Operations requirement for Black Brant rocket AA-II-41 : cosmic ray, neutron detector, Langmuir probe and micrometeorite launch from Churchill Research Range

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PROVISIONAL OPERATIONS REQUIREMENT FOR BLACK BRANT ROCKET AA-II-41

PREPARED BY

RADIO AND ELECTRICAL ENGINEERING DIVISION

O.R. NO. 117

OTTAWA

JUNE 1963

ANALYZED

OPERATIONS REQUIREMENT FOR BLACK BRANT ROCKET AA-II-41

Cosmic Ray, Neutron Detector, Langmuir Probe and Micrometeorite Launch from Churchill Research Range

CRR Operations Requirement No. 117

Prepared By: S.G. Jones and K. A. Steele

(Revised Edition)

OTTAWA

NOVEMBER 1963

FOREWORD

The Operations Requirement is a document prepared by the Range User, describing in detail the requirements at the rocket range to accomplish a specific test or a series of tests in the over all test program. The accepted OR is the established method by which Users obtain support from the Churchill Research Range.

ABSTRACT

Black Brant Rocket AA-II-41 was instrumented by NRC and University of Alberta to measure various phenomena in the upper atmosphere associated with auroral activity, including cosmic ray and neutron detector experiments concerned with the energy spectrum and direction of energetic particles, Langmuir probe measurements of the fine structure of electron density and energy spectra, and acoustic type impact counter for micrometeorite detection. The rocket will be directed into a visible auroral display under conditions of darkness, no cloud cover and no moon. The Operations Requirement states requirements for working space, transport, power, communications, meteorological and other scientific data at the Range. It describes briefly the test and the rocket, and gives details of the telemetry used and the data to be recorded. A detailed countdown is also included.

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15 June 1963 OR

1.0 GENERAL INFORMATION

1.1 Operations Command

The following personnel will be at the Rocket Facility, Fort Churchill, in connection with this program:

A total of ten Range User personnel (NRC) will work on this program at Fort Churchill.

One or two representatives from the University of Alberta may be present to assist in experimental preparations.

No visitors are expected at this test.

A list of names with duties and dates of arrival will be forwarded to RFOAR at a later date.

Trial Coordinator	-	S.G. Jones
Project Scientist	-	A.G. McNamara
Vehicle Controller	-	Capt. E.W. Rance

1.2 Range Time Utilization

1.2.1 Test Duration and Frequency

This OR is for requested support in firing one Black Brant IIA rocket. It is anticipated that Range User equipment and personnel will be at the Rocket Facility for about one month, commencing about January 3rd, 1964. Support for living accommodation, transport, equipment and rocket storage, assembly and blockhouse space, power, and communications is requested for this period. Rocket assembly, fin alignment, arming, placing the rocket on the launcher, etc. will be the responsibility of the range contractor. Operation of the Range Telemetry Station and radar may be requested a day or two before the scheduled firing in conjunction with nose cone instrumentation preparation and a complete "dress" rehearsal of the launching.

Day-to-day rescheduling of the launching may be necessary due to weather and other requirements of the vehicle and experiments. Data on vehicle performance and launch restrictions will be made available from CARDE for this particular rocket. This data is based, in part, on information supplied to CARDE by NRC on estimated nose cone weight and C. of G. and nose cone shroud holes and projections. It is understood that a report concerning the Black Brant IIA vehicle originating from CARDE is available to CRR.

Desired experiment conditions are:

(a) aurora

(b) darkness, no cloud cover and no moon

(c) no exceptional solar activity or polar cap absorption event

(d) during a near pass of the Alouette satellite, if still operating

and are listed in the order of decreasing importance. Absence of (a), (b) and (c) may justify postponement of a scheduled launching. A hold for aurora is desired at T - 3.5 min. with provision for resumption of count on 30 seconds notice.

1.2.2 General Countdown

TIME	FUNCTION/SERVICE
Preparation Phase:	
F-7 day	Rocket motor, fins, igniter, arrive at Fort Churchill via air transport. These parts may

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE
Preparation Phase:	
F-7 day (cont'd.)	be shipped several weeks prior to this time as the shipment may be included with the vehicles used in the CARDE launchings in the fall of 1963. Range requested to unload and transport to launch site storage (6.1.2). Nose cone, nose cone instrumentation, check-out equipment and nose cone control unit arrive at Fort Churchill. This equipment will be consigned to DRNL. DRNL is requested to supervise the unloading and arrange to have the equipment transported and stored in the preparation area allotted to this project. (6.1.2) Range User personnel arrive at Fort Churchill. Accommodation and personnel transportation support requested. (Request for accommodation will be made to DRNL.) (5.1.2)
F-6 day	Range User personnel begin setting up check-out equipment and preparation of nose cone instrumentation. Request: 1. Preparation area space (10.1). 2. Blockhouse space (10.1). 3. Transportation (6.1.1). 4. Power (5.1.1). 5. Support for connection of umbilical cable (4.3.3). 6. Communications (4.1). 7. Parallactic camera operation (1.6.1). 8. Meteorological services (3.0). 9. Office space at DRNL and telephone (10.1). 10. Support for setting up Range User's instrumentation (1.6).
F-1 day	Nose cone preparation complete. Move nose cone, payload control console, power supplies, etc., to blockhouse. Battery charging complete. Install all batteries to payload. Complete instrumentation check-out with nose cone shroud off. Radar beacon check. Magnetometer check. Request support of telemetry station, radar, DRNL and pad services and engineering for launch "dress rehearsal". (5.1.6)

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE
Launch Phase:	If it is very cold, it is desirable to keep the time between elevation of the launcher and ignition to a minimum. It is understood that minimum motor temperature for launching is 0°F on the engine skin. Heaters will be used in the nose cone payload space as the payload temperature must be kept above 32°F.
T-6:00:00	Final visual inspection of payload and battery check. Check complete length of umbilical cable from console in blockhouse to vehicle 50-pin connector with test box. Assemble nose cone shroud to payload. Pressurize nose cone to 5 p.s.i.g.
T-4:10:00	All Range User personnel on station.
T-4:00:00	Move nose cone to hazardous assembly.
T-3:50:00	Range begin count with Range User.
T-3:40:00	Mount nose cone on motor. Remove strippable paint and clean whole vehicle. Check pressure of nose cone and pump, if necessary.
T-3:00:00	Vehicle brought to launch bay.
T-2:50:00	Install vehicle on launcher. Check that payload control console is disconnected from umbilical. Connect umbilical to vehicle. Connect motor temperature sensor. Install telemetry antennas. Attach radioactive source to launch boom near sta. 28 of rocket to test neutron detector. Check nose cone pressure and pump if necessary. Install access hatch in forward body. Remove safety belts. Clean complete vehicle.
T-2:20:00	Clear launch bay for horizontal instrumentation checks:
T-2:15:00	Begin horizontal instrumentation checks.

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE
Launch Phase (cont'd.)	Link #1 (219.5 Mc) - External power. Discharge batteries to plateau. Internal power. Telemetry note signal condition of SCO's. Check Langmuir Probes with resistance unit (User in launch bay). Check micrometeorite detectors. Check neutron detector. Link #2 (228.0 Mc) - External power. Discharge batteries to plateau. Internal power. Telemetry note signal condition of SCO. Radar beacon check with external and internal power. Radar interrogate beacon while SCO calibration is done at 0, 2.5 and 5 volts. Payload switched to external. All umbilical power off.
T-1:35:00	Horizontal checks completed.
T-1:00:00	Arm vehicle.
T-0:30:00	Elevate launcher.
T-0:15:00	Begin vertical instrumentation checks. External power on (warm-up only). Internal power on. Check: Main telemetry, Twin Lakes telemetry. Telemetry note signal condition of SCO's. Check status of scientific experiments recorded by User at Operations Building. Check magnetometer readings and battery monitors. Check beacon. Radar interrogate beacon. Payload telemetry switched to 2.5 volt calibrate for adjustment of telemetry paper recorders. Telemetry paper recorders record signals for 30 seconds at 0.4" per second. Payload switched to external, filament power and heaters on only. All power off if hold of 30 minutes or more called.
T-0:08:00	Vertical checks complete. All instrumentation stations report status: Telemetry, Radar, Vehicle Payload, DRNL, Project Scientist.

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE
Launch Phase (cont'd.)	
T-0:06:00	Automatic hold, check with User Vehicle Controller. Indefinite hold, with one minute notice of resumption of count.
T-0:05:00	Direct voice count to camera sites begins.
T-0:04:00	External power on to payload filaments, if not already on.
T-0:03:30	Hold for aurora, resumption of count on 30 sec. notice.
T-0:03:00	All telemetry links turned on internal power and to signal input. Beacon turned on internal power. Check beacon. Radar interrogate beacon. Radar check instrumentation for ejected package range determination.
T-0:02:00	Start all instrumentation recorders. T/M acknowledge. Commence 2.5 volt calibration. T/M zero discriminators.
T-0:01:15	Begin 3 cycles of 11 point (0 to 5 volts) calibration on telemetry.
T-0:01:00	Telemetry switched to 0 volt calibration. Radar start camera for ejected package range determination.
T-0:00:50	Telemetry switched to 5 volt calibration.
T-0:00:40	Telemetry switched to signal input and internal calibration. Telemetry acknowledge signal condition of SCO's.
T-0:00:30	Arm squibs and firing circuits.
T-0:00:25	Acknowledge all green on payload control console.
T-0:00:00	Black Brant IIA rocket ignites.

