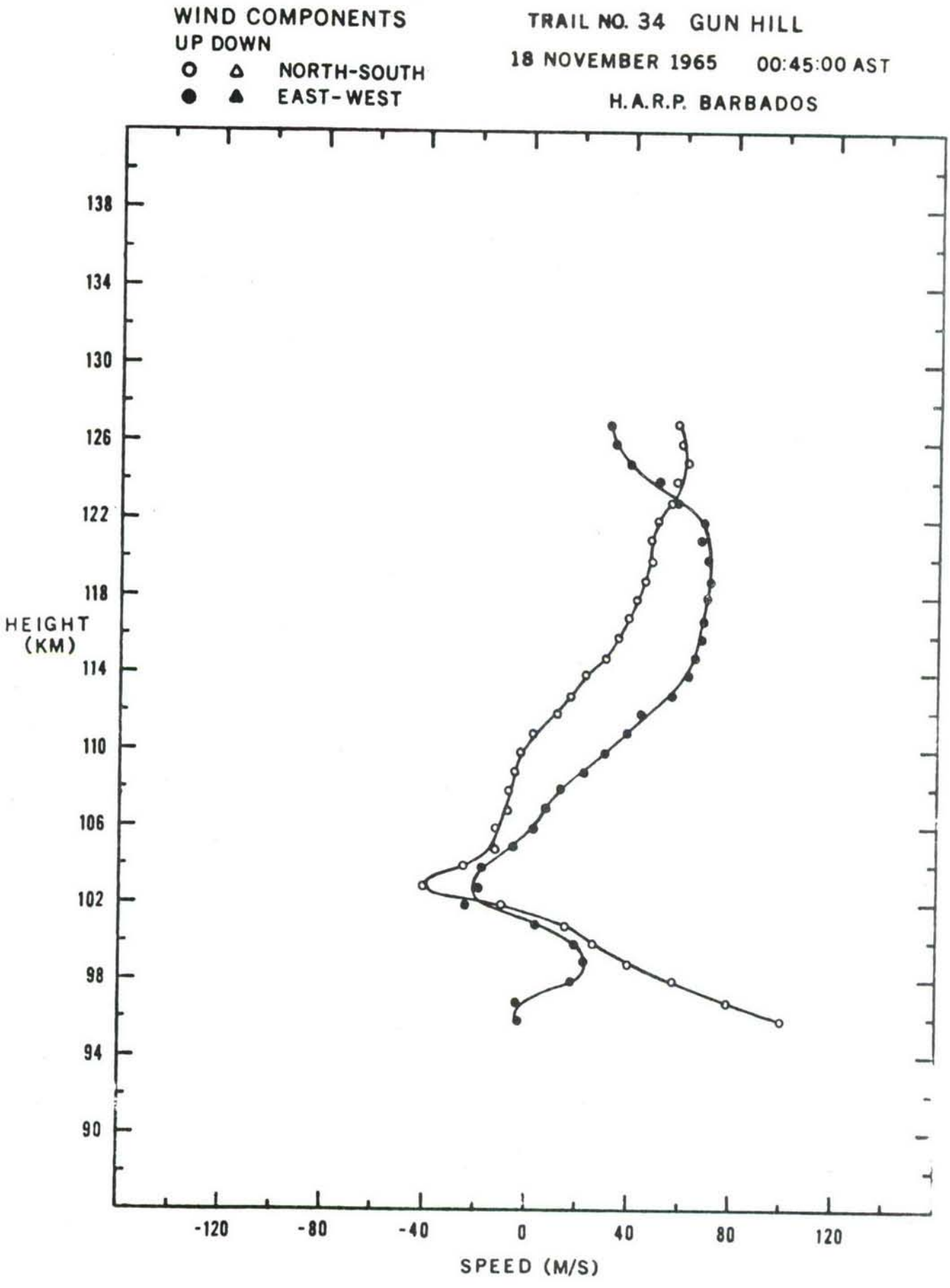

WIND SPEED
TRAIL NO. 33 FOUL BAY
17 NOVEMBER 1965 23:15:00 AST
H.A.R.P. BARBADOS
UP TRAIL
DOWN TRAIL
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
40
80
120
160
SPEED (M/S)

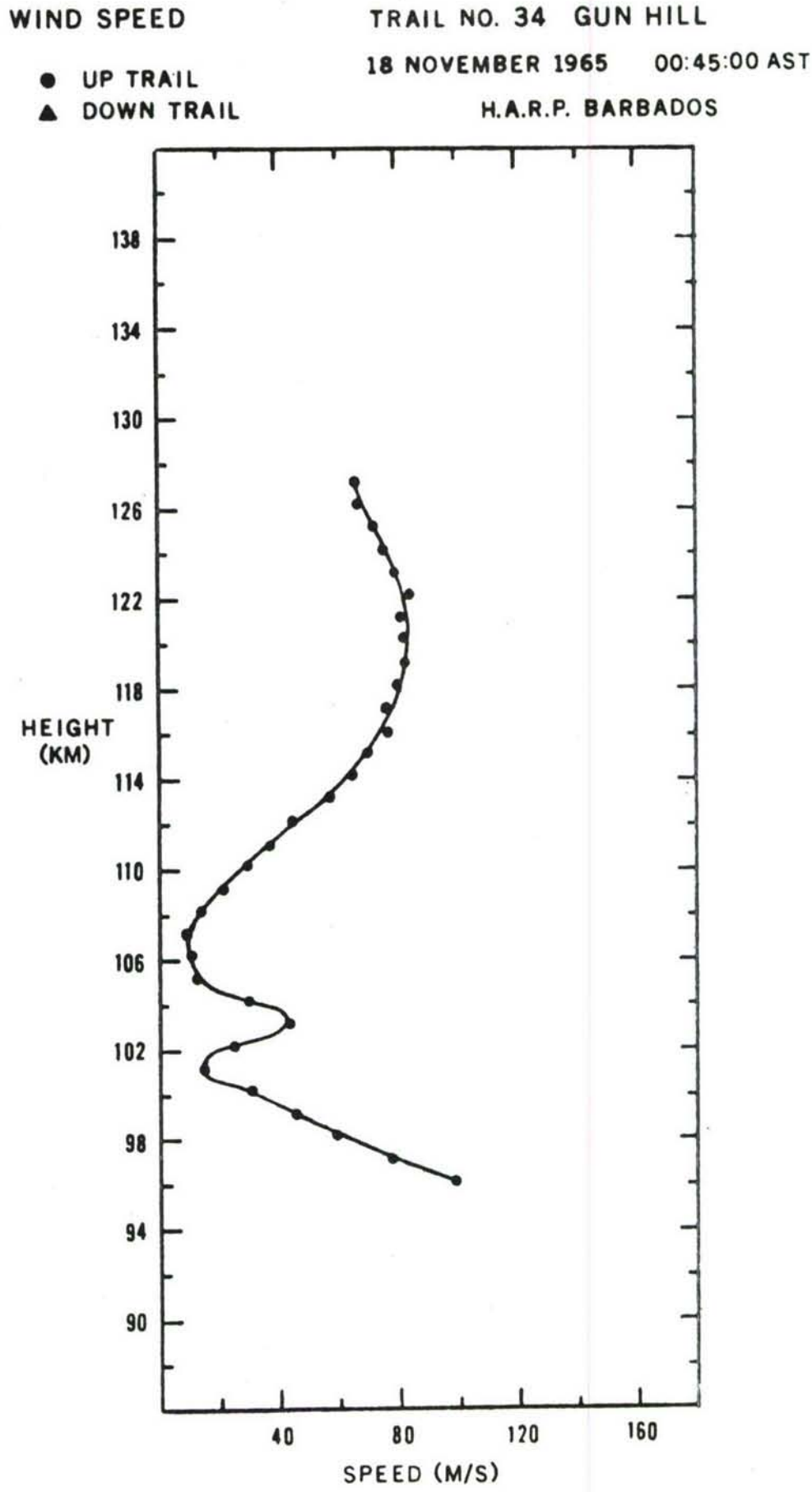

WIND DIRECTION
TRAIL NO. 33 FOUL BAY
17 NOVEMBER 1965 23:15:00 AST
H.A.R.P. BARBADOS
● UP TRAIL
▲ DOWN TRAIL
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
80
160
240
320
40
120
200
DIRECTION (DEG)

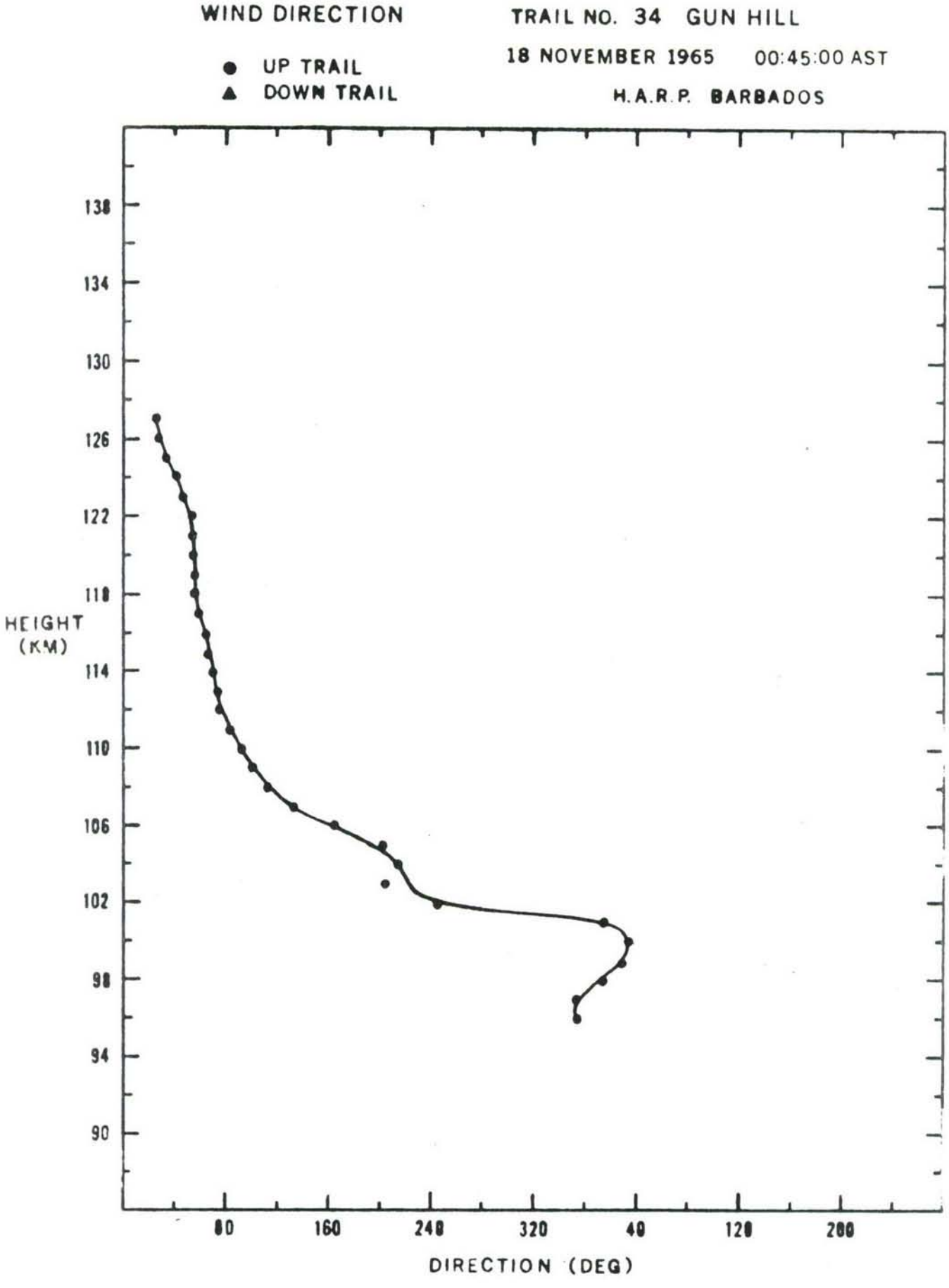
TRAIL NO. 34 GUN HILL

BARBADOS 18 NOVEMBER 1965 00-45-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
96.0	358.5	99.8	99.8	-2.7	98.3	17.5
97.0	357.1	78.4	78.3	-3.9	77.5	12.0
98.0	17.0	60.4	57.8	17.6	53.0	28.9
99.0	30.7	46.5	39.9	23.7	34.3	31.3
100.0	36.0	31.6	25.6	18.6	21.3	23.4
101.0	16.1	15.9	15.2	4.4	14.0	7.4
102.0	247.3	26.0	-10.0	-24.0	-4.9	-25.5
103.0	205.0	44.4	-40.2	-18.7	-35.6	-26.4
104.0	216.0	31.0	-25.0	-18.2	-20.8	-22.9
105.0	203.0	13.9	-12.8	-5.4	-11.4	-7.9
106.0	167.2	11.8	-11.5	2.6	-11.8	0.2
107.0	134.2	10.2	-7.1	7.3	-8.4	5.7
108.0	117.4	14.8	-6.8	13.2	-9.3	11.6
109.0	102.2	22.5	-4.8	22.0	-9.1	20.6
110.0	94.2	30.5	-2.3	30.4	-8.4	29.3
111.0	87.6	38.6	1.6	38.6	-6.2	38.1
112.0	76.1	45.5	11.0	44.2	1.8	45.5
113.0	73.9	58.3	16.2	56.0	4.5	58.1
114.0	70.1	65.6	22.4	61.7	9.5	65.0
115.0	65.7	71.2	29.3	64.9	15.6	69.5
116.0	66.0	85.4	34.7	78.0	18.2	83.4
117.0	60.2	77.0	38.3	66.8	24.0	73.2
118.0	58.5	80.6	42.0	68.7	27.2	75.8
119.0	57.3	83.5	45.1	70.3	30.0	78.0
120.0	55.9	83.2	46.6	68.9	31.7	76.9
121.0	54.5	81.9	47.6	66.7	33.1	74.9
122.0	53.3	85.0	50.8	68.1	36.0	77.0
123.0	46.8	80.0	54.8	58.3	41.9	68.2
124.0	41.5	76.2	57.0	50.5	45.6	61.0
125.0	32.3	73.3	61.9	39.2	52.7	50.9
126.0	29.1	67.6	59.1	32.9	51.2	44.2
127.0	28.2	66.2	58.3	31.2	50.8	42.3


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 34 GUN HILL
18 NOVEMBER 1965 00:45:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

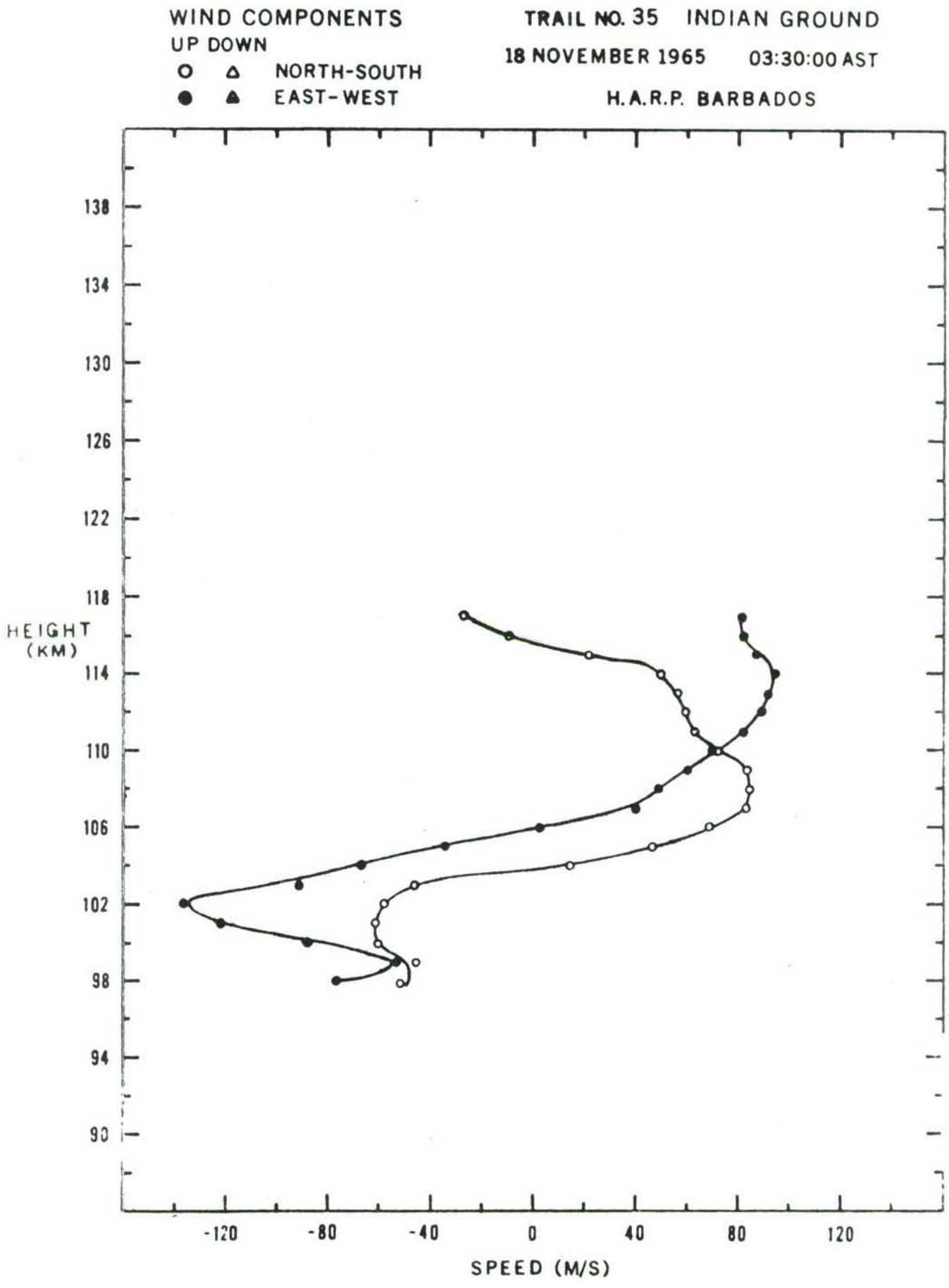

WIND SPEED
TRAIL NO. 34 GUN HILL
18 NOVEMBER 1965 00:45:00 AST
● UP TRAIL
▲ DOWN TRAIL
H.A.R.P. BARBADOS
138
134
130
126
122
118
HEIGHT (KM)
114
110
106
102
98
94
90
40
80
120
160
SPEED (M/S)