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE
Launch Phase (cont'd.)	
T+0:00:20	Rocket motor burns out.
T+0:00:40	Extension and turn-on of light. Extension of Langmuir long probes.
T+0:00:50	Ejection of package.
T+0:00:200	Apogee (approximately 85 miles alt.)
T+0:00:400	Impact.

Apart from initial preparations and checkout the camera sites at O'Day and Belcher need not be manned, except on those days scheduled for a launching or a complete "dress rehearsal". Helicopter may be required for up to five people and 500 lbs. of equipment.

1.3 Test Objectives

1.3.1 Primary

Concerned with measurements in the upper atmosphere:

(a) Cosmic Ray experiment concerned with study of particles associated with auroral activity (NRC).

(b) Langmuir Probe measurements of fine structure of electron density and electron energy spectrum inside and outside auroral formations (NRC).

(c) Micrometeorite Detector - an acoustic type impact counter concerned with impact rates and energy distribution inside and outside major meteor showers and association with auroral activity (NRC).

(d) Neutron Detector - is designed to measure the intensity of neutrons at high altitude in the energy range 0.2 to 10 Mev. It employs a 'phoswich' technique to discriminate between neutrons, γ-rays and charged particles. (U. of A.)

(e) Ejected package, carrying a plasma probe experiment, will also provide engineering data on the adequacy of the T/M transmitter-antenna system, and on the use of signal strength data in the determination of package attitude. (N.R.C.)

(f) Photometer to indicate periods during which the vehicle is within an auroral formation. (N.R.C.)

1.3.1 Primary (cont'd.)

(g) Quadraloop T/M Antennas - These antennas which have not been used previously on Black Brant II rockets will be checked during the flight. (N.R.C.)

1.4 Test Description

The Black Brant IIA rocket AA-II-41 will carry several experiments in its nose cone for scientific investigation of the upper atmosphere. It is desired that the vehicle be launched at an elevation of 85° nominal. There is no preferred launch azimuth. Presumably impact will be into Hudson's Bay. Recovery is not required. The desirable conditions at launching in order of importance are: (a) aurora, (b) darkness, no cloud cover, and no moon, (c) no exceptional solar activity or polar cap absorption event, and (d) during a near passage of the Alouette Satellite if still operating. Postponement of the launching may be requested if either of conditions (a), (b) or (c) is not met at a scheduled launch time.

Events of primary importance during flight are the extension of the light beacon and two Langmuir probes at T + 40 seconds, and the ejection of the package at T + 50 secs. Other events of interest are motor burnout, apogee and impact. It is requested that sound ranging equipment be used for impact data, although recovery is not required. Range User personnel will man only the nose cone instrumentation control console during the rocket flight. They will also operate equipment to monitor the outputs from the discriminators of the 219.5 mc link. RFOAR is requested to provide outputs from discriminators for Range User's oscilloscopes and recorders. It is assumed that the parallactic cameras will be operated by DRNL personnel.

1.5 Test Vehicle Description

The Black Brant IIA is a single-stage, solid-propellant, unguided, sounding rocket. This vehicle will be fitted with the Black Brant IIA modified fins.

Length	-	332.5 inches (approx.)
Diameter	-	17.2 inches
Launch weight	-	2750 lbs. approx.
Weight at burnout	-	900 lbs. approx.
Propellant	-	Aluminized single grain polyurethane-ammonium perchlorate

1.5 Test Vehicle Description (cont'd.)

Total Impulse (sea level)	-	380,000 lbs.
Motor burning time	-	15.5 seconds
Guidance	-	None - 3 fixed fin stabilization
Cut-down system	-	None

General performance of the vehicle will be obtained from CARDE. The weight and centre of gravity of the nose cone and payload are furnished by NRC to CARDE, who then calculate vehicle performance. It is understood that RFOAR has a manual on the Black Brant IIA furnished by CARDE. Special instructions concerning the fins fitted on AA-II-41 will be furnished to RFOAR by CARDE.

1.5.1 Vehicle Drawing

See Appendix I.

1.5.2 Nose Cone Drawing

See Appendix II.

1.5.3 Telemetry System

The nose cone telemetry is a PAM/FM/FM system operating at 219.5 mc with 218.0 mc as a possible alternate frequency, 1 watt. The antenna consists of three blade radiators mounted symmetrically about the surface of the nose cone at station 107.5. The polarization is linear. Also carrying the nose cone telemetry signals will be a second link on 240.2 mc, with a 5 watt transmitter. The purpose of this duplication is to test the operation of a pair of quadraloop type telemetry antennas on the Black Brant II rocket. The antennas are located on opposite sides of the nose cone at station 91, and have linear polarization.

The package ejected from the payload at T + 50 seconds contains a T/M Transmitter operating at 228 mc with one watt power output. The package contains one subcarrier oscillator (IRIG band 18), the input of which will be plasma probe data. The package has a dipole antenna, and the Range User will monitor the signal strength with the object of determining package attitude using an antenna-receiver system independent of range T/M facilities.

1.5.4 RFOAR is requested to provide a DPN-41 radar beacon, and Range User will provide space and mounts for the beacon, a box for holding five Yardney Type HR-3 batteries and wiring from the beacon to the batteries and to the umbilical connector. It is understood that check-out and control of the beacon requires the use of seven conductors through the umbilical connector, details of which are to be provided by RFOAR. The final check-out, operation and control of the beacon is to be the responsibility of RFOAR.

1.5.4 Beacon (cont'd.)

NRC will supply quadraloop antenna (as used on vehicles AA-I-26 and AD-I-23) tuned for a beacon transmitter frequency of 2880 mc and beacon receiver frequency of 2810 mc.

1.5.5 Command Control/Destruct System

The Black Brant IIA rocket contains no destruct of flight termination system.

1.5.6 Ordnance Items

Characteristics of propellant, igniter, and squib are available in CARDE manual on Black Brant IIA rocket.

Bellows actuators (squib), Type BA 31 D2, are used in the extension of two of the Langmuir probes, and in the release of the ejected package. Dimple Motors (squib), Type DM 25A 22, are used in the extension of the light beacon. These devices are made by Hercules Powder Company, Wilmington, Delaware.

	BA 31 D2	DM 25A 22
Bridge Resistance:	5-9 ohms	4-9 ohms
Maximum Non-fire:	50 ma., one 30 sec. pulse	50 ma., one 30 sec. pulse
Minimum Fire:	0.3 amp.	0.25 amp.
Recommended Fire:	1.0 amp.	1.0 amp.
Ignition Time:	0.25 milliseconds at 1.0 amp.	0.15 milliseconds at 1.0 amp.

The location of these items is shown on the drawing given in Appendix III. The Bellows actuator and dimple motor timer and arming circuit is given in Appendix IV.

1.6 Range User's Instrumentation

The Range User will supply all equipment for check-out and assembly of the nose cone payload. Range User personnel will operate the control unit for the payload and will monitor channels (IRIG Nos. 1-4 and Nos. 9-18 inclusive) of the

1.6 Range User's Instrumentation (cont'd.)

nose cone telemetry links in the blockhouse during the firings. Discriminator outputs at ±10V level for ±7.5% deviation into a 10K ohm load at the blockhouse are required. The discriminator outputs from Channels 1-4 and 9-17 inclusive must be available for monitoring, using high impedance instruments, in the User area adjacent to the telemetry room in the Operations Building. RFOAR is requested to provide outputs from the telemetry discriminators for all these monitors. In the same area, Range User personnel will receive signal strength data from the rocket and from the ejected package, and will provide an output for recording on track 2 of the T/M room magnetic tape recorders. To obtain a measure of the slant range to the ejected package, radar pulses will be received in the ejected package, and during a 100 millisecond interval every five seconds the received radar pulses will be superimposed on the 228 mc telemetry signal. The radar radiated pulse will be received at the Operations Building by the Range User. This signal will be recorded on track 1 of the T/M magnetic tape recorders.

Range User will provide a set of three telemetry band antennas with vertical, horizontal and RH circular polarization for mounting on the platform adjacent to the Operations Building. The signals from these antennas will be sampled and fed via coaxial cable to multicoupler and receivers in the User area adjacent to the telemetry room in the Operations Building. RFOAR is requested to assist with mounting of the antennas and to provide a suitable coaxial cable for receiver input and a shielded cable of four #20 or larger conductors for synchronizing signals to the multiplexer.

Range User will provide an S-band antenna for receiving radar transmitted pulses on the roof of the Operations Building. RFOAR is requested to assist with its installation and to provide a coaxial cable to connect the antenna to a receiver in the User area adjacent to the telemetry room in the Operations Building.

RFOAR is requested to provide a pair of coaxial cables from the User area adjacent to the telemetry room to the tape recorders input panel for the signals described above for tracks 2 and 1. A block diagram of the above instrumentation is included as Appendix VII.

Range User desires to have an antenna and receiver for the 228 mc telemetry signal from the ejected package, and a 5" oscilloscope with its trace initiated by the radar pulse trigger, all provided by RFOAR at the radar site (see Fig. VII). The

1.6 Range User's Instrumentation (cont'd.)

oscilloscope will display the transponded return of the radar pulse via the 228 mc telemetry link, and Range User will provide a camera for photographic recording of the data which will give a measure of the slant range to the ejected package. It is requested that Radar Site personnel check for satisfactory operation of the oscilloscope and receiver, and initiate camera operation at T-1 minute.

1.6.1 DRNL Instrumentation Support

DRNL will be requested to operate the following equipment prior to and during the launch phase:

(a) 4" by 5" Rapid Scan Spectrometer, 3000-11,000 A°.
(b) Hβ and other photometers.
(c) 16 mm All Sky Camera
(d) Flux Gate Magnetometer
(e) Height-Finding Stations (for aurora and rocket-borne light)
(f) Auroral Radar
(g) Prince Albert Radar (to be arranged by NRC with DRNL and PARL)
(h) Ionosonde (4 sweeps per minute from T+0 to T+6 min.)
(i) 30 mc Polar Riometer (to be arranged by NRC with CRR)
(j) DRNL will provide magnetic tape of voice countdown.
(k) Provide auroral activity predictions
(l) Communications for ground instrumentation (launch sight to Belcher and O'Day)
(m) Radio communication between DRNL and Prince Albert Radar.

1.7 Summary of Frequency Utilization

(a) Ground Link: DRNL to Belcher and O'Day radio link.
DRNL to Prince Albert Radar.
225.7 mc link - Radar to Operations Building.

(b) Rocket Links:

Freq.	Class	Equipment	Location
2380 mc	U	Radar beacon	Nose cone
219.5 mc or 218.0 mc alternate	U	Telemetry	Nose cone (1 watt blades
228 mc	U	Telemetry	Ejected Package
240.2 mc	U	Telemetry	Nose cone (5 watt quadraloop

2.0 DATA

2.1 Metric

Coordinate System: cartesian, with origin at base centre of launcher, Z-axis passing through origin and earth centre of gravity. X-axis passing through the origin perpendicular to Z-axis and oriented true North, Y-axis passing through origin and perpendicular to X and Z axes. Positive directions Z, X, Y are up, north and east respectively.

2.1.1 Launch to Impact

Item	Data	Interval	Data Points/Sec.	Reduced Data Accuracy Class I (Plotting Board)	Class II (ADR Tape)	Class III
1.	Position (X,Y,Z)	Throughout Flight	10 from T-0 to T+40 sec. 2 from T+40 to splash	1000 ft.	500 ft.	--
2.	Velocity (V_X, V_Y, V_Z, V_S)	Throughout Flight	10 from T-0 to T+40 sec. 2 from T+40 to splash	1000 ft.	500 ft.	--

where $\theta = \text{arcsine } \frac{V(Z)}{V(S)}$

$\phi = \text{arctangent } \frac{V(Y)}{V(X)}$

where V_S = tangential velocity.

Radar data is requested from Lift-off, T - 0.

2.1.2 Impact

Impact coordinates are desired by sound ranging equipment even though recovery is not a requirement.

2.2 Engineering Photography

Documentary 16 mm color photography is requested from the arrival time of project personnel. This is to include coverage of payload assembly and checkout as well as the launch phase.

The movie coverage should include the following sequences:

1. Setting up racks in preparation area.
2. Working on nose cone instrumentation with shroud off.
3. Placing shroud on instrumentation.
4. Moving nose cone to Hazardous Assembly.
5. Installing T/M antennas.
6. Assembly to motor.
7. Placing complete vehicle on launcher.
8. Launch.

4 x 5 still photography is requested on call throughout the program for coverage of payload assembly, checkout, and vehicle assembly. One negative of each photograph taken is to be sent to NRC, Radio and Electrical Engineering Division, Attention: Mr. W.L. Haney.

Still photographs, which may include some 35 mm color transparencies, should include the following:

1. Equipment in preparation area.
2. Nose cone instrumentation, shroud off.
3. Nose cone instrumentation, shroud on.
4. Control console in blockhouse.
5. Assembled rocket and motor on dolly.
6. Rocket on launcher, horizontal.
7. Rocket on launcher, vertical.
8. Close up of umbilical cable from launcher boom to vehicle.
9. Equipment at DRNL.
10. Equipment at radar site.
11. NRC antennas on platform near Operations Building.
12. Scientists observation platform.

2.2 Engineering Photography (cont'd.)

Engineering analysis of the launch phase is not required.

2.3 Telemetry

It would be desirable to duplicate all telemetry reception and recording functions whenever possible. Appendix V contains a list of equipment Range User will take to Fort Churchill. Some items, such as receivers, may be made available for operation and under complete control by the RFOAR telemetry station for this program.

Operation of the telemetry facilities at Twin Lakes to duplicate functions at the launch site as much as possible is requested.

2.3 Telemetry (cont'd.)

ITEM NO.	LINK FREQ.	NO.	FREQ.	DEV. ±%	MEASURING RATE	RECORDING INTERVAL	CLASS	ACCURACY ±%	REMARKS
1	219.5 mc FM/FM	1	400 cps	7.5	Cont.	T-0:02 to splash	I	)	
2	219.5 mc FM/FM	2	560 cps	7.5	Cont.	T-0:02 to splash	I	)	Event Channels
3	219.5 mc FM/FM	3	730 cps	7.5	Cont.	T-0:02 to splash	I	)	
4	219.5 mc FM/FM	4	960 cps	7.5	Cont.	T-0:02 to splash	I	)	
5	219.5 mc FM/FM	9	3.9 kc	7.5	Cont.	T-0:02 to splash	I	2%	
6	219.5 mc FM/FM	10	5.4 kc	7.5	Cont.	T-0:02 to splash	I	2%	
7	219.5 mc FM/FM	11	7.35 kc	7.5	Cont.	T-0:02 to splash	I	2%	
8	219.5 mc FM/FM	12	10.5 kc	7.5	Cont.	T-0:02 to splash	I	2%	
9	219.5 mc FM/FM	13	14.5 kc	7.5	Cont.	T-0:02 to splash	I	2%	
10	219.5 mc FM/FM	14	22.0 kc	7.5	Cont.	T-0:02 to splash	I	2%	
11	219.5 mc FM/FM	15	30.0 kc	7.5	Cont.	T-0:02 to splash	I	2%	
12	219.5 mc FM/FM	16	40.0 kc	7.5	Cont.	T-0:02 to splash	I	2%	
13	219.5 mc FM/FM	17	52.5 kc	7.5	Cont.	T-0:02 to splash	I	2%	

2.3 Telemetry (cont'd.)

ITEM NO.	LINK FREQ.	NO.	FREQ.	DEV. ±%	MEASURING RATE	RECORDING INTERVAL	CLASS	ACCURACY ±%	REMARKS
13	219.5 mc PAM/FM/FM	18	70.0 kc	7.5	300/sec.	T-0:02 to splash	I	2%	Commutated Channel, 30 x 10 per sec.
14	228 mc FM/FM	18	70.0 kc	7.5	Cont.	T-0:02 to splash	I	2%	Transmitter in Ejected package
15	240.2 mc FM/FM	1-18	Duplicate output on 219.5 mc link given in detail above. A 5 watt transmitter and quadraloop antennas are used primarily for testing these antennas on the Black Brant II rocket (1 watt transmitter and blade antennas on 219.5 mc link).						

2.3.1 Recordings

The following recordings on magnetic tape are requested: (From T-0:02:00 to splash)

Track	Record
1	Timing Signals, IRIG Format "B" and "C" and received radar pulse.
2	Received Signal Strengths
3	Link #2 (228 mc) telemetry - ejected package
4	Voice Countdown, tape servo reference, and radar data
5	Link #1 (219.5 mc) telemetry - nose cone/ blade antennas
6	Link #1 (219.5 mc) telemetry - nose cone/ blade antennas
7	Link #3 (240.2 mc) telemetry - nose cone/ quadraloop antennas

The tape servo reference to be recorded on Track 4 should be a 17 kc square wave, modulated 50% by a precision 60 cps supply. A 100 kc sinusoidal reference is to be recorded on track 5 along with the telemetry signals.

Two timing signals are requested:

(a) standard time, Format "B", with a 1 kc carrier.

(b) standard time, Format "C", with a 100 cps carrier.

First motion is to be indicated by an increase in amplitude of the timing signals (level increased by three times).

The signal strength information of the 219.5 mc link, and the 228 mc link, is to be recorded from T-0:02:00 to impact. This will be recorded on Track 2 as FM information, using a set of voltage-controlled subcarrier oscillators supplied by the Range User.