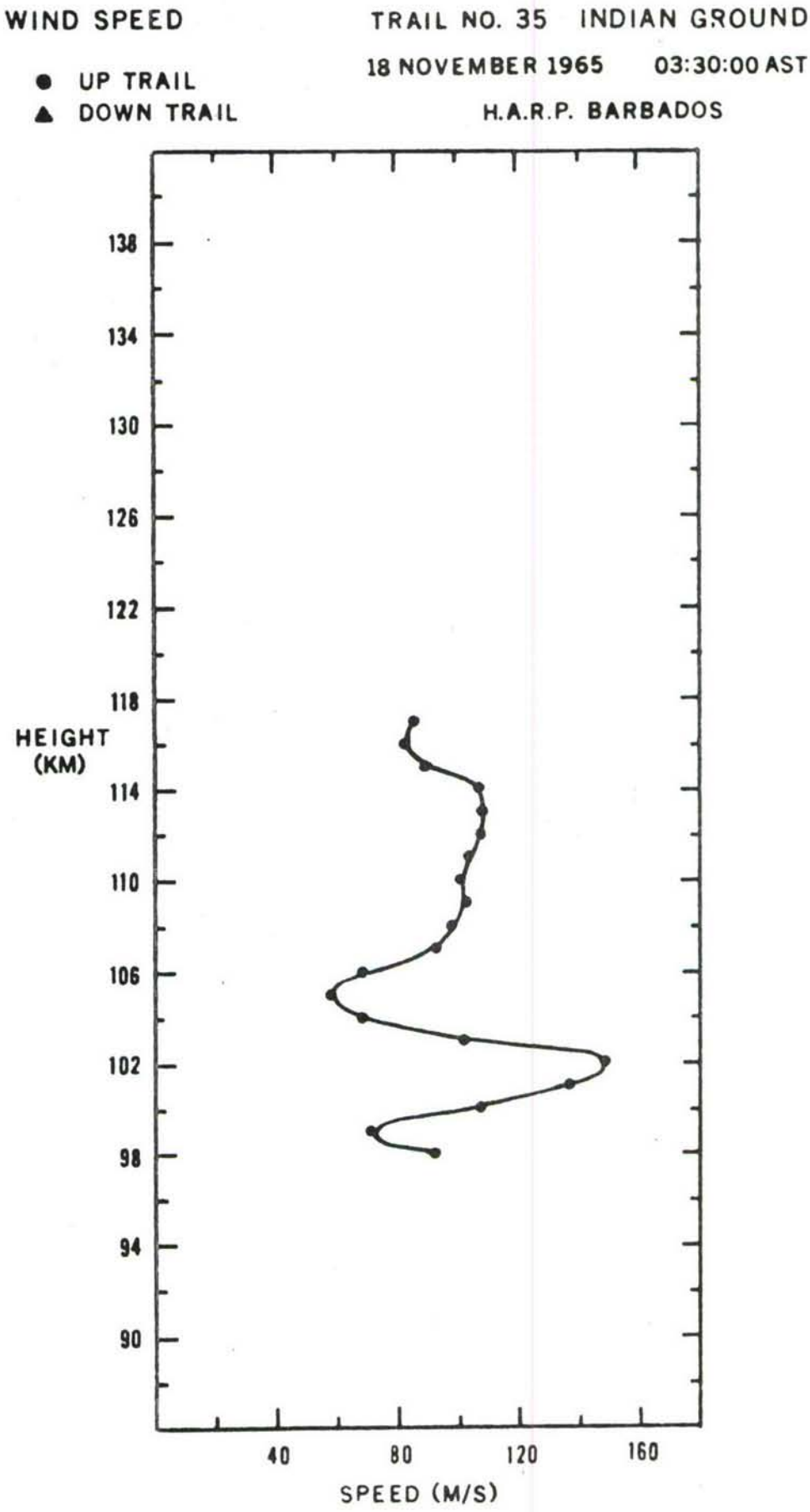

WIND DIRECTION
TRAIL NO. 34 GUN HILL
18 NOVEMBER 1965 00:45:00 AST
H.A.R.P. BARBADOS
UP TRAIL
DOWN TRAIL
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
80
160
240
320
40
120
200
DIRECTION (DEG)

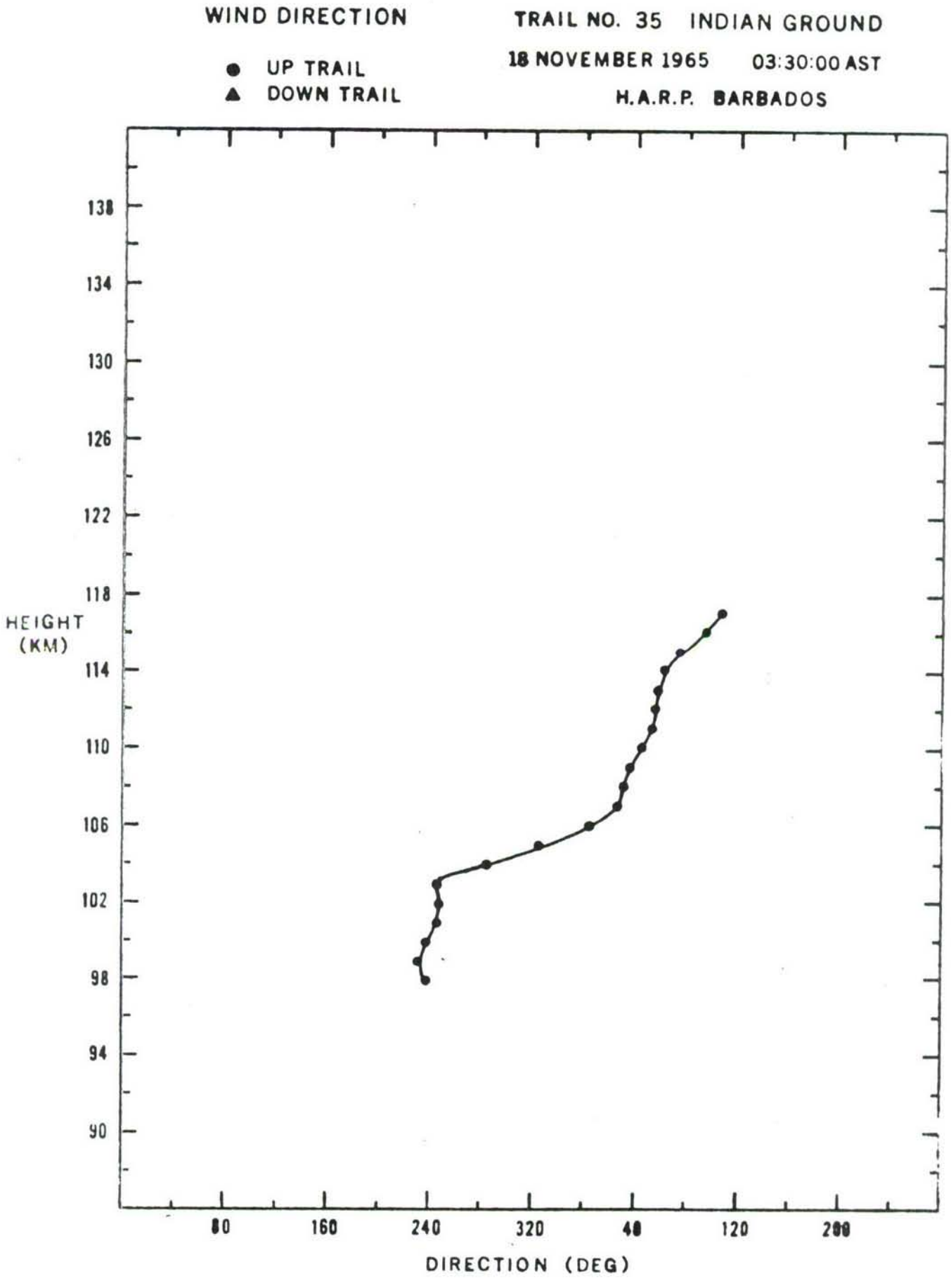
TRAIL NO. 35 INDIAN GROUND

BARBADOS 18 NOVEMBER 1965 03-30-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
98.0	236.0	92.1	-51.5	-76.3	-35.0	-85.1
99.0	229.6	70.8	-45.9	-53.9	-34.1	-62.1
100.0	235.6	106.5	-60.2	-87.8	-41.2	-98.2
101.0	243.1	136.1	-61.7	-121.3	-35.9	-131.3
102.0	246.9	148.1	-58.0	-136.2	-29.3	-145.1
103.0	243.0	101.6	-46.2	-90.8	-26.9	-98.3
104.0	282.5	68.3	14.7	-66.7	27.9	-62.3
105.0	323.6	57.8	46.5	-34.3	52.5	-24.2
106.0	2.3	68.5	68.5	2.7	66.5	16.5
107.0	25.8	92.4	83.2	40.2	73.4	56.2
108.0	30.1	97.4	84.2	48.9	72.6	64.9
109.0	36.2	102.8	83.0	60.8	69.0	76.3
110.0	44.1	100.4	72.1	69.9	56.5	83.0
111.0	52.2	103.7	63.6	81.9	45.7	93.1
112.0	56.2	107.2	59.6	89.1	40.4	99.3
113.0	58.5	107.6	56.3	91.8	36.6	101.3
114.0	62.0	106.5	49.9	94.1	29.8	102.2
115.0	75.9	89.2	21.7	86.5	3.8	89.1
116.0	96.8	82.6	-9.8	82.0	-26.2	78.4
117.0	108.8	85.8	-27.7	81.2	-43.5	73.9


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 35 INDIAN GROUND
18 NOVEMBER 1965 03:30:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

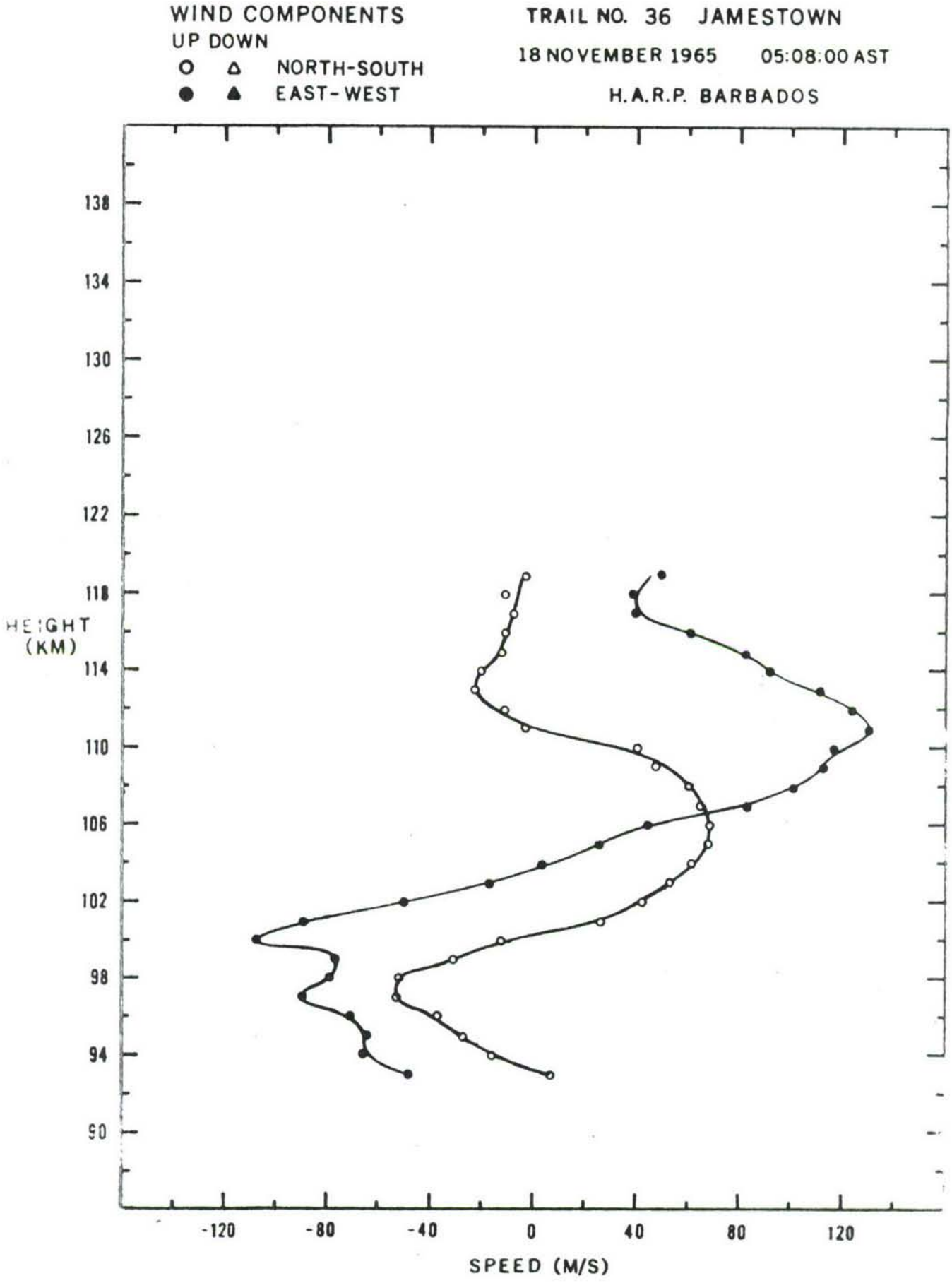

WIND SPEED
TRAIL NO. 35 INDIAN GROUND
18 NOVEMBER 1965 03:30:00 AST
H.A.R.P. BARBADOS
● UP TRAIL
▲ DOWN TRAIL
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
40
80
120
160
SPEED (M/S)


WIND DIRECTION
TRAIL NO. 35 INDIAN GROUND
18 NOVEMBER 1965 03:30:00 AST
H.A.R.P. BARBADOS
UP TRAIL
DOWN TRAIL
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
80
160
240
320
40
120
200
DIRECTION (DEG)

TRAIL NO. 36 JAMESTOWN

BARBADOS 18 NOVEMBER 1965 05-08-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
93.0	278.0	49.0	6.9	-48.5	16.6	-46.1
94.0	256.3	68.1	-16.2	-66.2	-2.5	-68.1
95.0	247.4	70.4	-27.1	-65.0	-13.4	-69.1
96.0	241.6	80.7	-38.4	-71.0	-23.2	-77.3
97.0	239.4	104.9	-53.4	-90.3	-34.0	-99.2
98.0	236.4	95.3	-52.7	-79.4	-35.6	-88.4
99.0	248.1	83.3	-31.1	-77.3	-14.8	-82.0
100.0	263.4	109.2	-12.5	-108.5	9.7	-108.8
101.0	286.3	93.5	26.3	-89.7	43.9	-82.3
102.0	309.7	65.9	42.1	-50.7	51.5	-41.1
103.0	343.0	56.1	53.6	-16.4	55.8	-5.2
104.0	3.4	61.3	61.2	3.6	59.2	15.9
105.0	20.6	72.8	68.1	25.6	61.5	38.8
106.0	32.9	81.6	68.5	44.4	58.1	57.3
107.0	51.9	105.5	65.0	83.0	46.9	94.4
108.0	59.2	117.7	60.2	101.1	38.5	111.2
109.0	66.9	122.0	47.9	112.3	24.2	119.7
110.0	70.9	123.4	40.4	116.6	16.0	122.4
111.0	91.7	130.5	-3.9	130.4	-30.2	126.9
112.0	95.2	124.5	-11.3	124.0	-36.1	119.2
113.0	101.6	113.9	-22.9	111.6	-45.0	104.7
114.0	102.5	93.9	-20.2	91.7	-38.3	85.7
115.0	98.9	83.5	-12.8	82.5	-29.2	78.2
116.0	100.8	61.5	-11.5	60.4	-23.5	56.8
117.0	101.3	40.2	-7.9	39.4	-15.7	37.0
118.0	106.2	40.3	-11.2	38.7	-18.8	35.6
119.0	94.4	49.5	-3.8	49.3	-13.7	47.3