RECEIVED SIGNAL STRENGTH ON TRACK 2

Link	Antenna	Subcarrier Freq.	IRIG No.
219.5 mc	Range T/M	3.9 kc	9
"	User Circular Pol.	5.4 kc	10
"	User Vert. Pol.	7.35 kc	11
"	User Horiz. Pol.	10.5 kc	12
240.2 mc	User Circular Pol.	14.5 kc	13
"	User Vert. Pol.	22.0 kc	14
"	User Horiz. Pol.	30.0 kc	15
228 mc	User Circular Pol.	40.0 kc	16
"	User Vertical Pol.	52.5 kc	17
"	User Horiz. Pol.	70.0 kc	18

2.3.2 Special Requirements

Real time paper records of the following channels is requested.

ITEM NO.	S.C.O. FREQ.	DATA FREQ. (cps)	PAPER RATE (in./sec.)	RECORD INTERVAL (sec.)	DATA
219.5 Mc FM/FM Link					
1	400 cps	5	0.4	T-2 to Impact	Langmuir probe extension
2	560 cps	5	0.4	T-2 to Impact	Package ejection
3	730 cps	5	0.4	T-2 to Impact	Micrometeorite
4	960 cps	5	0.4	T-2 to Impact	Light beacon monitor
5	3.9 kc	10	0.4	T-2 to Impact	Neutron detector 1
6	5.4 kc	81	2	T-2 to Impact	Neutron detector 2
7	7.35 kc	110	2	T-2 to Impact	Neutron detector 3
8	10.5 kc	160	2	T-2 to Impact	Plasma probe-planar signal
9	14.5 kc	220	2	T-2 to Impact	Plasma probe-3" trap A-C signal
10	22.0 kc	330	2	T-2 to Impact	Plasma probe-3" sphere A-C signal
11	30.0 kc	450	10	T-2 to Impact	Cosmic ray pitch angle unit
12	40.0 kc	600	2	T-2 to Impact	Plasma probe-3" sphere D-C signal
13	52.5 kc	790	2	T-2 to Impact	Plasma probe-3" trap D-C signal
14	70.0 kc	Commutator 30 x 10/sec.	10	T-2 to Impact	All commutated data
Ground Telemetry					
15	Direct Record	50	0.4	T-2 to Impact	Signal strength 219.5 mc link
16	Direct Record	50	0.4	T-2 to Impact	Signal strength 228.0 mc link
228 Mc FM/FM Link					
17	70.0 kc	1000	2	T-2 to Impact	Plasma probe in ejected package.

(cont'd.)

2.3.2 Special Requirements

Real time paper records of the following channels is requested.

ITEM NO.	S.C.O. FREQ.	DATA FREQ. (cps)	PAPER RATE (in./sec.)	RECORD INTERVAL (sec.)	DATA

Note: Items 1, 2, 3, 4, 15, 16 may be recorded, each equal displacement, on one paper tape.

Items 5, 6, 7, 11, 14 are desired on one paper record, each equal displacement.

Items 8, 9, 10, 12, 13, 17, are requested on one real time paper record, each equal displacement.

Paper records at 4 inches per second or slower should include timing Format C and those at faster than 4 inches per second should have timing Format B.

2.3.2 Special Requirements (cont'd.)

Range User will monitor the outputs of the 219.5 mc link in the blockhouse. For the 70 kc channel (commutated) both a 17-inch oscilloscope display and a decommutator connected to a Range User's meter panel will be used. For the other channels (IRIG 1-4 and 10-17 inclusive) the real time meter facility in the blockhouse will be used, together with an oscilloscope with differential input amplifier and a switch to select the desired channel. RFOAR is requested to provide the real time meter facility in the blockhouse and connecting wired circuits to the telemetry room in the Operations Building. Discriminator outputs giving zero and full scale meter reading for ± 7.5% deviation are required at the blockhouse. Range User may also operate a telemetry receiver, tunable discriminator, and auxiliary display oscilloscope beside the payload control console in the blockhouse. RFOAR is requested to have a telemetry antenna on the roof of the blockhouse available for use with Range User's receiver. The antenna with lead-in available to Range User in April 1963 would be suitable.

RFOAR is requested to provide discriminator outputs from the telemetry station in the Operations Building to the adjacent User preparation area. Outputs from the 3.9 kc to 52.5 kc channels inclusive of the 219.5 mc link and from the 70 kc channel of the 228 mc link are requested for monitoring with User instrumentation by User scientists.

Range User will provide an audio monitor from the output of the receiver (RFOAR) on the 219.5 mc link. This will be used by a Range User representative to observe the "event" channels during the launch phase.

RFOAR is requested to supply a ground telemetry link from the Radar Site to the Operations Building for the transmission of the coded radar data from the automatic data recording (ADR) equipment and the AGC voltage from the beacon receiver. Range User will supply the subcarrier oscillators required. These data will be recorded on track 4 of the magnetic tape recorders in the telemetry room at the Operations Building.

Calibration:

(a) 219.5 mc and 240.2 mc links: The event channels - 560 and 960 cps - are not calibrated, but will not be deviated more than ±7.5%. The 400 cps and 730 cps band channels should be calibrated in terms of a 0 to 5 volt signal for ±7.5% deviation (0 volts corresponds to a +7.5% deviation and +5V to -7.5% deviation.) This band has four state levels corresponding to the following conditions: both probes retracted (off), probe #1 extended, probe #2 extended, both probes extended.

The calibration on the subcarrier oscillators including the 3.9 kc unit and higher is 0 to 5 volts for a ±6.75%

2.3.2 Special Requirements (cont'd.)

deviation. (Zero level corresponds to +6.75% deviation and 5 volts to -6.75% deviation.) A Zener diode reference of +5 volts is connected to channel 2 of the commutator on the 70 kc subcarrier oscillator. This reference is also applied at 10-second intervals to the 3.9 kc, 5.4 kc, 7.35 kc, 10.5 kc, 40 kc and 52.5 kc subcarrier channels by a calibrator unit in the nose cone.

(b) 228 mc link: This link with the ejected package has a single subcarrier oscillator on 70.0 kc, the calibration of which is 0 to 5 volts for a ±6.75% deviation.

(c) Signal Strength: Calibration for the 219.5 mc link, the 240.2 mc link, and the 228 mc link is requested in terms of 0 to 1 millivolt, applied to the receiver or pre-amplifier input. The telemetry report should include details such as receiving antenna type, gain, and polarization, pre-amplifier and/or multicoupler gain, and diversity combiner characteristics (if used).

2.4 Other Data

Other data collected includes photographs from the parallactic cameras of the star field and light on the rocket nose cone, and other records furnished by DRNL in reduced form. This data does not require processing or reduction by RFOAR.

Range User personnel assigned to instrumentation sites are as follows:

NAME	SECURITY CLEARANCE	PURPOSE	PLACE
1 person	--	Audio monitor the composite video signal from the 219.5 mc link for observation of the low frequency "event" channels. This function may be duplicated at Range User's monitoring equipment in the blockhouse.	RFOAR, Telemetry, Operations Building

Names, location and duties of other Range User personnel will be supplied at a later date.

3.0 METEORLOGICAL SERVICES

3.1 Forecasts

Data concerning launching restriction due to weather conditions may be obtained from CARDE. The following information is requested for planning and operational purposes (concerning the nose cone payload). This information should be presented to the Range User Trial Coordinator who will be responsible for informing all Range User personnel in the Fort Churchill area. DRNL should keep the personnel at the outlying camera sites informed of anticipated weather conditions.

3.1.1 Long Range

3-5 day outlook of general weather conditions, particularly temperature, wind, and cloud cover.

3.1.2 Planning

30-72 hour forecasts (wind, cloud cover, temperature).

3.1.3 Operational

30 hour or less forecasts (wind, cloud cover, temperature). It is requested that the RFOAR meteorologist be available for consultation from T-12 hours to launch.

3.2 Observations

Rawinsonde data on wind, temperature, humidity, pressure and density is requested as close to the firing time and launch site as possible. Standard surface measurement of wind velocity, temperature and pressure are also requested commencing at T-6 hours at one-hour intervals.

It is likely that wind data will be requested to at least 2000 feet at hourly intervals from T-6 to launching for use of Range wind predictor and Range Safety Officer.

3.3 Minima

The camera sites at O'Day and Belcher must be clear of cloud cover and ground haze for a clear view of the aurora and light on the rocket. It is realized that presence of the aurora may rule out detection of the light during a portion or all of the flight. It is essential that visibility be at least 7 miles, and that the aurora be visible from the launch site and camera sites at launch time.

4.0 SUPPORT INSTRUMENTATION

4.1 Communications - General

Intercom communications (User net) are requested between the preparation area, project scientists' observation station on Operation's Building roof, blockhouse, hazardous assembly, launch bay, and DRNL. It is understood that DRNL will provide communication by SSB to the camera sites at Belcher and O'Day. DRNL is also requested to provide radio communication with PARL.

A User hard line is requested between the blockhouse and two locations in the Operations Building: (a) the Project Scientists' observation station on the roof, and (b) the User preparation area adjacent to the telemetry station. This will be used primarily for conferences between the Project Scientist and the User Vehicle Controller.

None of the transmissions need be recorded.

4.2 Radio

The Frequency Control and Analysis Facility should be available to monitor radio frequency transmissions during the test.

4.3 Wire

4.3.1 MOPS

It is requested that a loudspeaker on the missile operations intercom should be located near the checkout and control console provided by the Range User. A clock or digital display of the countdown time is also requested near the control console and in the User area in the Operations Building and the observation station on the roof. Wire communication with DRNL is required for relaying the countdown to the camera sites from T-5 minutes to the termination of the voice count.

A wire line to DRNL is requested for transmission of Range timing for time correlation of ground measurements made by DRNL with vehicle data.

4.3.2 Telephone

Telephones for Range User personnel are requested at the following locations:

a) DRNL

b) User Preparation Area in Operations Building

c) Project Scientists' Station on roof of Operations Building

d) User Area in Blockhouse.

Charges for long distance service will be borne by the Range User.

4.3.3 Umbilical Cable

The presently installed cable from the blockhouse terminates in two junction boxes on the launcher pedestal. One box contains the terminations of 70 No. 6 conductors and the other contains the terminations of 70 No. 16 conductors. There is no connection between these boxes. Cabling containing 140 No. 16 conductors connects the pedestal junction boxes to boxes mounted on the launcher boom. It is requested that the heavy wiring (No. 6 conductors) from the blockhouse be continued onto the launcher boom (i.e. replace 70 of the 140 No. 16 wires from launcher pedestal to boom with 70 No. 10 wires) or that provision be made for connections between the two junction boxes on the launcher pedestal.

Range User will supply a 15-foot cable and junction box containing interconnection panel for connection between the User payload control console and the umbilical terminal boxes in the blockhouse. A short cable and junction box with interconnection panel for connection between the umbilical terminal boxes on the launcher boom and the umbilical connector on the rocket will also be supplied by the Range User.

4.4 Timing

Timing on the magnetic tape records is requested to be:

a) IRIG Format B, 100 pps with a 1 kc carrier, and

b) IRIG Format C, 2 pps with a 100 cps carrier.

4.4 Timing (cont'd.)

First motion is to be indicated by an increase in the amplitude of the timing pulses. It is assumed that timing commences with calibration at T - 0:02.

Timing Format C is requested on all paper records at 4 inches per second or slower. Timing Format B is requested on all paper records at 10 inches per second or higher.

4.5 Sequence

NO.	FUNCTION	INTERVAL START	INTERVAL STOP	REMARKS
1	Ignition Pulse	T-0	--	--

Voice Countdown - The noise time count is requested at each minute T - 00:05:00 to T - 00:01:00, at 10-second intervals from T - 00:01:00 to T - 00:00:10, at 1 second intervals from T - 00:00:10 to T + 00:00:10, and at 10-second intervals from T + 00:00:10 to splash.

4.6 Visual Countdown and Status Indicators

NO.	FUNCTION TO BE DISPLAYED	TYPE INDICATOR	INTERVAL START	INTERVAL STOP	REMARKS
1	Range Countdown	Clock, digital preferred	T - 6 hrs.	T + 10 mins.	To be easily viewed from payload control console. Same facility desired in nose cone preparation area, in Operations Building and Project Scientists' Station on the roof.

4.7 Data Handling

Range User will obtain all data produced by the CRR from Detachment #2, USAF/OAR, Fort Churchill.

4.8 Command Control

No command control or destruct system will be used.

4.9 Other Support Instrumentation

It is requested that sound ranging equipment be used to determine impact coordinates. Recovery is not required.

5.0 MATERIAL AND SERVICES

5.1 Services

5.1.1 Power

115V, 60 cps power is requested in assembly area and blockhouse. This should consist of one 30 amp. service outlet and three 15 amp. outlets. Each service is to be independently fused.

5.1.2 Food Services

Ten NRC personnel will require food services for approximately one month. DRNL will be requested to arrange for this service and accommodation.

5.1.3 Fire Protection

No additional fire protection services are anticipated in excess of normal.

5.1.4 Medical Service

None required in excess of normal.

5.1.5 Guards and Security - NR

5.1.6 Pad Services and Engineering

A complete "dress rehearsal" of the launching is requested on the day previous to the scheduled firing. This will include installing the rocket on the launcher, performing all payload checks, and testing of all communications. All personnel and services involved in an actual launching should be involved in this system test.

5.1.7 Water - NR

5.1.8 Survey

Belcher and C'Day height finding stations relative to launcher.

5.1.9 Air

A supply of clean, dry air to pressurize the conical section of the nose cone to about 5 p.s.i.g. is requested to be available in the hazardous assembly. The fitting on the nose cone will be similar to that used on automobile tires. The Range User will supply a suitable pressure gauge.

5.2 Vehicles and Ground Handling Equipment

5.2.1 Vehicles

The rocket and all necessary hardware will be supplied to RFOAR by NRC or CARDE.

5.2.2 Ground and Heavy Equipment

RFOAR should supply suitable dollies and lifting equipment for movement of the motor and complete rocket in the assembly area and at the launcher.

5.2.3 Search Lights and Floodlights - NR

5.2.4 Other Equipment

RFOAR is requested to supply equipment for, and obtain all up weight and centre of gravity of the nose cone and of the complete vehicle. This may be done during the launch "dress rehearsal"

5.3 Propellants, Gases, Chemicals - NR

5.4 Chemical and Physical Analysis - NR

5.5 Bioscience - NR

5.6 Test Instrument Maintenance and Calibration

RFOAR is requested to supply the calibration for the signal strength records of the 219.5, 240.2 and 228 mc links. A 5-volt reference, accurate to 1/10 of 1 per cent for checking Range User's voltmeter would be desirable.

5.7 Climatic Clothing Requirements

DRNL will be requested to supply the climatic clothing requirements of Range User personnel.

6.0 TRANSPORTATION LOGISTICS

6.1 Surface

6.1.1 Personnel

On occasion, Range User personnel may wish to use the bus service provided by the Range Contractor for transport of range personnel to and from the launch site.

RFOAR is requested to have two bicycles available at the blockhouse for use by Range User personnel proceeding to and from the launch site.

DRNL will be requested for the loan of two station wagons or panel trucks for the full-time use of the User personnel attached to this program. Drivers will have DND operator's permits.

6.1.2 Cargo

DRNL is requested to provide for the unloading and transport to the Range of the nose cone and check-out equipment. RFOAR is requested to provide for the unloading and transport to the Range of the motor and fin assembly. The motor and fin assembly will arrive at Fort Churchill by air transport. Other equipment will probably arrive by air but may be shipped by rail.

It is assumed that any special equipment, such as may be required for vehicle assembly, fin alignment, etc., will be supplied by CARDE.

a) Motor in crate: 3000 lbs., 24 in. x 30 in. x 17 ft.

b) Fin assembly in crate: 300 lbs.

c) Check-out equipment: Estimate is for about 60 wooden boxes, each weighing between 20 and 200 lbs. Total weight about 6000 lbs.

d) Nose cone and payload in crate: Approximately 350 lbs., 24 in. x 24 in. x 10 ft.

Item (c) includes equipment used in other launch programs sponsored by NRC during the same time period.

6.1.2 Cargo (cont'd.)

Item (d) will arrive at Fort Churchill by air about F-7 on the same plane as the main group of range user personnel.

6.2 Air - NR

7.0 RECOVERY

No recovery is required.

8.0 AIRCRAFT AND SEACRAFT

A helicopter for up to five men and as much as 500 lbs. of equipment may be required for transport to Belcher and O'Day.

9.0 DATA PROCESSING AND DISPOSITION

9.1 General Information

After the one-year period of retention, all raw data is to be released to NRC (Radio & Electrical Engineering Division, Attention: Mr. W.L. Haney).

After the two years retention period, all file copies of the Flight Test Report are to be released to NRC (Radio and Electrical Engineering Division, Attention: Mr. W.L. Haney).

If all NRC personnel have departed from the range before data is available, data should be forwarded to NRC (Radio and Electrical Engineering Division, Attention: Mr. W.L. Haney).

9.2 Disposition of Data

ITEM NO.	DESCRIPTION	ORIG.	CYS.	TIME REQUIRED	FINAL RECIPIENT	AGENCY TO PICK UP DATA	TYPE OF PRESENTATION	REMARKS
	9.2.1 Metric Data							
	9.2.1.1 Launch to Impact							
1	Position		1	T+6H	CARDE	NRC	R-PLOT	note (a)
		1	1	T+6H	NRC	NRC		
2	Position, Velocity, Trajectory Angles ($X, Y, Z, V_X, V_Y, V_Z, V_S, \theta, \phi$)		5	T+30 CD	NRC	NRC	F-TRPT and F-PLOT	note (b)
			1	T+30 CD	CARDE	NRC		
	9.2.1.2 Impact							
3	Impact Coordinates		1	T+10	CARDE	NRC	F-FRPT	
			1	T+10	NRC	NRC		

Note (a) - Real time plotting board data of range, azimuth, and elevation is requested.