WIND COMPONENTS
UP DOWN
O Δ NORTH-SOUTH
● ▲ EAST-WEST
TRAIL NO. 36 JAMESTOWN
18 NOVEMBER 1965 05:08:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

WIND SPEED

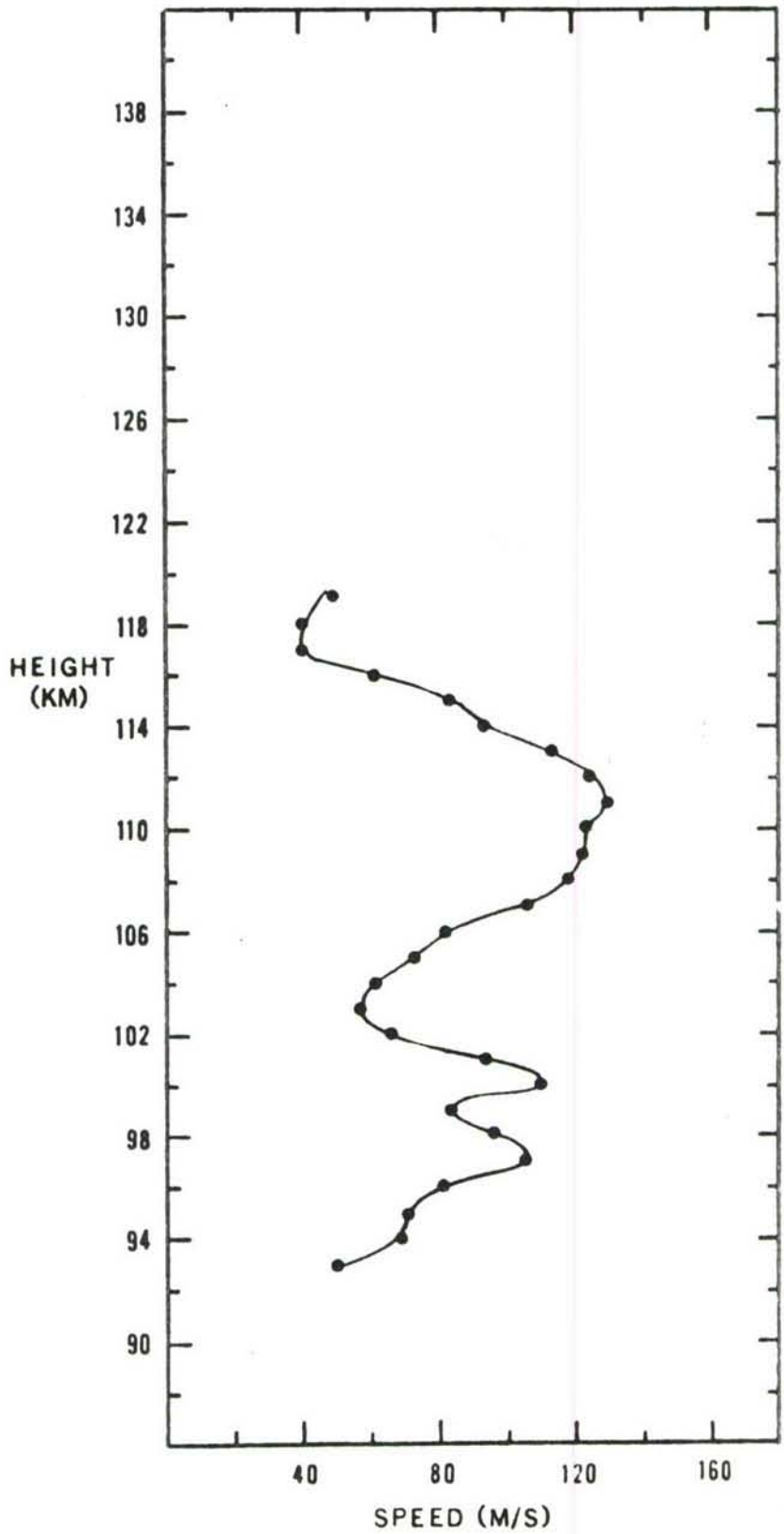
TRAIL NO. 36 JAMESTOWN

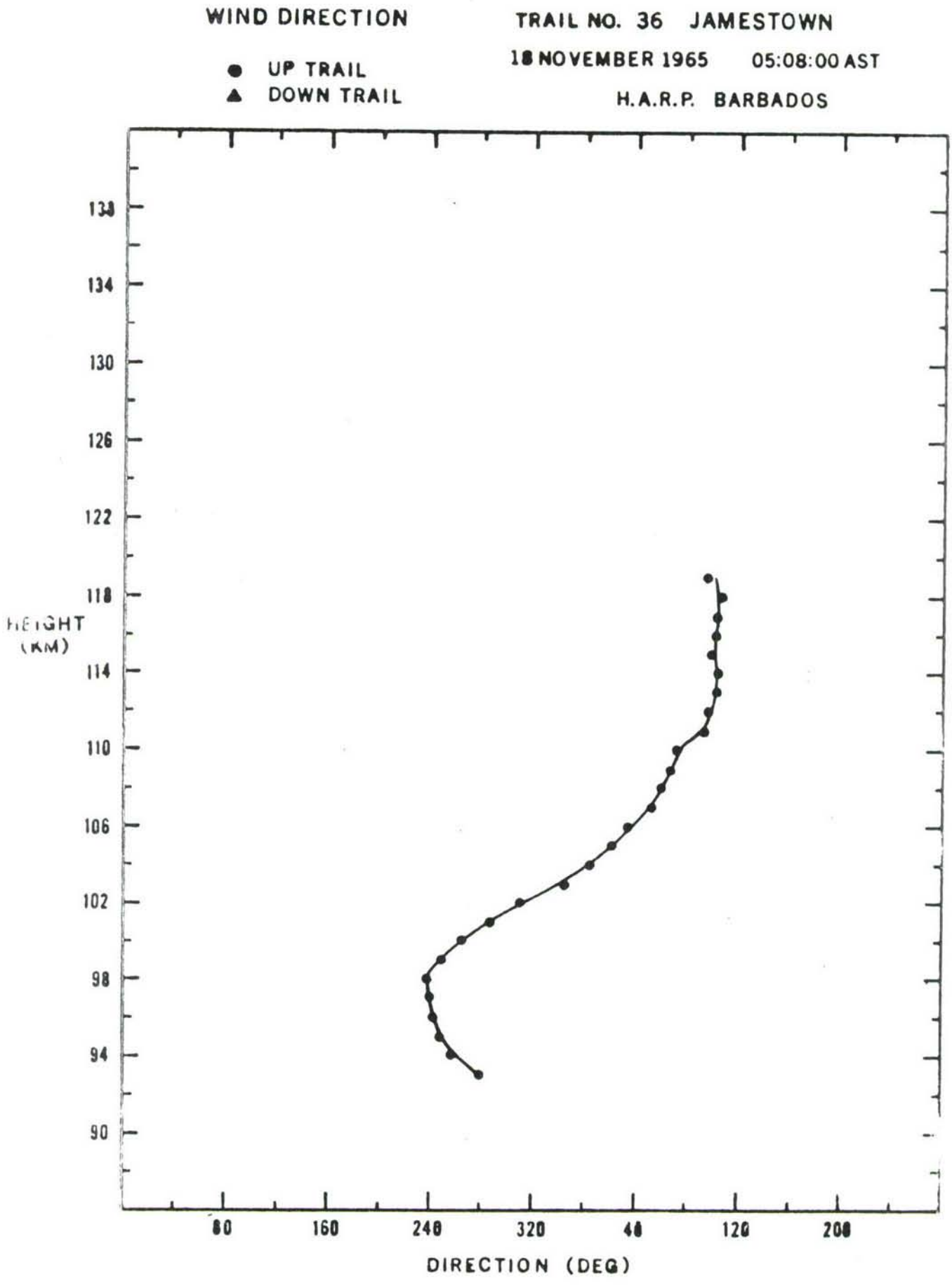
18 NOVEMBER 1965 05:08:00 AST

● UP TRAIL

▲ DOWN TRAIL

H.A.R.P. BARBADOS

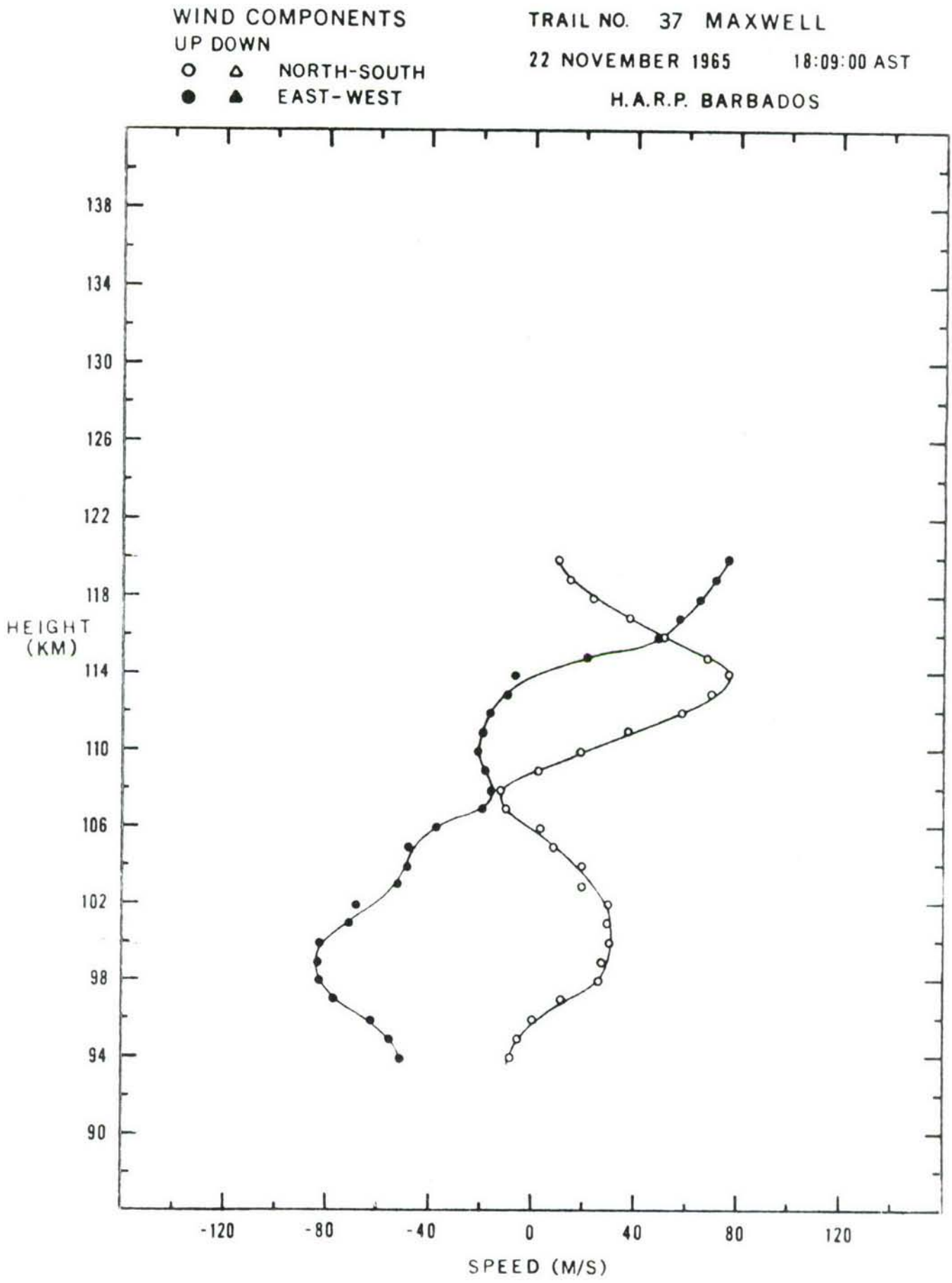


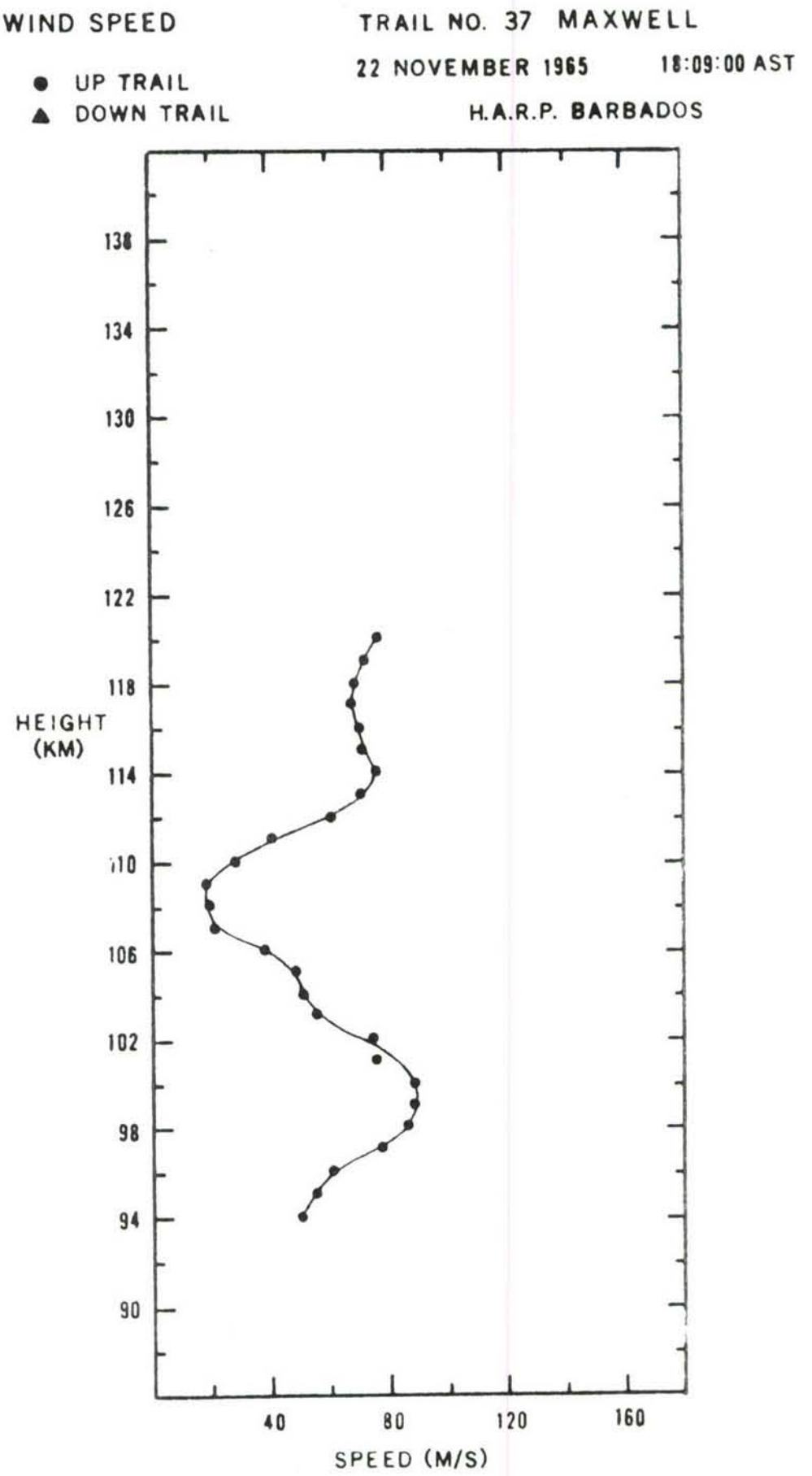

WIND DIRECTION
TRAIL NO. 36 JAMESTOWN
18 NOVEMBER 1965 05:08:00 AST
H.A.R.P. BARBADOS
● UP TRAIL
▲ DOWN TRAIL
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
80
160
240
320
40
120
200
DIRECTION (DEG)