(b) - This report should include tabulated data and plots of position, velocity, and trajectory angles with time. The method of smoothing data should be explained.

9.2 Disposition of Data (cont'd.)

ITEM NO.	DESCRIPTION	ORIG.	CYS.	TIME REQUIRED	FINAL RECIPIENT	AGENCY TO PICK UP DATA	TYPE OF PRESENTATION	REMARKS
	9.2.2 Photography							
4	Still Photos and Documentary Film		1	T+15	NRC	NRC	R-PHOTO	Note (c)
	9.2.3 Telemetry							
	9.2.3.1 Recording							
5	Magnetic tape recording of telemetry data	1		T+5 CD	NRC	NRC	R-MAGT	5.2.1.1(3)
			1	T+5 CD	NRC	NRC	R-MAGT	5.2.1.2(3)
			1	T+5 CD	NRC	NRC	R-MAGT	5.3.1.3(3)
	9.2.3.2 Special Requirements							
6	Real time paper records		1	T+12 H	NRC	NRC	R-GRAF	
	9.2.4 Other Data - DRNL							
7	Magnetic recording of voice countdown, Records and reduced data from DRNL observations	1		T+15CD	NRC	NRC	F-FRPT and R-MAGT	
	9.3 Meteorological Data							
8	Report on all requested observations		1	T+15	CARDE	NRC	F-FRPT	
		1	3	T+15	NRC	NRC		

Note (c) - One negative of all photos (still and movie documentary) and one copy of the processed documentary are requested.

9.2 Disposition of Data (cont'd.)

ITEM NO.	DESCRIPTION	ORIG.	CYS.	TIME REQUIRED	FINAL RECIPIENT	AGENCY TO PICK UP DATA	TYPE OF PRESENTATION	REMARKS
	9.3 Meteorological Data (cont'd.)							
9	Final report on all requested observations		3	T+30 CD	NRC	NRC	F-FRPT	
	9.4 Support Instrumentation - NR							
	9.5 Material and Services Report - NR							
	9.6 Transportation Reports							
10	Receiving and Shipping Report		1	T+30	NRC	NRC	F-FRPT	All equipment in and out of Fort Churchill
	9.7 Recovery Reports - NR							
	9.8 Aircraft Reports - NR							

10.0 FACILITIES

10.1 Facilities - General

(1) Storage for equipment crates of about 200 sq. ft. area by 8 ft. high. It is requested that no Range User equipment be stored where the equipment temperature may become lower than 0°F.

(2) Preparation area of about 300 sq. ft. for nose cone assembly and check-out.

(3) Hazardous storage for the motor, igniter and squib is requested.

(4) About 100 square feet of space is requested in the blockhouse for the payload checkout console and associated equipment (power supplies, battery chargers, receiver, discriminators, display oscilloscopes, etc.).

(5) Office space and telephone at DRNL.

(6) An observation station on the roof of the Operations Building for use of the Project Scientist. A suggested plan for this station has been forwarded to the Range. A telephone, an intercom on the User net, and a hard line to the User area in the blockhouse would be desired at this station, also a digital clock of range countdown.

These facilities are requested for the period January 3rd, 1964 to February 3rd, 1964.

11.0 RANGE SAFETY

RFOAR is responsible for all range safety.

CLASSIFICATION

This document is Unclassified.