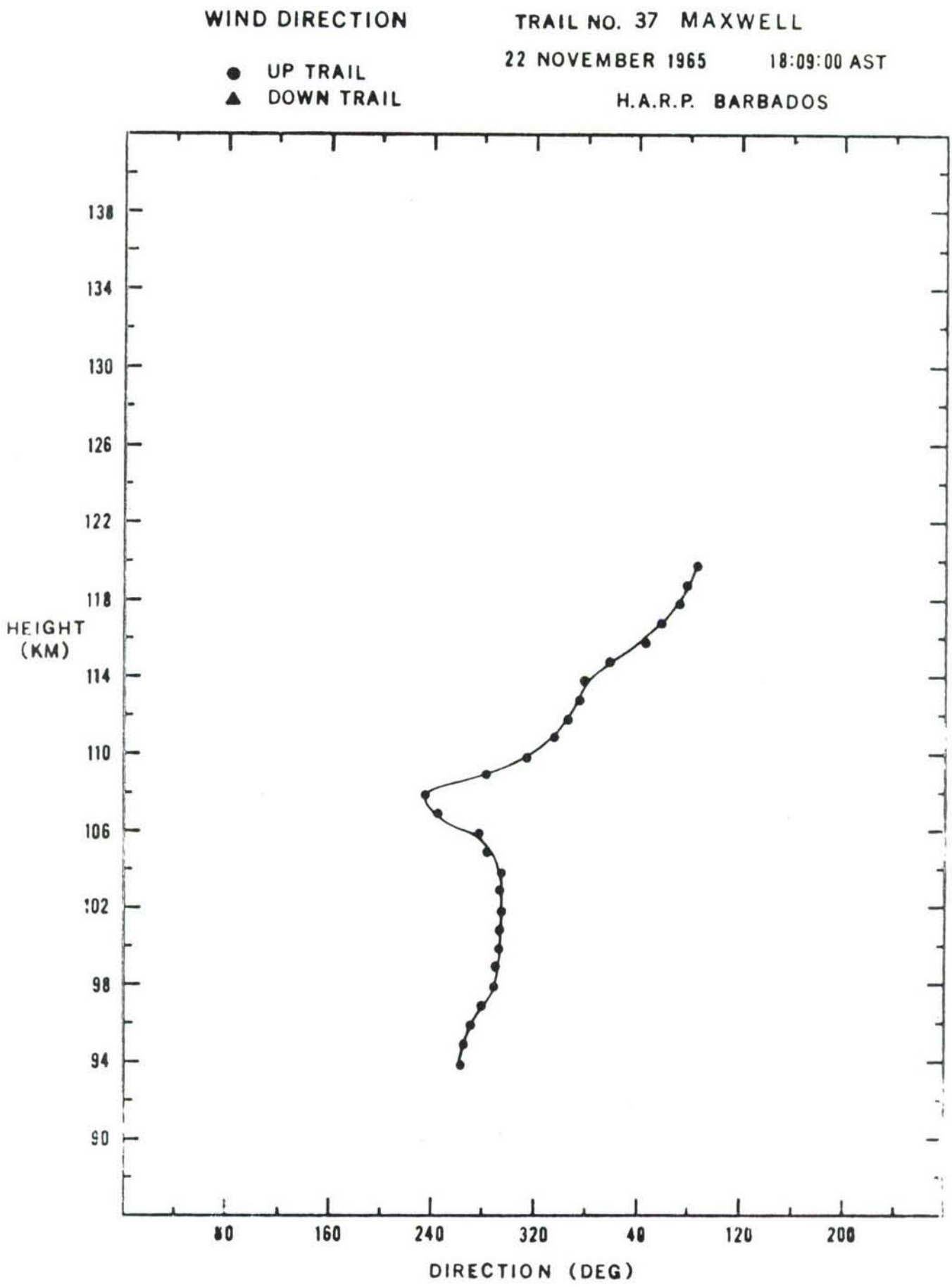
TRAIL NO. 37 MAXWELL

BARBADOS 22 NOVEMBER 1965 18-09-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
94.0	261.4	51.7	-7.8	-51.1	2.7	-51.6
95.0	264.9	55.5	-5.0	-55.2	6.3	-55.1
96.0	270.6	62.7	0.7	-62.6	13.3	-61.2
97.0	278.8	78.3	12.0	-77.4	27.4	-73.4
98.0	287.6	86.6	26.2	-82.6	42.4	-75.6
99.0	288.0	88.3	27.3	-84.0	43.7	-76.7
100.0	290.4	88.6	30.9	-83.0	47.0	-75.0
101.0	292.4	76.4	29.2	-70.7	42.9	-63.3
102.0	293.7	74.8	30.0	-68.5	43.2	-61.0
103.0	290.9	55.7	19.8	-52.1	29.9	-47.0
104.0	292.4	52.5	20.0	-48.6	29.4	-43.6
105.0	280.6	49.3	9.1	-48.5	18.7	-45.7
106.0	275.5	37.5	3.6	-37.3	11.1	-35.8
107.0	242.7	21.4	-9.8	-19.0	-5.8	-20.6
108.0	232.8	20.4	-12.3	-16.2	-8.8	-18.4
109.0	280.1	19.0	3.3	-18.7	7.0	-17.6
110.0	311.5	28.8	19.1	-21.6	23.1	-17.3
111.0	332.9	42.1	37.5	-19.2	40.6	-11.2
112.0	344.2	60.5	58.2	-16.5	60.3	-4.4
113.0	352.5	70.6	70.0	-9.4	70.5	4.9
114.0	355.5	76.8	76.6	-6.1	76.3	9.5
115.0	17.2	72.1	68.8	21.3	63.1	34.8
116.0	43.6	71.1	51.5	49.1	40.5	58.5
117.0	56.7	68.7	37.7	57.4	25.3	63.8
118.0	69.8	69.5	24.0	65.2	10.3	68.7
119.0	78.4	72.6	14.6	71.2	-0.1	72.7
120.0	82.6	76.8	9.9	76.2	-5.7	76.6


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 37 MAXWELL
22 NOVEMBER 1965 18:09:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

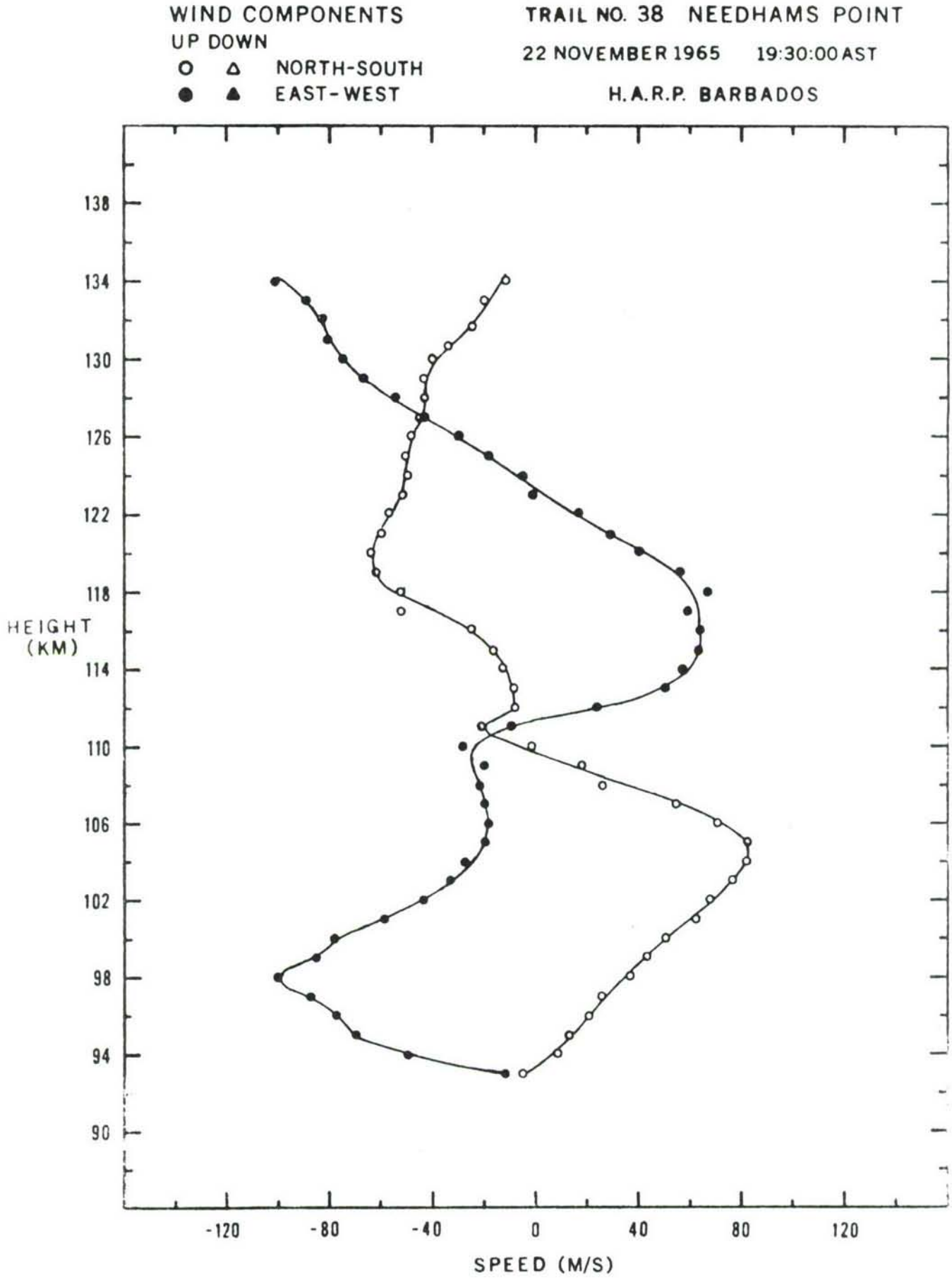

WIND SPEED
TRAIL NO. 37 MAXWELL
22 NOVEMBER 1965 18:09:00 AST
● UP TRAIL
▲ DOWN TRAIL
H.A.R.P. BARBADOS
138
134
130
126
122
118
HEIGHT (KM)
114
110
106
102
98
94
90
40
80
120
160
SPEED (M/S)


WIND DIRECTION
TRAIL NO. 37 MAXWELL
22 NOVEMBER 1965 18:09:00 AST
● UP TRAIL
▲ DOWN TRAIL
H.A.R.P. BARBADOS
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
80
160
240
320
40
120
200
DIRECTION (DEG)

TRAIL NO. 38 NEEDHAM'S POINT

BARBADOS 22 NOVEMBER 1965 19-30-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
93.0	247.4	13.0	-5.0	-12.0	-2.5	-12.8
94.0	279.7	50.7	8.5	-49.9	18.4	-47.2
95.0	281.4	71.4	14.1	-70.0	28.0	-65.7
96.0	285.0	80.4	20.8	-77.6	36.1	-71.8
97.0	286.3	91.2	25.7	-87.5	42.9	-80.5
98.0	289.7	107.1	36.0	-100.9	55.7	-91.5
99.0	296.4	95.6	42.6	-85.6	59.0	-75.2
100.0	302.8	93.2	50.5	-78.4	65.3	-66.6
101.0	316.2	85.4	61.6	-59.1	72.3	-45.4
102.0	326.6	80.4	67.1	-44.3	74.7	-29.8
103.0	336.6	82.9	76.0	-33.0	81.1	-16.9
104.0	341.0	85.7	81.1	-27.9	85.1	-10.9
105.0	346.0	84.0	81.5	-20.3	83.9	-3.4
106.0	345.5	73.0	70.7	-18.2	72.9	-3.5
107.0	339.7	57.9	54.3	-20.1	57.2	-8.7
108.0	319.0	33.8	25.5	-22.2	29.5	-16.6
109.0	310.6	27.1	17.7	-20.6	21.5	-16.6
110.0	266.7	28.2	-1.6	-28.1	4.1	-27.8
111.0	205.6	23.4	-21.1	-10.1	-18.6	-14.2
112.0	109.8	25.0	-8.5	23.5	-13.1	21.3
113.0	100.0	50.6	-8.8	49.9	-18.7	47.1
114.0	103.0	58.2	-13.1	56.7	-24.3	52.9
115.0	104.8	65.0	-16.6	62.9	-29.0	58.2
116.0	112.1	68.5	-25.8	63.5	-38.1	57.0
117.0	132.1	78.6	-52.7	58.3	-63.4	46.4
118.0	128.8	84.6	-53.0	66.0	-65.3	53.9
119.0	138.2	83.9	-62.6	55.9	-72.6	42.1
120.0	148.6	75.1	-64.1	39.1	-70.7	25.3
121.0	155.0	66.7	-60.5	28.2	-65.0	15.4
122.0	164.3	59.3	-57.1	16.0	-59.2	4.1
123.0	182.3	52.4	-52.3	-2.1	-50.8	-12.6
124.0	185.9	50.9	-50.7	-5.2	-48.6	-15.3
125.0	199.9	54.5	-51.2	-18.6	-46.4	-28.6
126.0	212.5	57.0	-48.1	-30.7	-40.9	-39.8
127.0	224.3	62.9	-45.0	-43.9	-35.2	-52.1
128.0	232.2	70.1	-43.0	-55.4	-30.9	-63.0
129.0	236.6	80.4	-44.3	-67.2	-29.8	-74.8
130.0	242.0	85.6	-40.2	-75.6	-24.1	-82.2
131.0	247.2	87.8	-34.0	-81.0	-16.9	-86.2
132.0	253.6	86.9	-24.5	-83.4	-7.1	-86.6
133.0	256.9	91.9	-20.9	-89.5	-2.4	-91.9
134.0	263.3	102.2	-12.0	-101.5	8.8	-101.8


WIND COMPONENTS
UP DOWN
O △ NORTH-SOUTH
● ▲ EAST-WEST
TRAIL NO. 38 NEEDHAMS POINT
22 NOVEMBER 1965 19:30:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

WIND SPEED

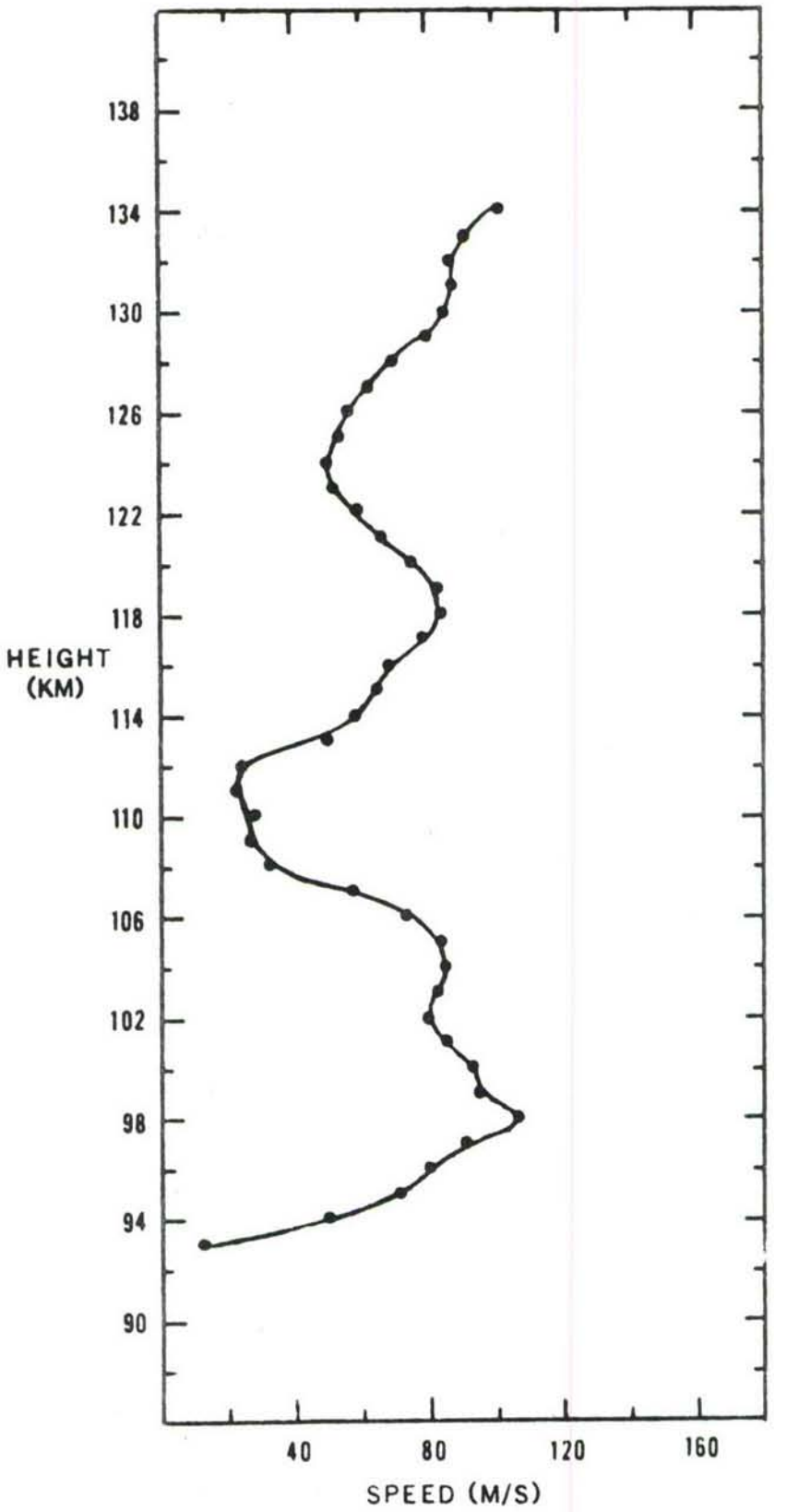
TRAIL NO. 38 NEEDHAMS POINT

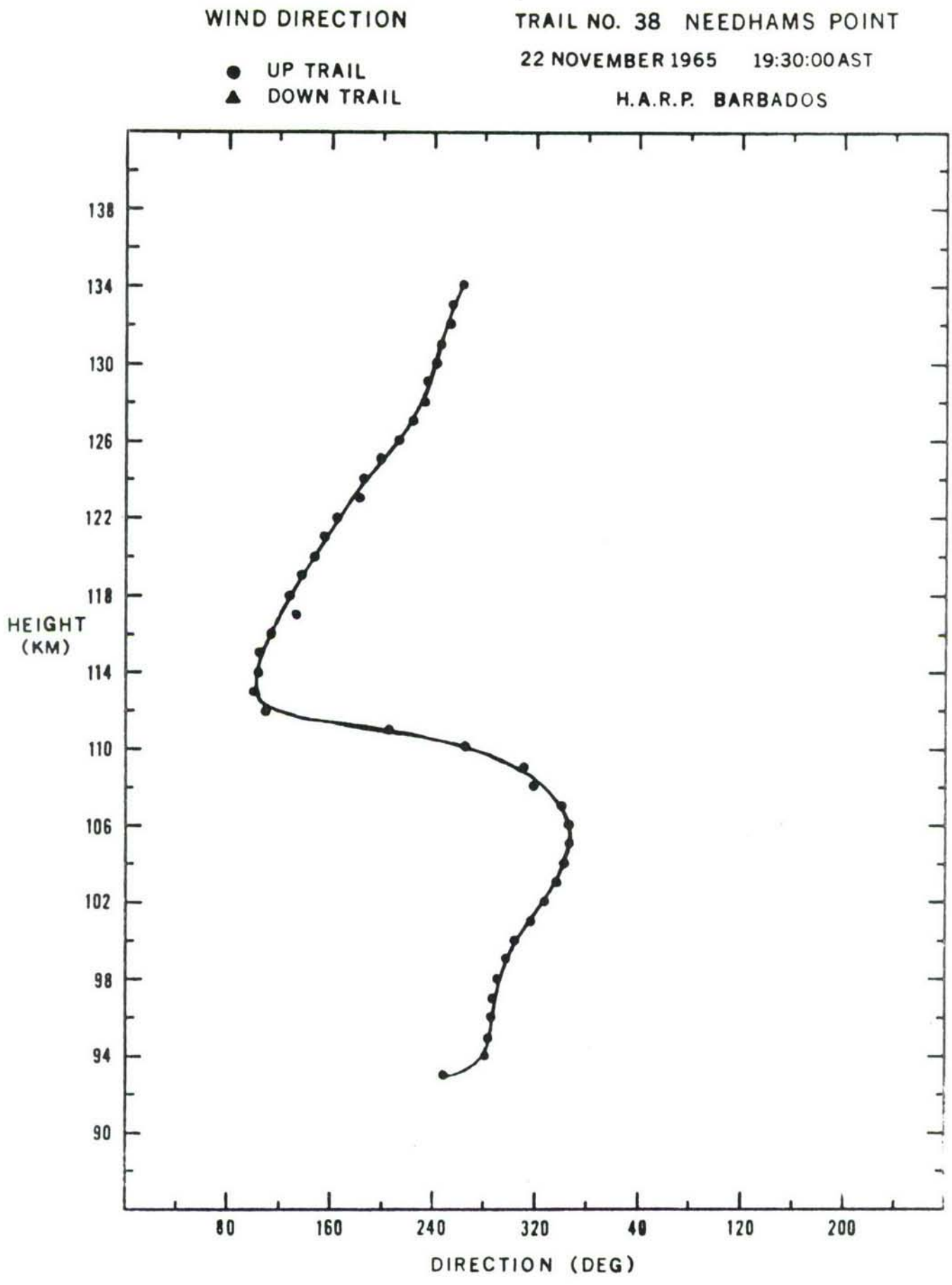
22 NOVEMBER 1965 19:30:00 AST

● UP TRAIL

▲ DOWN TRAIL

H.A.R.P. BARBADOS

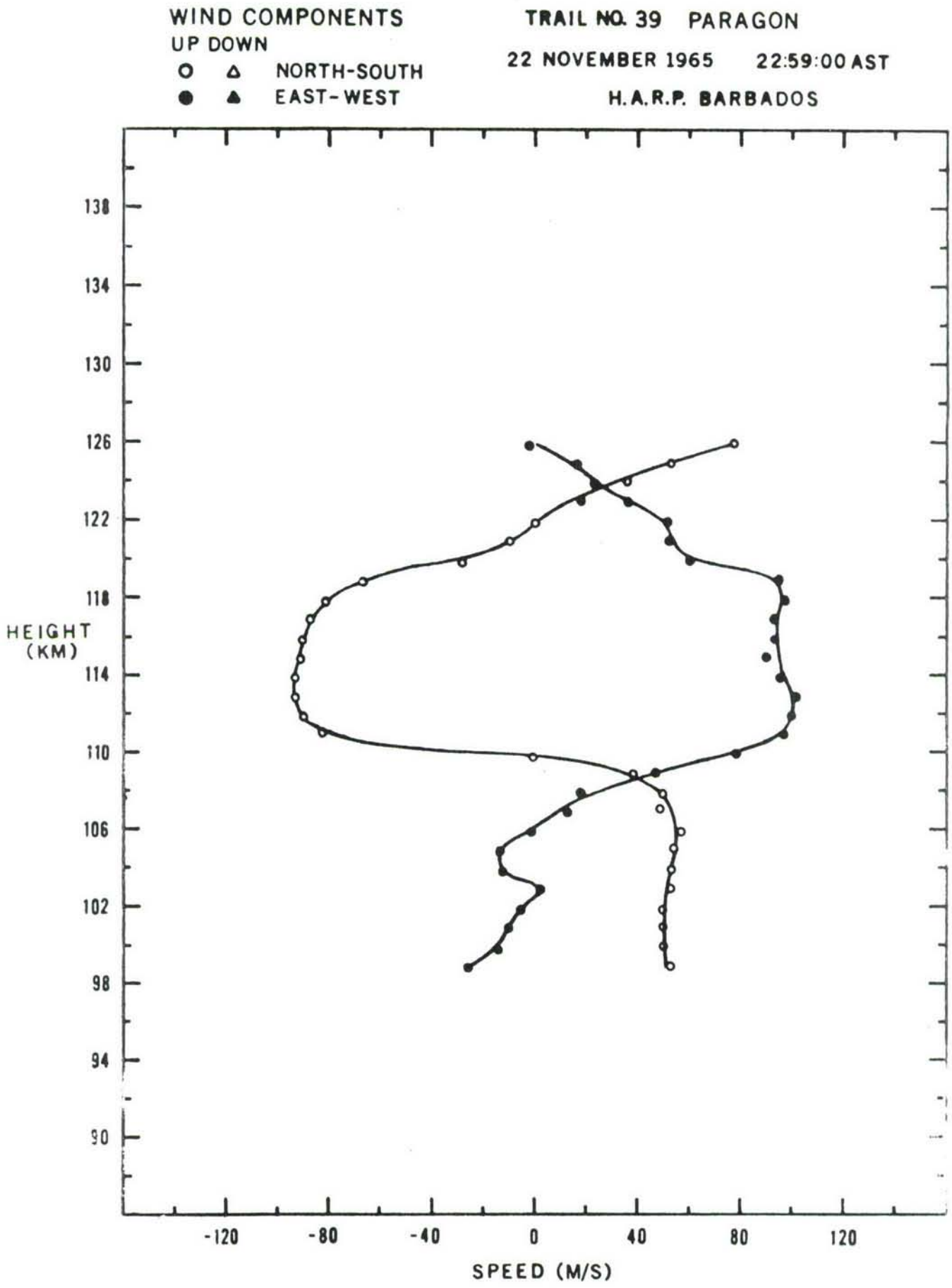



WIND DIRECTION
● UP TRAIL
▲ DOWN TRAIL
TRAIL NO. 38 NEEDHAMS POINT
22 NOVEMBER 1965 19:30:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
80
160
240
320
40
120
200
DIRECTION (DEG)

TRAIL NO. 39 PARAGON

BARBADOS 22 NOVEMBER 1965 22-59-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
99.0	334.1	59.0	53.0	-25.8	57.1	-14.5
100.0	344.3	52.9	50.9	-14.3	52.7	-3.7
101.0	349.4	51.6	50.7	-9.5	51.6	0.9
102.0	354.3	50.6	50.3	-5.0	50.3	5.3
103.0	3.3	53.1	53.0	3.0	51.3	13.7
104.0	348.3	55.1	54.0	-11.2	55.1	0.0
105.0	346.8	56.4	54.9	-12.9	56.4	-1.5
106.0	358.7	57.6	57.5	-1.3	56.6	10.4
107.0	15.6	49.9	48.1	13.5	44.4	22.9
108.0	19.9	53.4	50.2	18.2	45.5	28.0
109.0	51.5	60.6	37.7	47.4	27.3	54.0
110.0	90.0	78.7	0.0	78.7	-15.9	77.1
111.0	130.0	126.7	-81.4	97.1	-99.4	78.6
112.0	131.3	133.6	-88.1	100.4	-106.6	80.5
113.0	132.2	137.9	-92.7	102.1	-111.4	81.2
114.0	134.2	133.1	-92.7	95.5	-110.1	74.8
115.0	135.0	129.0	-91.2	91.1	-107.7	70.8
116.0	133.2	130.1	-89.2	94.8	-106.5	74.8
117.0	132.4	128.5	-86.7	94.9	-104.1	75.4
118.0	129.2	126.6	-80.0	98.1	-98.2	79.9
119.0	124.6	116.2	-66.0	95.7	-84.0	80.4
120.0	114.2	66.7	-27.4	60.8	-39.1	54.0
121.0	98.6	54.3	-8.2	53.7	-18.9	50.9
122.0	89.2	53.4	0.8	53.4	-10.0	52.5
123.0	64.8	41.5	17.7	37.5	9.8	40.3
124.0	33.8	44.4	37.0	24.7	31.2	31.7
125.0	18.9	56.7	53.7	18.4	48.9	28.9
126.0	358.8	78.9	78.9	-1.7	77.6	14.3


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 39 PARAGON
22 NOVEMBER 1965 22:59:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