RF

APPENDICES

I. Vehicle Drawing

II. Nosecone Drawing

III. Ordnance Items Locations

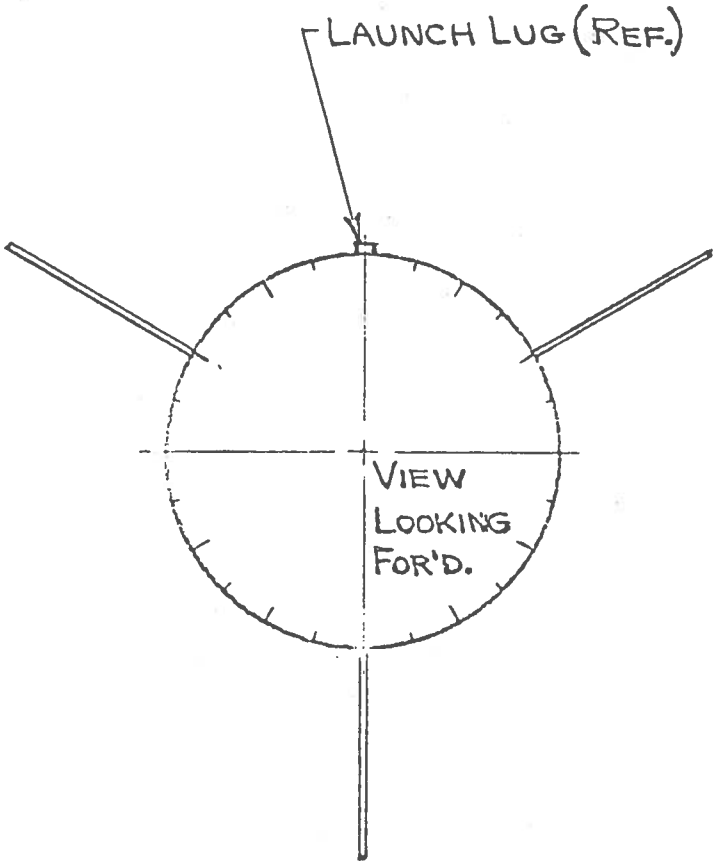
IV. Squib Firing Circuit

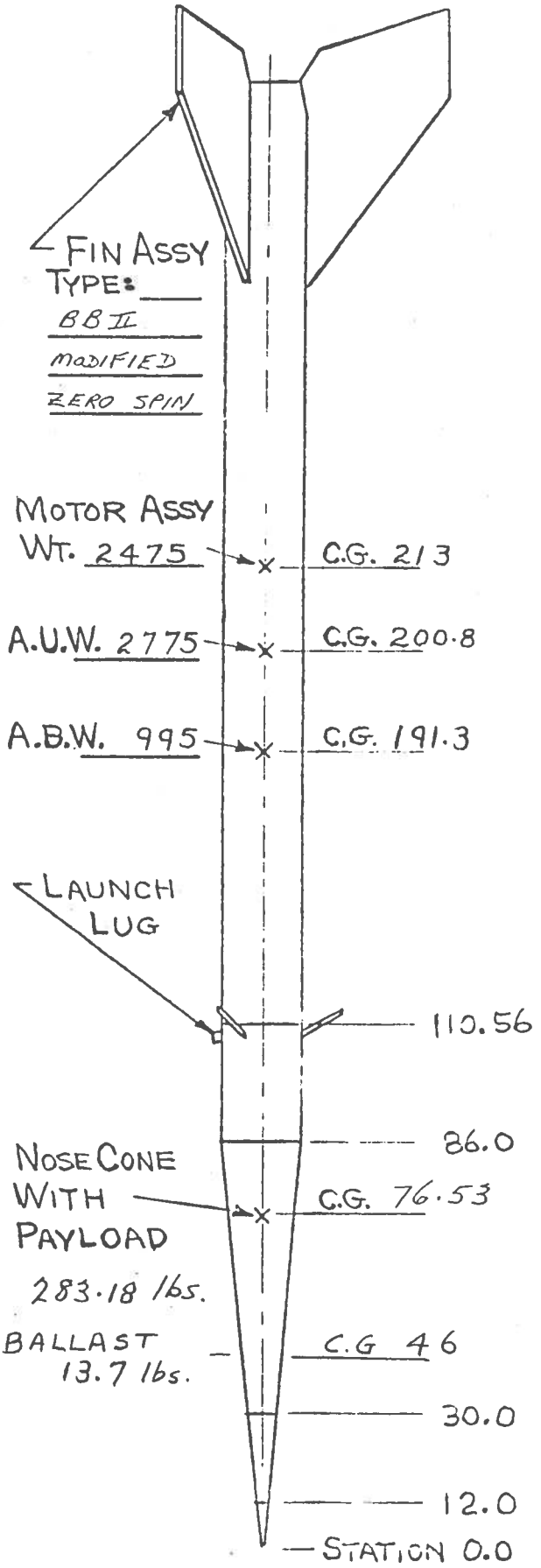
V. Range User Equipment

VI. Monitor and Control System

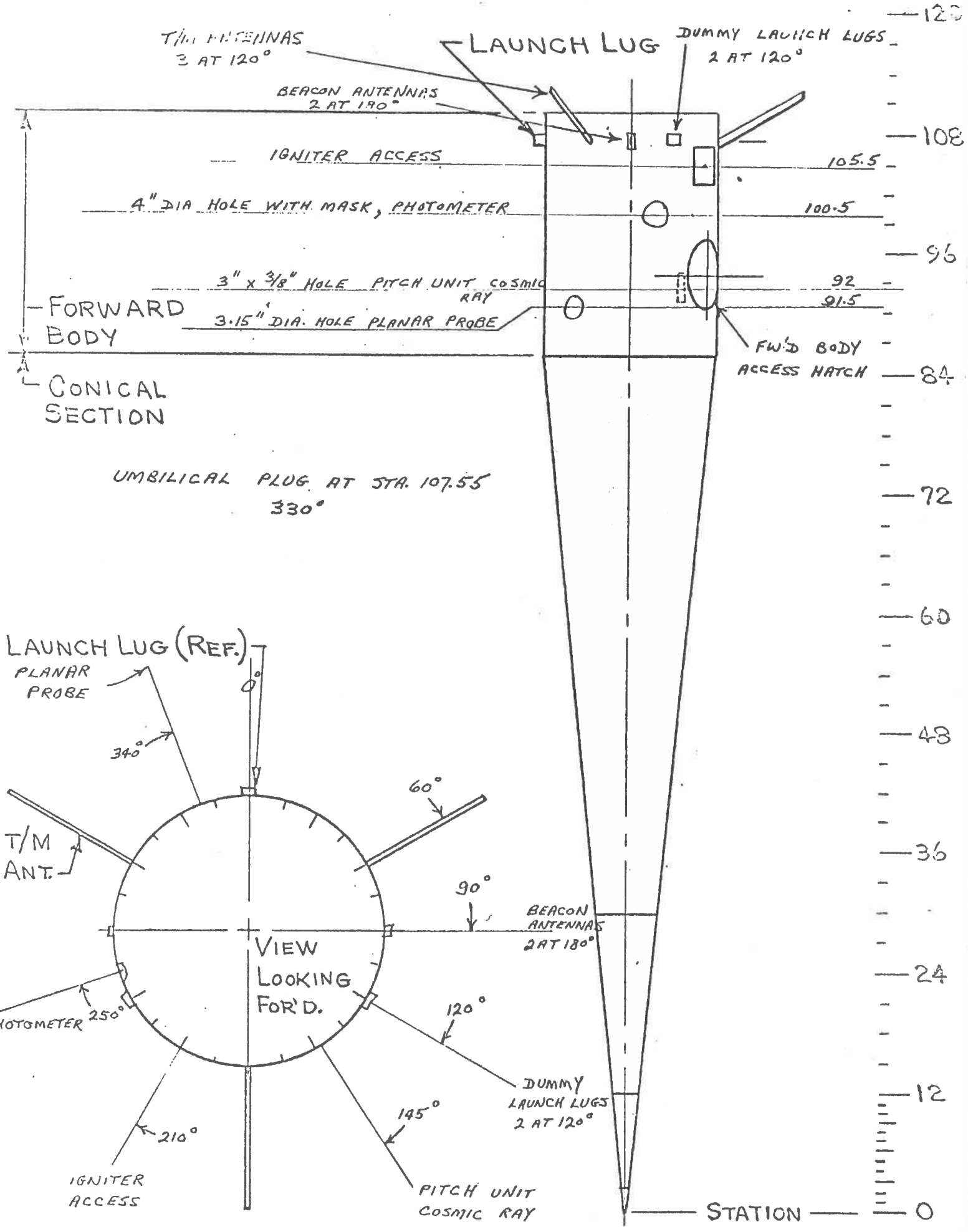
VII. Range User Support Instrumentation

APPENDIX I

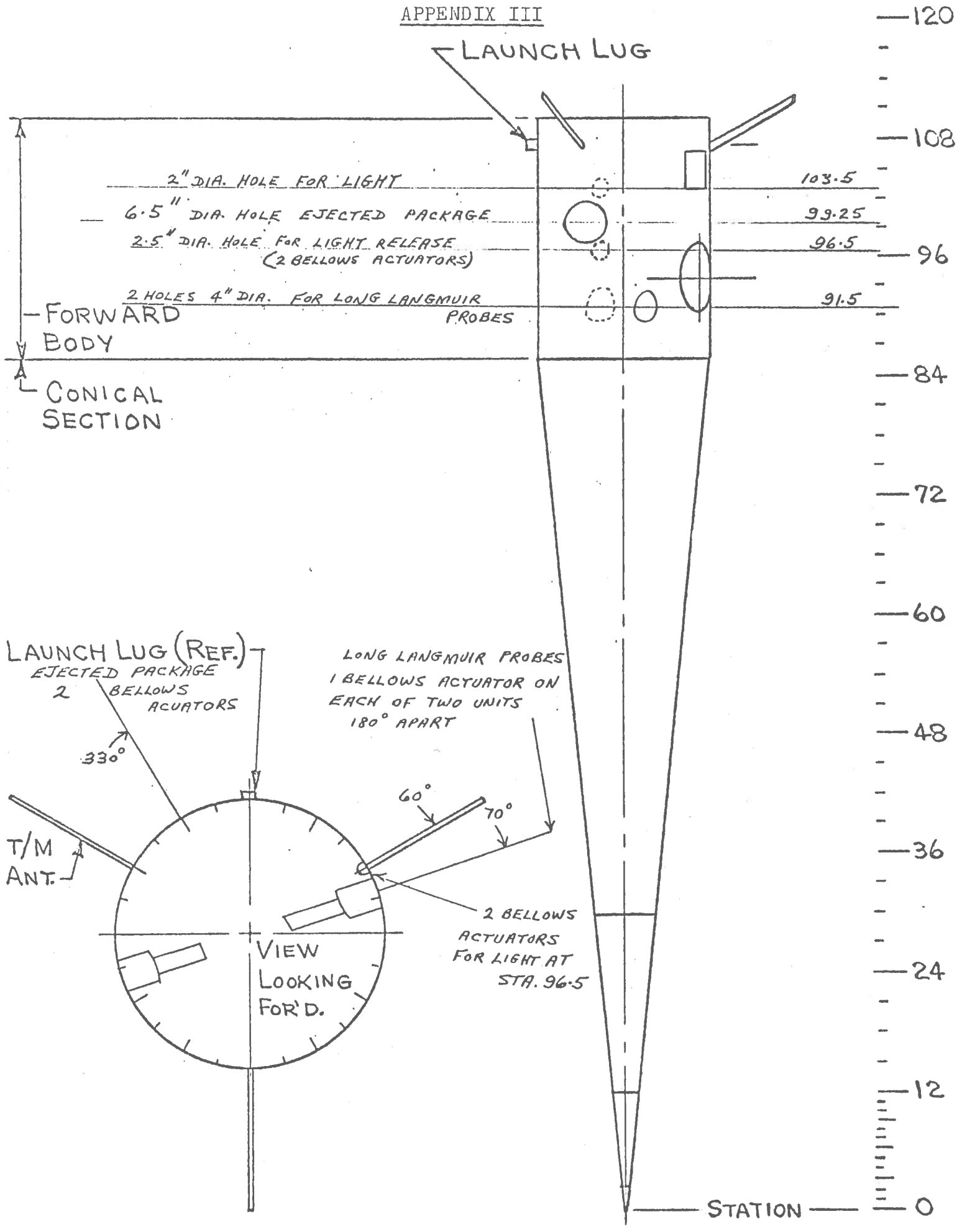

LAUNCH LUG (REF.)
VIEW LOOKING FOR'D.


FIN ASSY TYPE: BB II MODIFIED ZERO SPIN
MOTOR ASSY WT. 2475
C.G. 213
A.U.W. 2775
C.G. 200.8
A.B.W. 995
C.G. 191.3
LAUNCH LUG
110.56
86.0
NOSE CONE WITH PAYLOAD
283.18 lbs.
C.G. 76.53
BALLAST 13.7 lbs.
C.G 46
30.0
12.0
STATION 0.0