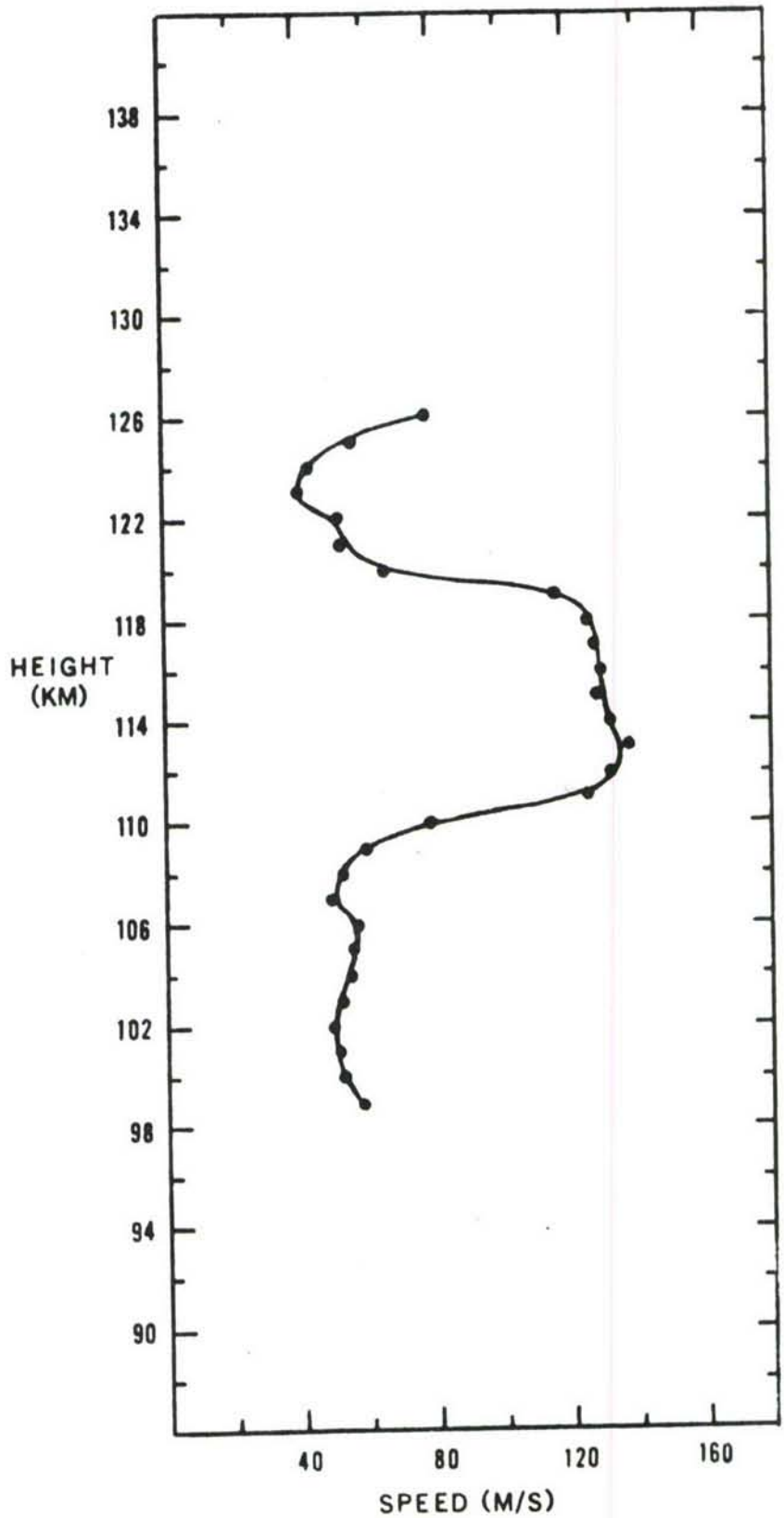
WIND SPEED

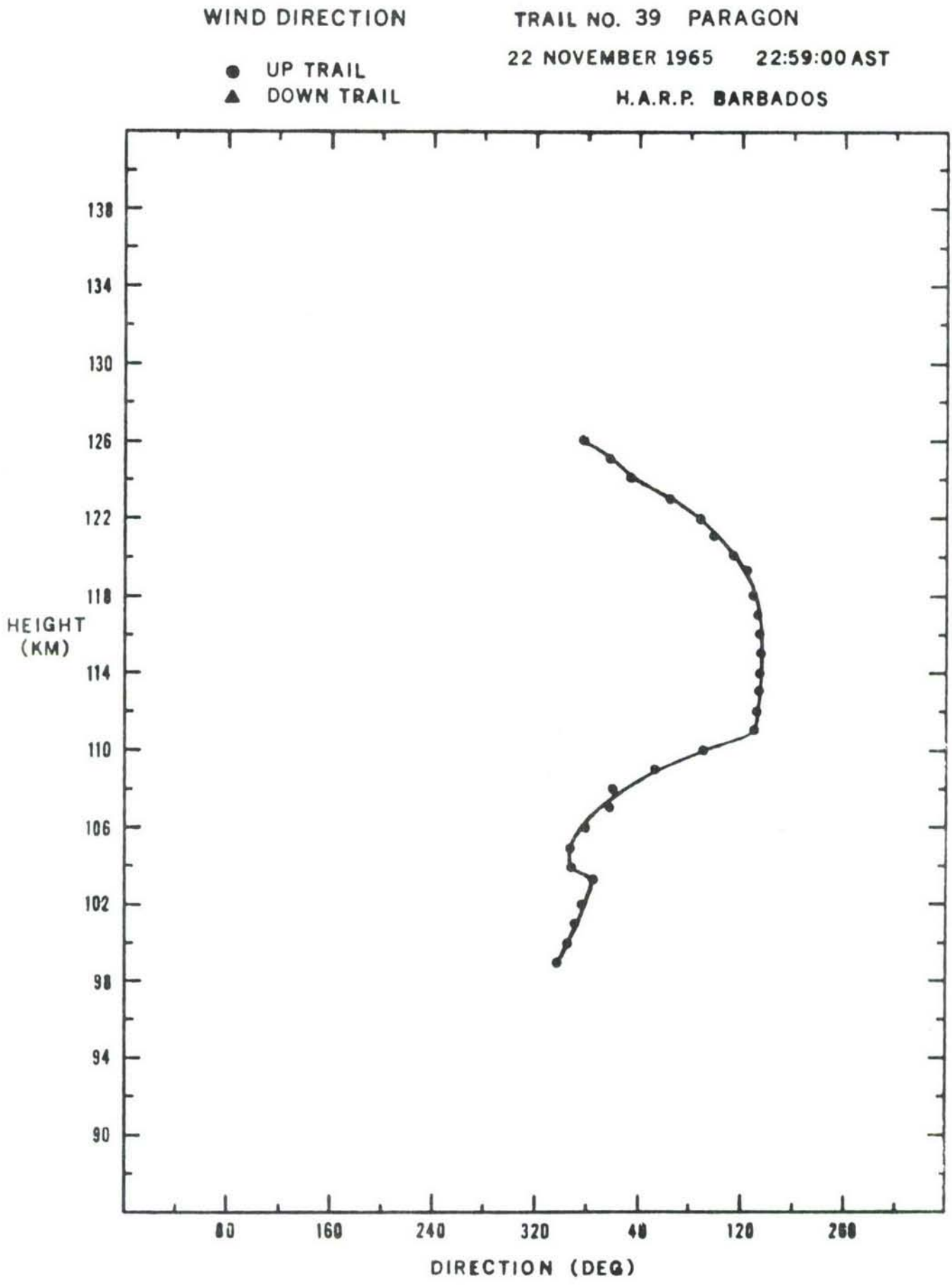
TRAIL NO. 39 PARAGON

22 NOVEMBER 1965 22:59:00 AST

● UP TRAIL
▲ DOWN TRAIL

H.A.R.P. BARBADOS

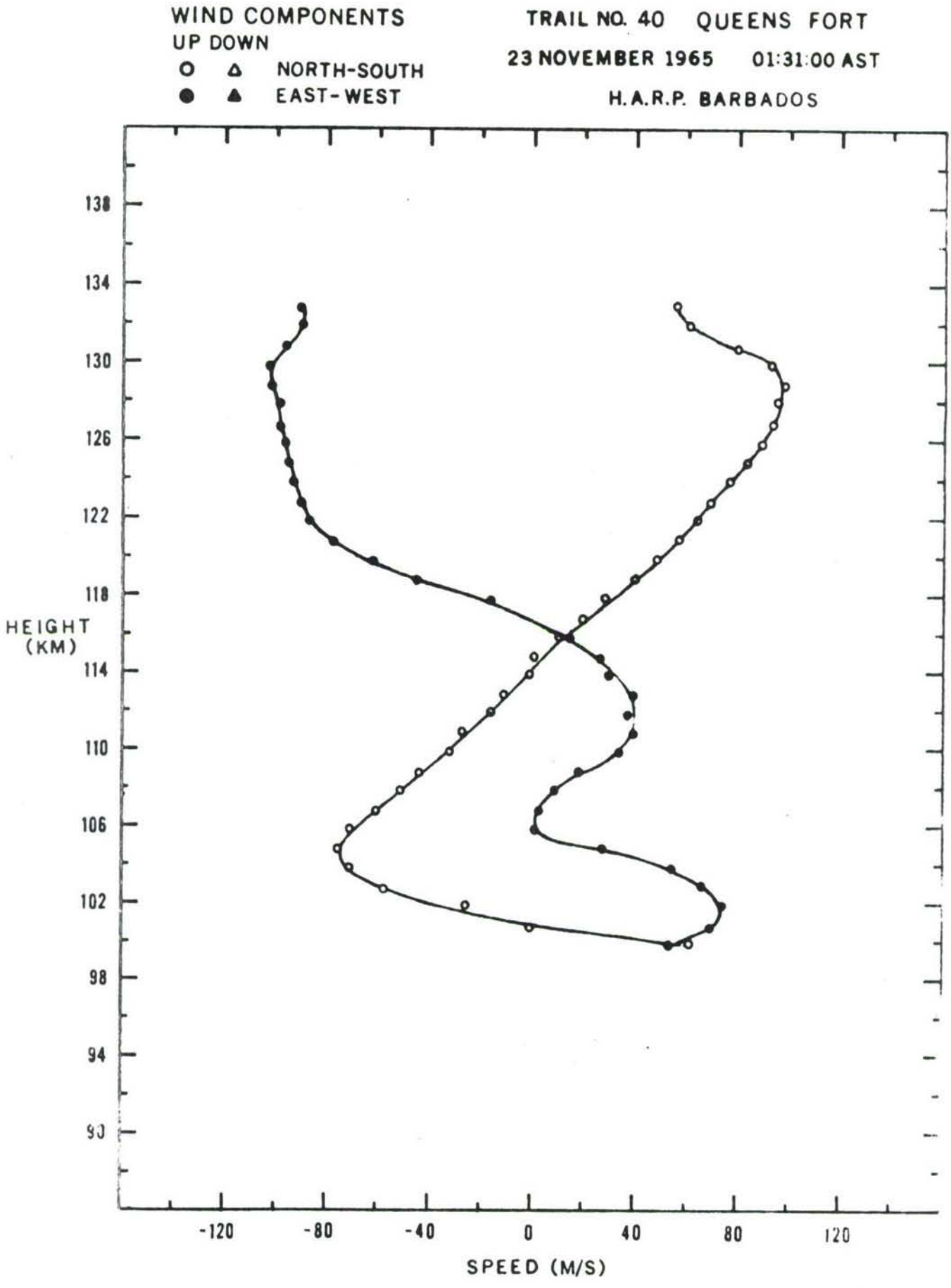



WIND DIRECTION
TRAIL NO. 39 PARAGON
22 NOVEMBER 1965 22:59:00 AST
UP TRAIL
DOWN TRAIL
H.A.R.P. BARBADOS
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
80
160
240
320
40
120
200
DIRECTION (DEG)

TRAIL NO. 40 QUEEN S FORT

BARBADOS 23 NOVEMBER 1965 01-31-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
100.0	41.0	78.9	59.6	51.8	47.9	62.8
101.0	91.3	68.1	-1.5	68.1	-15.2	66.4
102.0	110.8	76.4	-27.1	71.5	-41.0	64.5
103.0	132.9	86.9	-59.2	63.6	-70.8	50.3
104.0	144.5	90.3	-73.5	52.4	-82.6	36.5
105.0	161.3	81.6	-77.2	26.2	-80.9	10.0
106.0	180.3	72.4	-72.4	-0.3	-70.8	-14.9
107.0	179.4	63.3	-63.3	0.7	-62.1	-12.1
108.0	172.8	54.2	-53.8	6.8	-54.1	-4.2
109.0	159.4	49.4	-46.3	17.4	-48.9	7.7
110.0	136.3	46.8	-33.8	32.3	-39.6	24.8
111.0	127.8	47.6	-29.2	37.6	-36.2	30.9
112.0	116.8	40.5	-18.3	36.2	-25.2	31.8
113.0	109.8	39.4	-13.4	37.0	-20.6	33.5
114.0	94.6	27.7	-2.2	27.6	-7.7	26.6
115.0	89.1	25.4	0.4	25.4	-4.7	25.0
116.0	55.8	16.2	9.1	13.4	6.2	15.0
117.0	359.2	18.2	18.2	-0.3	17.9	3.4
118.0	325.1	32.1	26.3	-18.4	29.5	-12.7
119.0	310.1	59.6	38.4	-45.6	46.8	-36.9
120.0	306.3	78.8	46.7	-63.5	58.6	-52.7
121.0	304.9	96.4	55.2	-79.1	70.1	-66.3
122.0	305.0	108.5	62.2	-88.8	78.9	-74.4
123.0	306.0	113.9	66.9	-92.2	84.2	-76.8
124.0	308.3	120.8	74.8	-94.9	92.4	-77.8
125.0	310.4	125.4	81.3	-95.5	98.9	-77.1
126.0	311.8	131.5	87.7	-98.0	105.7	-78.2
127.0	313.2	136.4	93.4	-99.5	111.6	-78.6
128.0	313.3	136.7	93.7	-99.5	111.9	-78.5
129.0	313.2	140.8	96.4	-102.6	115.2	-81.0
130.0	311.5	139.2	92.1	-104.3	111.3	-83.5
131.0	309.2	125.1	79.0	-97.0	97.0	-79.0
132.0	303.1	108.9	59.5	-91.2	76.7	-77.3
133.0	300.7	106.8	54.6	-91.8	72.0	-78.9


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 40 QUEENS FORT
23 NOVEMBER 1965 01:31:00 AST
H.A.R.P. BARBADOS
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
-120
-80
-40
0
40
80
120
SPEED (M/S)

WIND SPEED

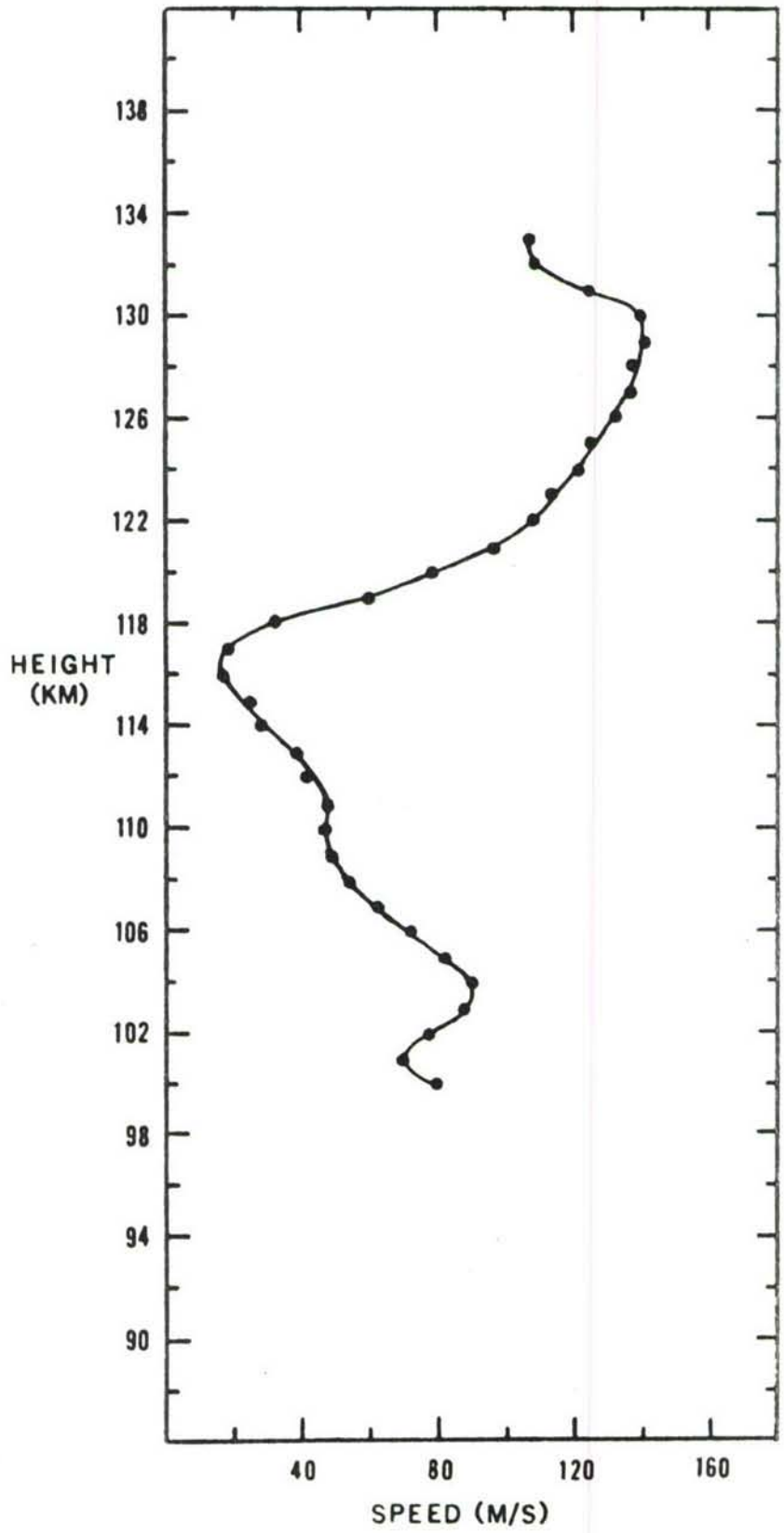
TRAIL NO. 40 QUEENS FORT

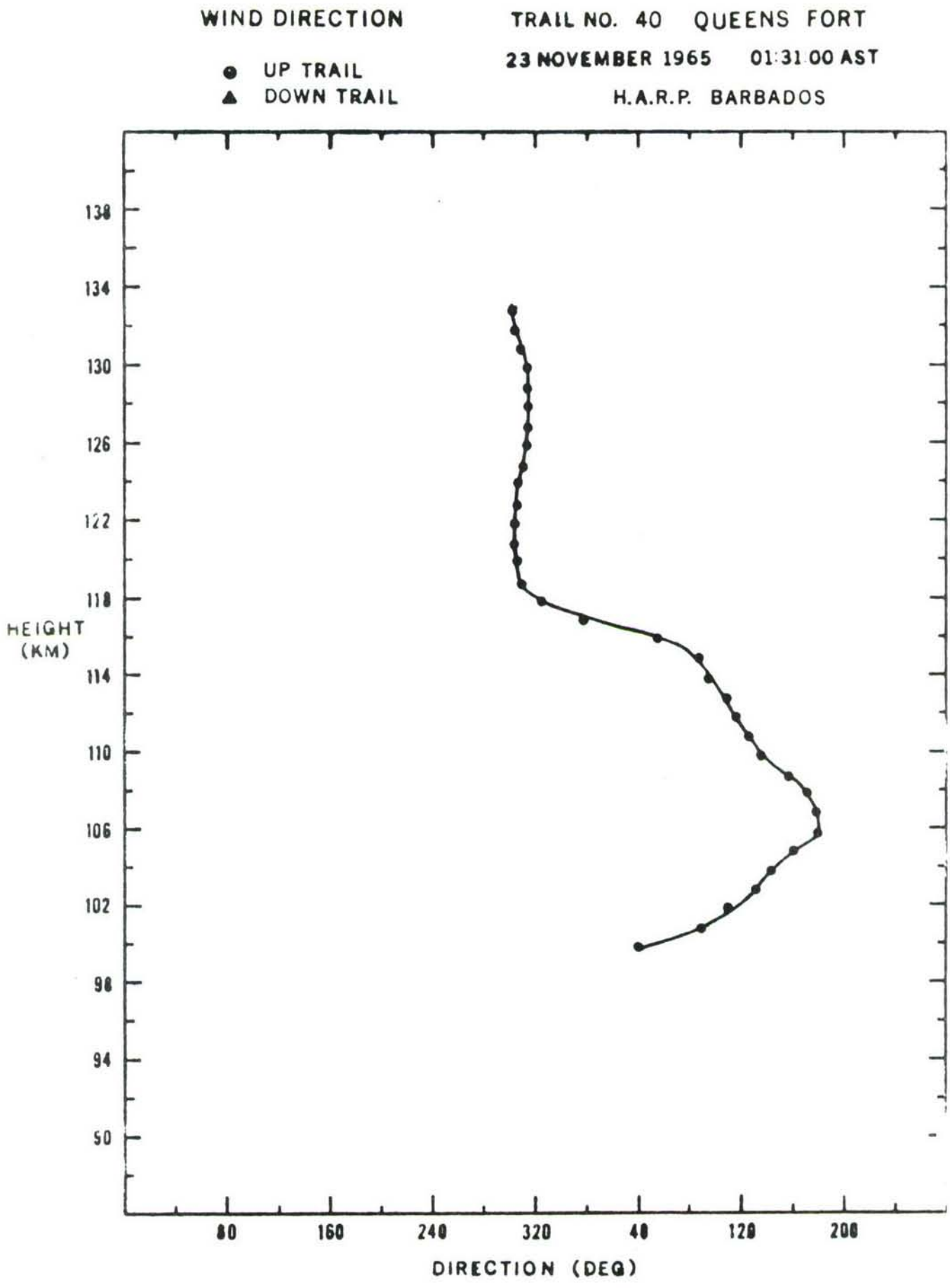
23 NOVEMBER 1965 01:31:00 AST

● UP TRAIL

▲ DOWN TRAIL

H.A.R.P. BARBADOS

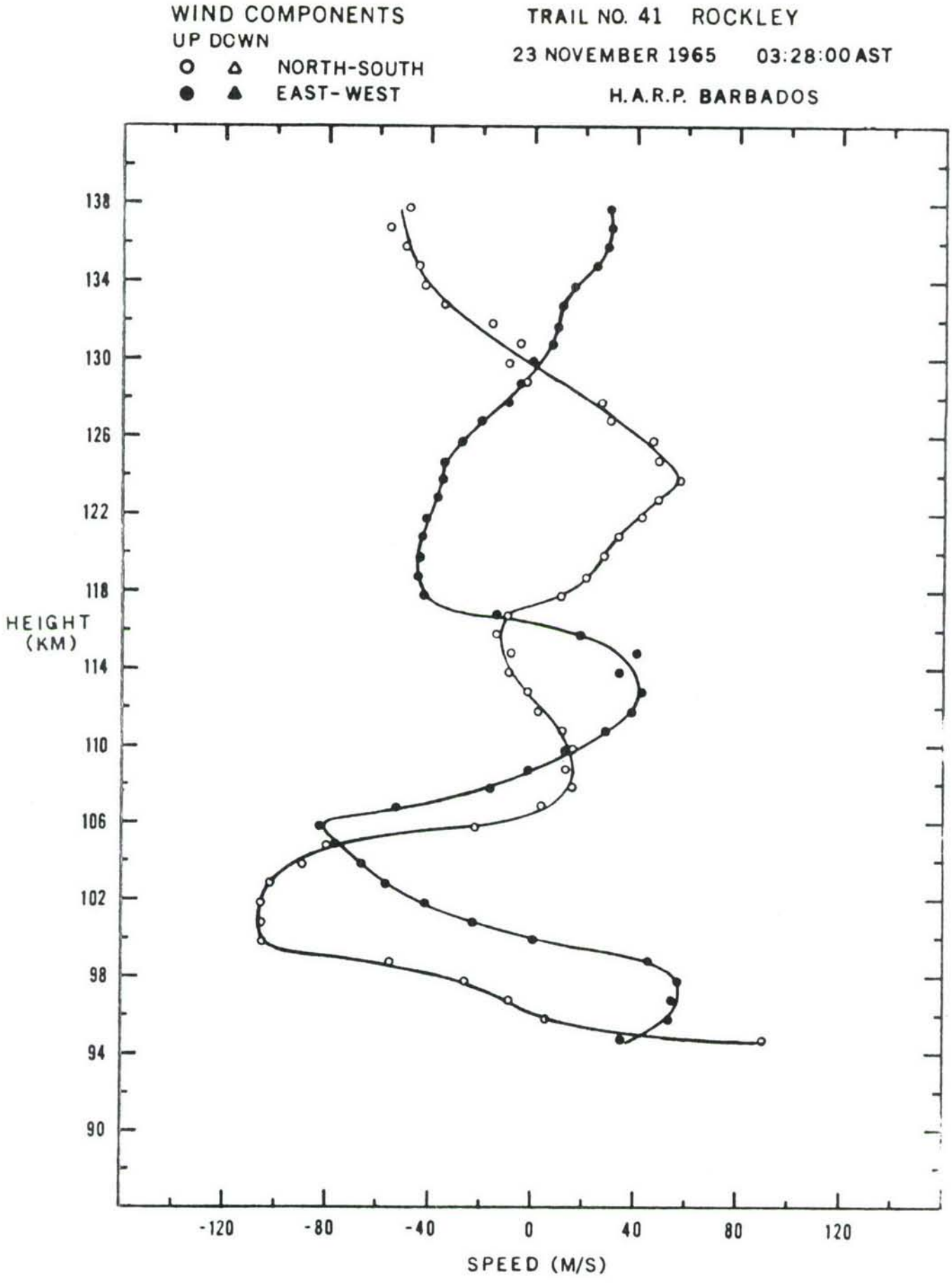


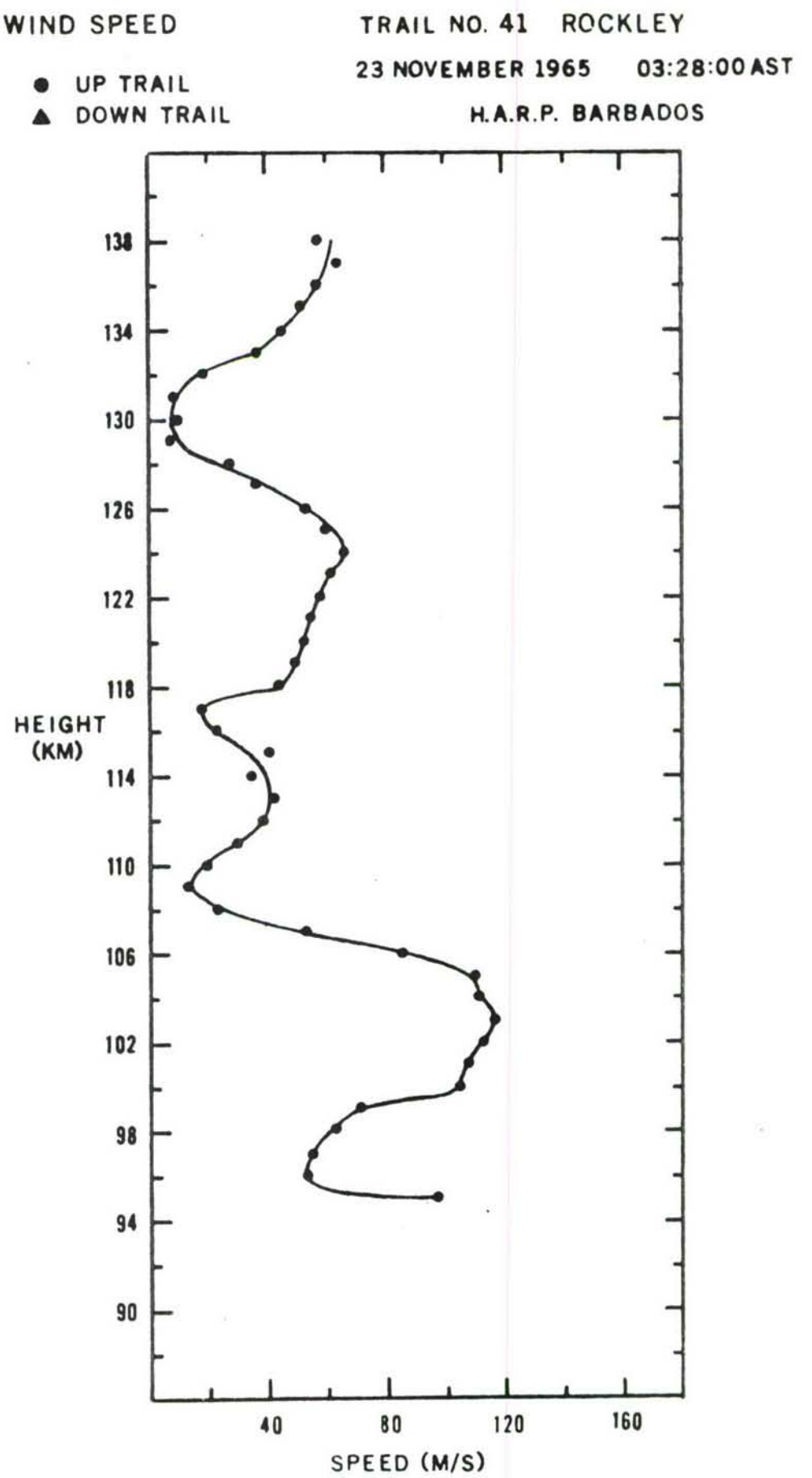

WIND DIRECTION
UP TRAIL
DOWN TRAIL
TRAIL NO. 40 QUEENS FORT
23 NOVEMBER 1965 01:31:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
80
160
240
320
40
120
200
DIRECTION (DEG)

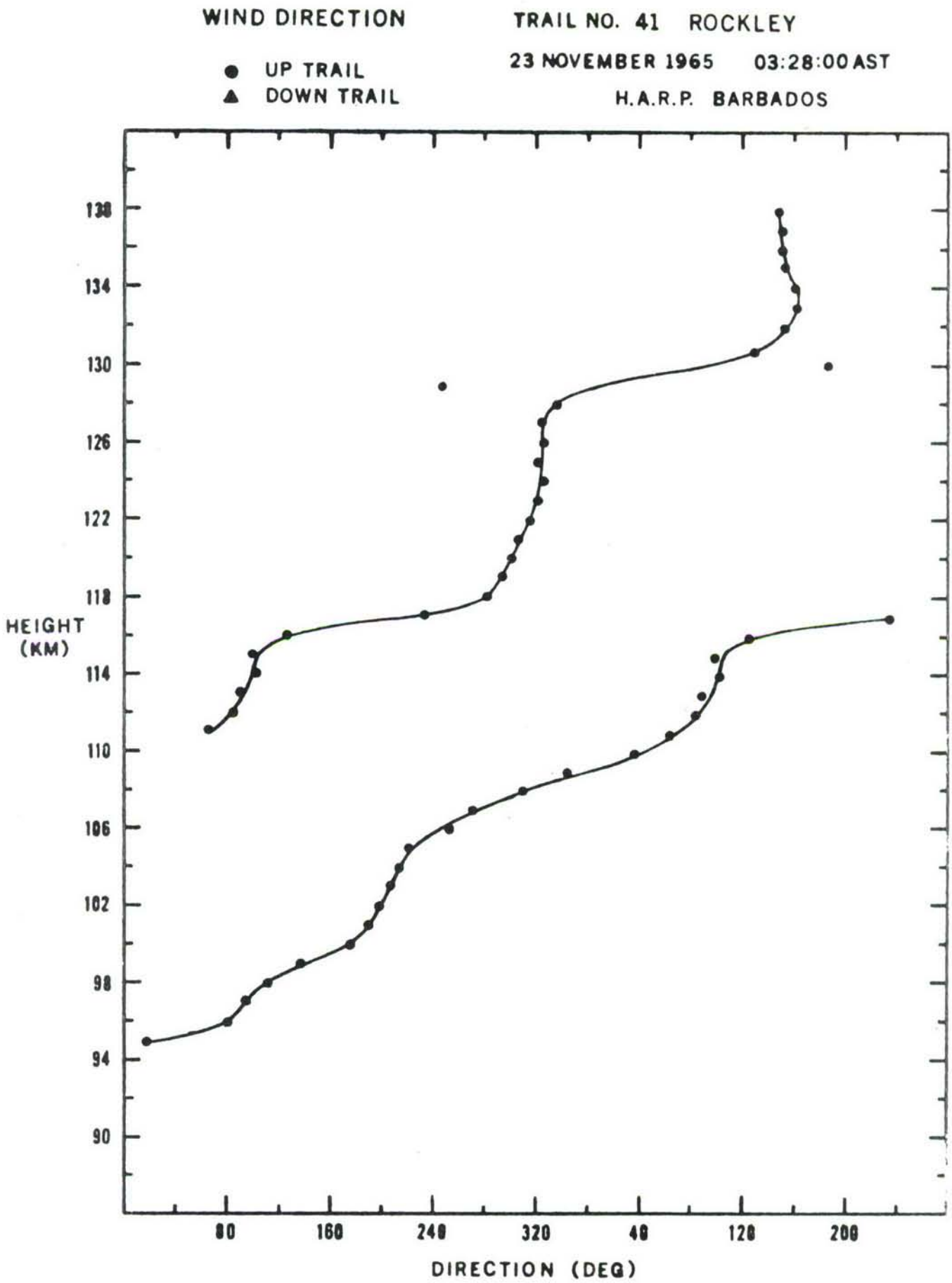
TRAIL NO. 41 ROCKLEY

BARBADOS 23 NOVEMBER 1965 03-28-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
95.0	21.2	97.1	90.5	35.2	81.5	52.8
96.0	83.6	54.4	6.1	54.0	-4.9	54.1
97.0	98.3	55.4	-8.1	54.9	-19.0	52.1
98.0	114.4	63.2	-26.1	57.5	-37.2	51.0
99.0	140.3	71.9	-55.3	45.9	-63.4	33.8
100.0	179.8	105.1	-105.1	0.3	-103.0	-21.0
101.0	192.4	107.9	-105.4	-23.2	-98.5	-44.0
102.0	201.5	113.5	-105.6	-41.6	-95.0	-62.1
103.0	209.5	116.7	-101.6	-57.5	-87.9	-76.9
104.0	216.7	111.7	-89.5	-66.8	-74.1	-83.5
105.0	223.9	110.8	-79.8	-76.9	-62.6	-91.4
106.0	255.1	85.7	-22.1	-82.8	-4.9	-85.6
107.0	274.4	53.4	4.1	-53.3	14.8	-51.4
108.0	313.1	23.0	15.7	-16.8	18.8	-13.3
109.0	348.4	13.3	13.0	-2.7	13.3	0.0
110.0	40.0	19.9	15.2	12.8	12.3	15.6
111.0	67.8	30.4	11.9	28.0	6.0	29.8
112.0	87.5	38.6	1.7	38.6	-6.1	38.1
113.0	91.8	42.7	-1.3	42.6	-9.9	41.5
114.0	105.1	35.0	-9.1	33.8	-15.7	31.3
115.0	101.8	40.9	-8.4	40.1	-16.3	37.6
116.0	127.9	23.8	-14.6	18.8	-18.1	15.5
117.0	236.1	17.9	-10.0	-14.9	-6.8	-16.6
118.0	283.5	44.5	10.4	-43.2	18.9	-40.2
119.0	294.7	49.9	20.9	-45.3	29.6	-40.1
120.0	301.4	52.6	27.4	-44.9	35.9	-38.4
121.0	307.5	54.5	33.1	-43.3	41.2	-35.7
122.0	316.5	58.0	42.1	-40.0	49.3	-30.7
123.0	321.4	61.7	48.2	-38.5	55.0	-28.0
124.0	327.6	66.5	56.1	-35.6	62.1	-23.5
125.0	322.8	60.3	48.0	-36.5	54.4	-26.0
126.0	328.2	54.0	45.9	-28.5	50.7	-18.6
127.0	325.9	36.3	30.1	-20.4	33.6	-13.9
128.0	338.4	27.5	25.6	-10.1	27.1	-4.7
129.0	249.1	7.3	-2.6	-6.8	-1.2	-7.2
130.0	188.7	10.3	-10.2	-1.6	-9.7	-3.6
131.0	129.5	9.0	-5.7	6.9	-7.0	5.6
132.0	151.5	18.3	-16.1	8.7	-17.5	5.3
133.0	163.2	36.0	-34.5	10.4	-35.9	3.2
134.0	160.5	45.0	-42.4	15.0	-44.6	6.1
135.0	151.7	51.0	-44.9	24.2	-48.9	14.6
136.0	151.0	57.0	-49.9	27.6	-54.5	16.9
137.0	152.2	64.0	-56.6	29.9	-61.5	17.8
138.0	149.1	56.9	-48.9	29.2	-53.8	18.7


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO. 41 ROCKLEY
23 NOVEMBER 1965 03:28:00 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)

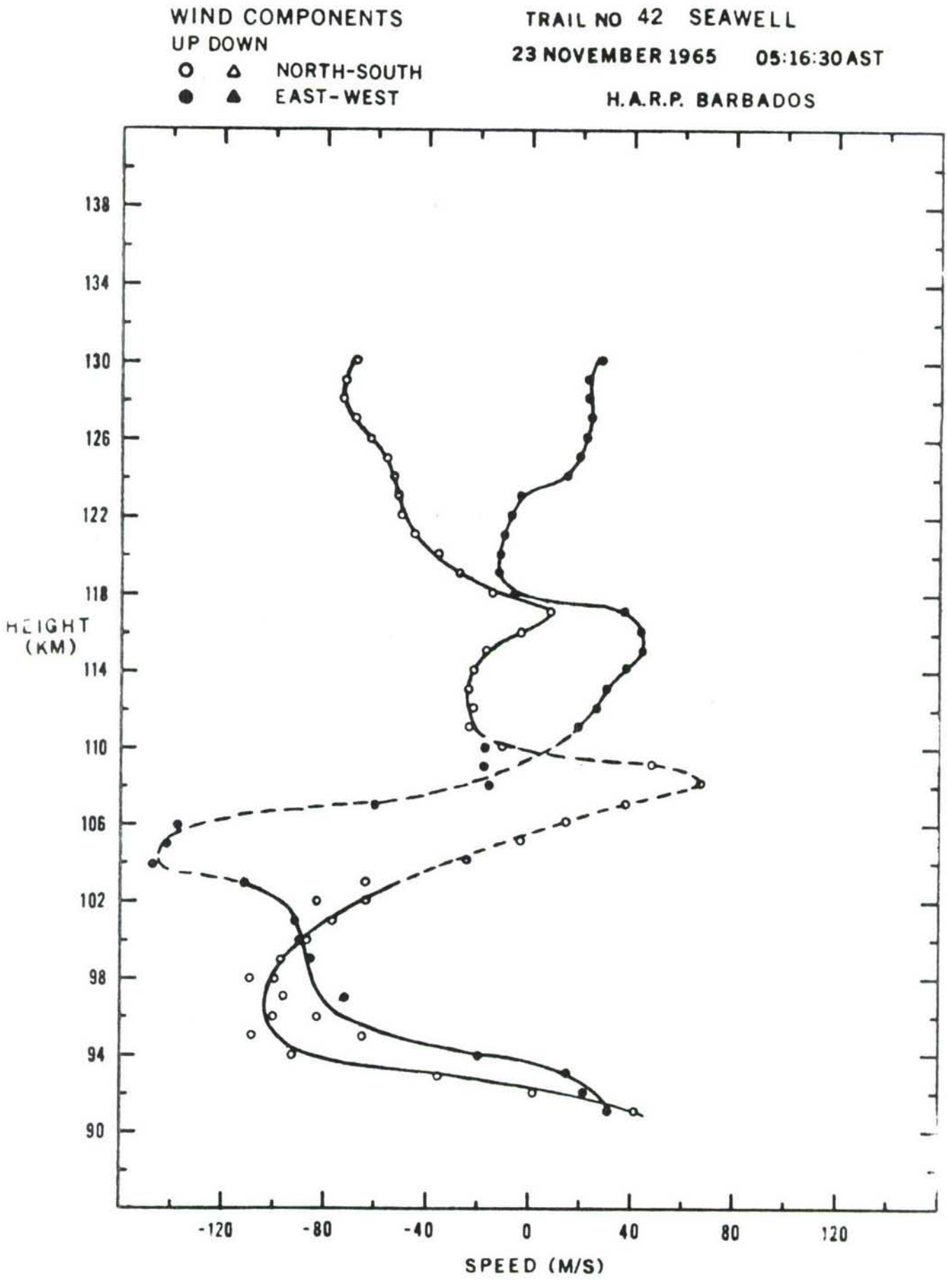

WIND SPEED
TRAIL NO. 41 ROCKLEY
23 NOVEMBER 1965 03:28:00 AST
● UP TRAIL
▲ DOWN TRAIL
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
40
80
120
160
SPEED (M/S)

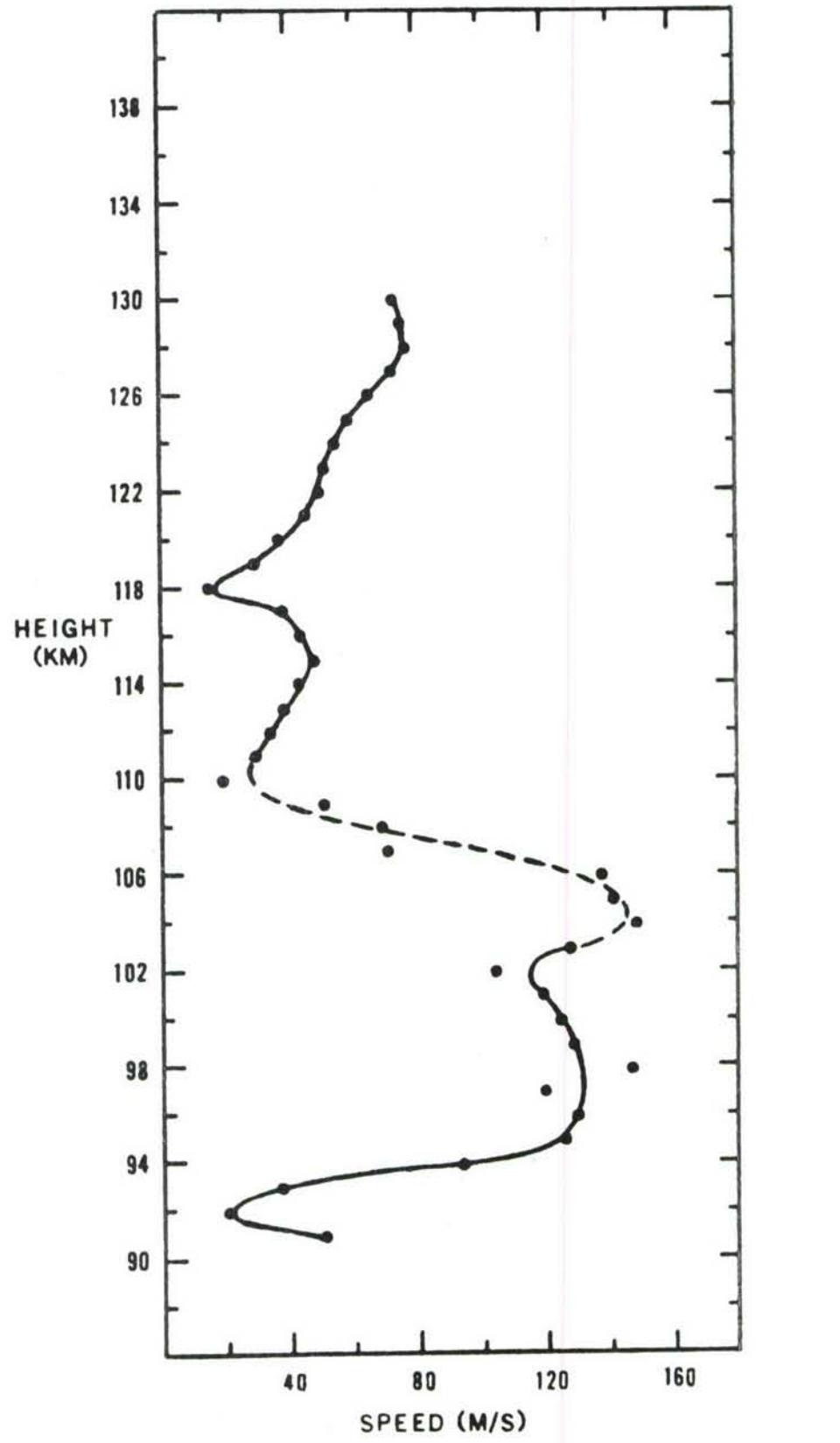

WIND DIRECTION
TRAIL NO. 41 ROCKLEY
23 NOVEMBER 1965 03:28:00 AST
H.A.R.P. BARBADOS
UP TRAIL
DOWN TRAIL
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
80
160
240
320
40
120
200
DIRECTION (DEG)

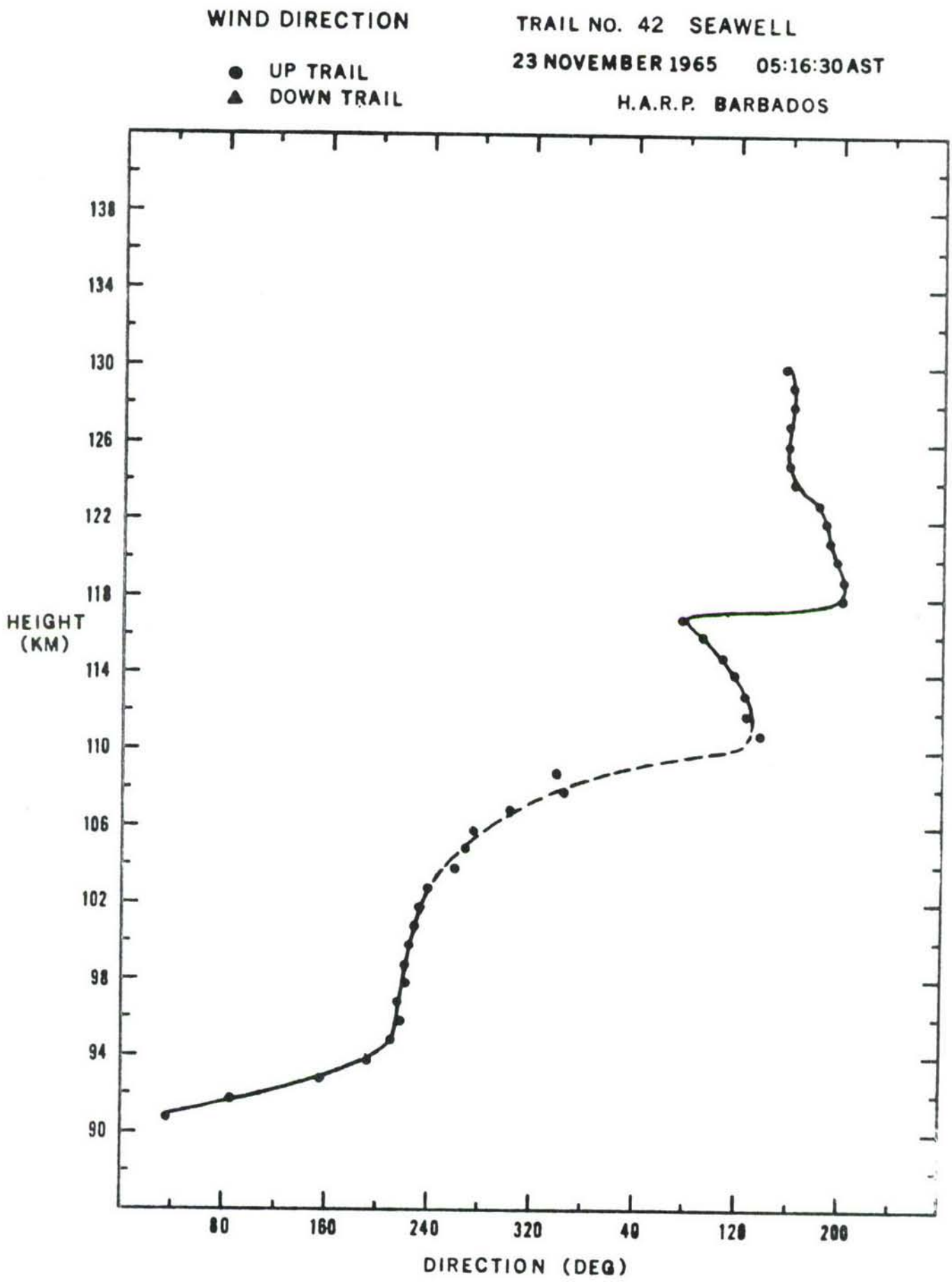
TRAIL NO. 42 SEAWELL

BARBADOS 23 NOVEMBER 1965 05-16-30 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) GEOGRAPHIC N-S	GEOGRAPHIC E-W	MAGNETIC N-S	MAGNETIC E-W
91.0	36.1	51.4	41.6	30.3	34.6	38.1
92.0	85.8	21.1	1.5	21.1	-2.8	21.0
93.0	157.1	37.8	-34.9	14.7	-37.2	7.3
94.0	192.1	94.8	-92.7	-19.9	-86.8	-38.2
95.0	211.1	126.4	-108.3	-65.2	-92.9	-85.8
96.0	219.5	130.6	-100.7	-83.1	-81.8	-101.7
97.0	216.9	120.6	-96.5	-72.4	-79.9	-90.4
98.0	222.3	147.5	-109.1	-99.2	-86.8	-119.2
99.0	221.3	129.4	-97.2	-85.4	-77.9	-103.3
100.0	225.9	125.6	-87.4	-90.2	-67.4	-106.0
101.0	230.0	119.7	-76.9	-91.7	-56.8	-105.4
102.0	232.3	105.0	-64.2	-83.1	-46.1	-94.4
103.0	239.8	128.5	-64.5	-111.1	-40.7	-121.8
104.0	260.7	148.8	-24.2	-146.8	6.0	-148.7
105.0	268.4	141.2	-3.9	-141.2	24.7	-139.1
106.0	276.0	137.8	14.5	-137.0	41.9	-131.2
107.0	302.1	71.2	37.9	-60.4	49.3	-51.5
108.0	346.9	69.3	67.5	-15.7	69.3	-1.7
109.0	340.2	51.6	48.6	-17.5	51.1	-7.3
110.0	237.8	19.4	-10.4	-16.4	-6.9	-18.2
111.0	140.0	30.6	-23.4	19.6	-26.9	14.5
112.0	129.3	34.6	-21.9	26.8	-26.9	21.8
113.0	128.1	38.9	-23.9	30.6	-29.6	25.1
114.0	119.4	43.7	-21.5	38.1	-28.8	33.0
115.0	110.2	47.8	-16.5	44.8	-25.2	40.5
116.0	94.1	44.2	-3.2	44.1	-12.1	42.5
117.0	77.4	38.5	8.4	37.6	0.6	38.5
118.0	202.0	15.1	-14.0	-5.7	-12.6	-8.4
119.0	202.5	29.1	-25.9	-11.2	-24.1	-16.4
120.0	197.2	36.8	-35.2	-10.9	-32.3	-17.8
121.0	191.6	45.3	-44.3	-9.1	-41.5	-17.9
122.0	187.8	49.6	-49.2	-6.7	-46.8	-16.5
123.0	183.3	51.1	-51.0	-2.9	-49.4	-13.2
124.0	163.7	54.9	-52.7	15.4	-54.7	4.4
125.0	159.7	58.8	-55.1	20.4	-58.1	8.8
126.0	159.3	65.7	-61.4	23.3	-64.8	10.4
127.0	159.7	72.2	-67.7	25.1	-71.4	10.9
128.0	161.5	76.4	-72.5	24.2	-75.9	9.0
129.0	161.0	75.2	-71.1	24.5	-74.6	9.6
130.0	156.7	73.7	-67.7	29.1	-72.2	14.8


WIND COMPONENTS
UP DOWN
NORTH-SOUTH
EAST-WEST
TRAIL NO 42 SEAWELL
23 NOVEMBER 1965 05:16:30 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
-120
-80
-40
0
40
80
120
SPEED (M/S)


WIND SPEED
TRAIL NO. 42 SEAWELL
23 NOVEMBER 1965 05:16:30 AST
● UP TRAIL
▲ DOWN TRAIL
H.A.R.P. BARBADOS
138
134
130
126
122
118
114
110
106
102
98
94
90
HEIGHT (KM)
40
80
120
160
SPEED (M/S)


WIND DIRECTION
UP TRAIL
DOWN TRAIL
TRAIL NO. 42 SEAWELL
23 NOVEMBER 1965 05:16:30 AST
H.A.R.P. BARBADOS
HEIGHT (KM)
138
134
130
126
122
118
114
110
106
102
98
94
90
80
160
240
320
40
120
200
DIRECTION (DEG)

APPENDIX A-1

LIST OF FORMER TEST FIRING SERIES

With the 16.4" Barbados Gun, until September 1965

SERIES	NOS.	DATE	SLUGS	MARTLET		MARTLET				MARTLET		TOTAL
				1A	1B	2A	2B	2C	2D	3A	3B	
I	1-4	Jan 25-Feb 1/63	2	1	1							4
II	5-12	Jun 5-June 19/63	4			4						8
III	13-18	Aug 28-Sept 5/63					2			4		6
IV	19-34	Jan 4-Jan 15/64				9				7		16
V	35-38	June 23-June 26/64				4						4
VI	39-72	July 6-July 25/64	1			23					10	34
VII	73-76	Sept 8-Sept 9/64									4	4
VIII	77-79	Nov 5-Nov 6/64	3									3
IX	80-93	Dec 8-Dec 14/64	3			4		4			3	14
X	94-107	Mar 23-Mar 29/65				4		6	1		3	14
XI	108-127	May 31-June 12/65				3		15			2	20
XII	128-130	Aug 4-Aug 6/65						3				3
XIII	131-152	Sept 14-Sept 25/65	2			2		18				22
	TOTAL 1963 - September 1965		15	1	1	53	2	46	1	11	22	152

APPENDIX A-2

LIST OF FORMER TMA TRAILS (Nos. 1-29)

Trail No.	Name	Shot No.	Date	Time AST	Altitude km
1	IRIS	42	7 Jul 64	1902	94 - 109
2	JANET	43	7 Jul 64	2110	86 - 95
3	SHARON	62	22 Jul 64	1900	95 - 98
4	QUEENIE	67	24 Jul 64	1945	90 - 96
5	LUPACA	97	23 Mar 65	2124	92 - 114
6	MIAMI	98	24 Mar 65	0103	101 - 110
7	NOOTKA	103	27 Mar 65	0220	92 - 111
8	OTTAWA	104	28 Mar 65	2002	105 - 119
9	PUEBLO	105	28 Mar 65	2220	90 - 117
10	MARIUS	112	3 Jun 65	1957	102 - 114
11	NERO	113	3 Jun 65	2241	88 - 94
12	ELAGABULUS	114	4 Jun 65	0135	91 - 121
13	FABIUS	115	4 Jun 65	0317	92 - 107
14	OVID	122	9 Jun 65	2157	95 - 103
15	CICERO	123	9 Jun 65	2358	91 - 103
16	PLINY	125	10 Jun 65	2107	97 - 108
17	TIBERIUS	129	5 Aug 65	2020	95 - 107
18	UMBRIA	130	6 Aug 65	0244	94 - 106
19	BELAIR	133	20 Sep 65	1930	90 - 132
20	CONOWINGO	134	20 Sep 65	2052	88 - 136
21	EDGEWOOD	136	21 Sep 65	0024	90 - 123
22	FOUNTAIN GREEN	137	21 Sep 65	0221	88 - 128
23	GALENA	138	21 Sep 65	0335	91 - 138
24	HAVRE DE GRACE	139	21 Sep 65	0500	90 - 123
25	LINTHICUM	142	22 Sep 65	1924	91 - 127
26	MAGNOLIA	144	23 Sep 65	0150	94 - 126
27	NANTICOKE	145	23 Sep 65	0315	98 - 133
28	OLNEY	146	23 Sep 65	0407	88 - 126
29	PERRYMAN	147	23 Sep 65	0505	98 - 124

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Space Research Institute
McGill University
Montreal, P.Q., Canada

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
REPORT OF THE NOVEMBER 1965 TEST FIRING SERIES PROJECT HARP

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*
H.J. Luckert

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
November 1966	251	7

8a. CONTRACT OR GRANT NO.
DA 18-001-AMC-746(X)

b. PROJECT NO.
RDTE 1V014501B53C

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
SRI-R-20

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT
Distribution of the report is unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
Ballistic Research Laboratories
Aberdeen Proving Ground, Md.

13. ABSTRACT

The report is a review and analysis of results of the fourteenth test firing series of Project HARP with the Barbados 16 inch gun.

The series consisted of twenty-seven rounds, fired in the period from 10 to 23 November 1965. Fifteen rounds carried TMA release payloads for wind measurements in two night series. A further round had a Cesium payload with a point release for ionospheric studies. The remaining eleven rounds were for engineering development tests of a sea-impact payload (two rounds), the self-destruct system (three rounds), an ejection system with a parachute telemetry package (three rounds). Two rounds carried a telemetry package to measure time pulses and temperatures in the electronics section and to test a high gain differential amplifier, in one of these rounds in addition to the TMA payload in the synoptic series. Finally two test slugs were fired as engineering tests of the gun and another propellant whereby also a new method of loading, by inserting spacers between the propellant bags, was tried out.

The series was generally successful. The gun performance was satisfactory, and the new loading technique with spacers to achieve smoother burning of the propellant proved successful. All vehicles performed satisfactorily with the exception of three Martlet 2C (Mod. 2) which were unsuccessful probably owing to pusher plate failure and resultant vehicle damage.

The sea impact payload tests were satisfactory, and so were the parachute ejection tests; in one of the three rounds, however, the parachute did not open. Not so successful were the Martlet 3B rounds since the destruct system was activated ahead of the planned time though not as a result of ground control.

The telemetry systems, carried in eight rounds, did not perform to complete satisfaction. The tests so far have shown, however, that the units can stand the high accelerations associated with gun launch.

The TMA release rounds, finally, have shown again the reliability of the Martlet 2C vehicles and their release system. With the exception of three rounds which were unsuccessful owing to pusher plate failure, all TMA rounds gave good trails in two synoptic series, and wind data were obtained for an altitude band from 91 to 138 km. One further round with point release of Cesium was also successful.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
HARP						
High Altitude Research Project						
Vertical-fired Gun Probes						
Gun Launched Projectiles						
Gun Boosted Rockets						
Ionospheric Winds						