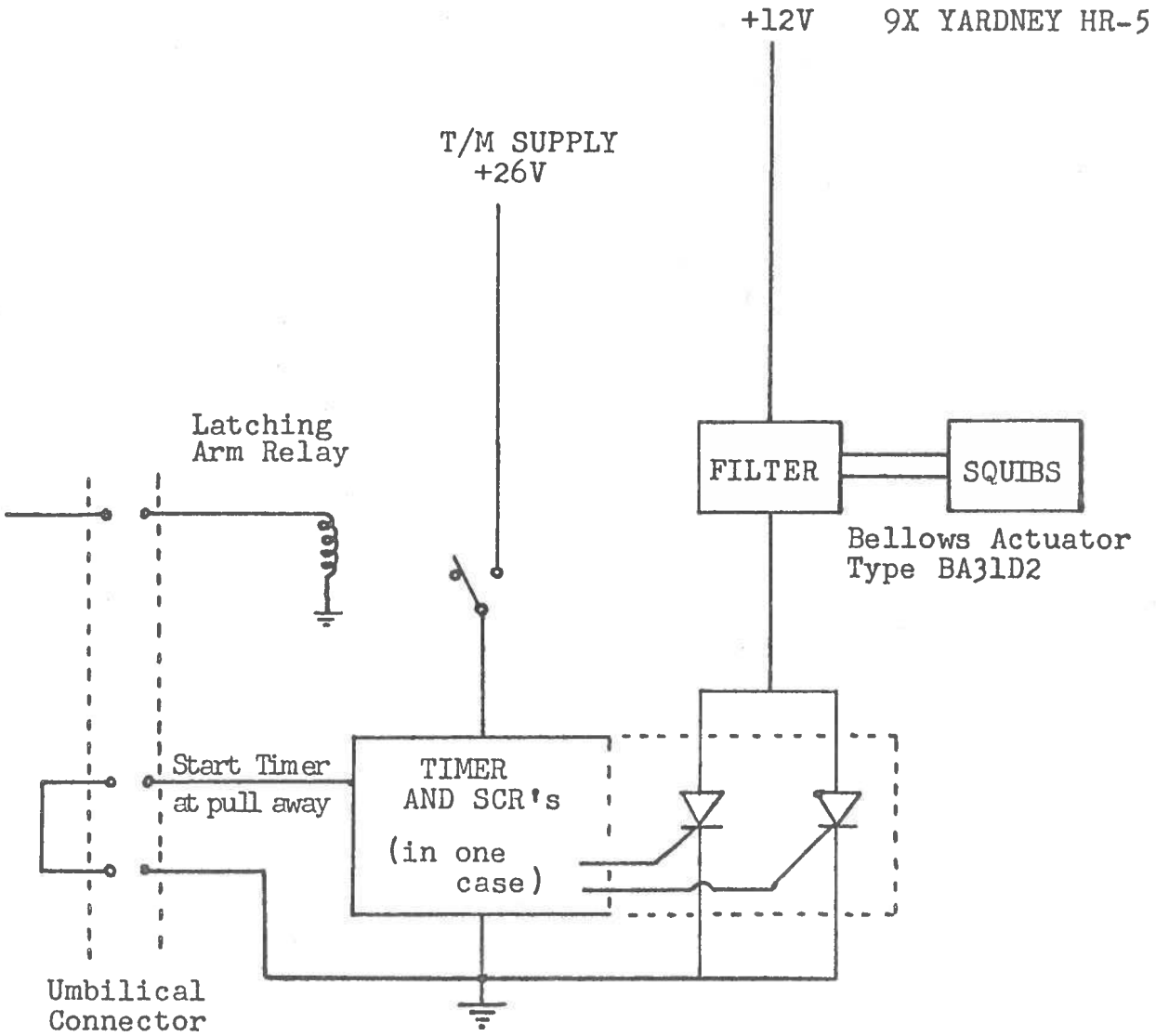
APPENDIX II


T/M ANTENNAS 3 AT 120°
LAUNCH LUG
DUMMY LAUNCH LUGS 2 AT 120°
BEACON ANTENNAS 2 AT 180°
IGNITER ACCESS
105.5
4" DIA HOLE WITH MASK, PHOTOMETER
100.5
3" x 3/8" HOLE PITCH UNIT COSMIC RAY
92
3.15" DIA. HOLE PLANAR PROBE
91.5
FORWARD BODY
CONICAL SECTION
FW'D BODY ACCESS HATCH
UMBILICAL PLUG AT STA. 107.55
330°
LAUNCH LUG (REF.)
PLANAR PROBE
0°
340°
60°
T/M ANT.
90°
BEACON ANTENNAS 2 AT 180°
VIEW LOOKING FOR'D.
PHOTOMETER
250°
120°
DUMMY LAUNCH LUGS 2 AT 120°
210°
145°
IGNITER ACCESS
PITCH UNIT COSMIC RAY
STATION
120
108
96
84
72
60
48
36
24
12
0

APPENDIX III



APPENDIX IV



SQUIB FIRING CIRCUIT

AA-II-25	--	1 Circuit
AA-II-41	--	2 Circuits
AD-II-42	--	2 Circuits

APPENDIX V

PRELIMINARY LIST OF RANGE USER EQUIPMENT FOR FALL FIRINGS AT FORT CHURCHILL

Panoramic Telemetering Indicator, Model TMI-Ib

Telemetering Test Oscillator, HP Model 200TR

FM-AM Signal Generator, Boonton Model 202G

Telemetry Receivers, Nems Clarke Model 1433 (two)

Telemetry Receivers, Nems Clarke Model 1432

Telemetry Receivers, Nems Clarke Model 1501A

Telemetry Receivers, Defence Electronics Model TMR-2A

Oscilloscope, 5", HP Model 122AR

Oscilloscope, 5", Tektronic Model 536

Oscilloscope, 3", Tektronic Model 310

Oscilloscope, 3", Tektronic Model 316

Oscilloscope, 17", I.T.T. Model 1735-0

Counter, Computer Meas. Model 225-C

V.T.V.M., HP Model 400 HR

Voltmeter, Digital, HP Model 405 CR

Telemetry Calibrator, Dynatronics Model 612

Tunable Discriminator, EMR Model 97H

Variable Filter, EMR Model 95F

Power Supplies 0-36V, Harrison Labs Model 808A

Power Supplies 0-36V, Harrison Labs Model 809A

Power Supplies 0-36V, Harrison Labs Model 814A

(cont'd.)

Spectrum Display, Nems-Clarke Model 200-3

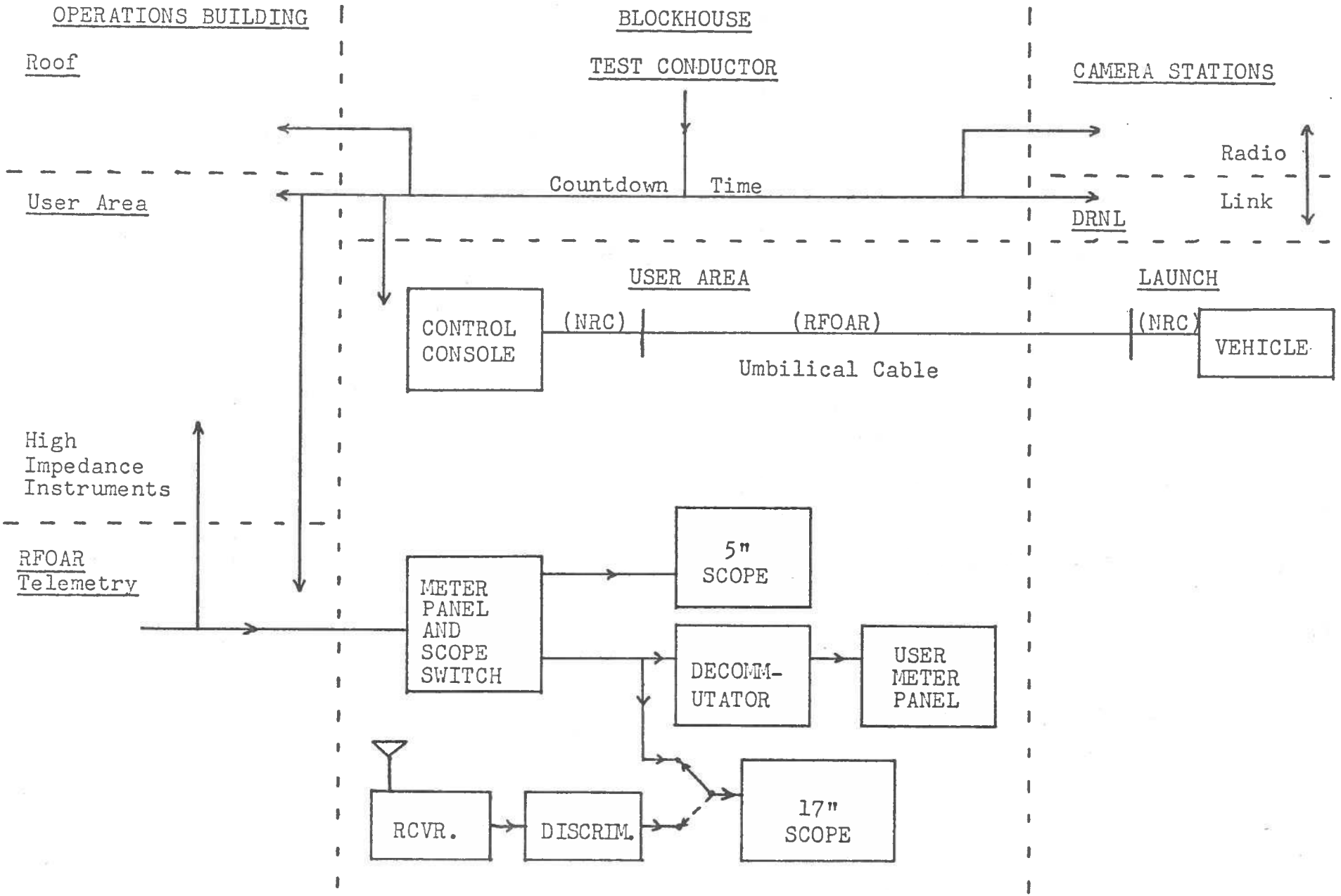
Multicoupler, Nems-Clarke Model MC-406-45-237

Pre-amplifier (RF), Nems-Clarke Model PR-203-45-237

Audio Amplifier, Heathkit Model EA-3

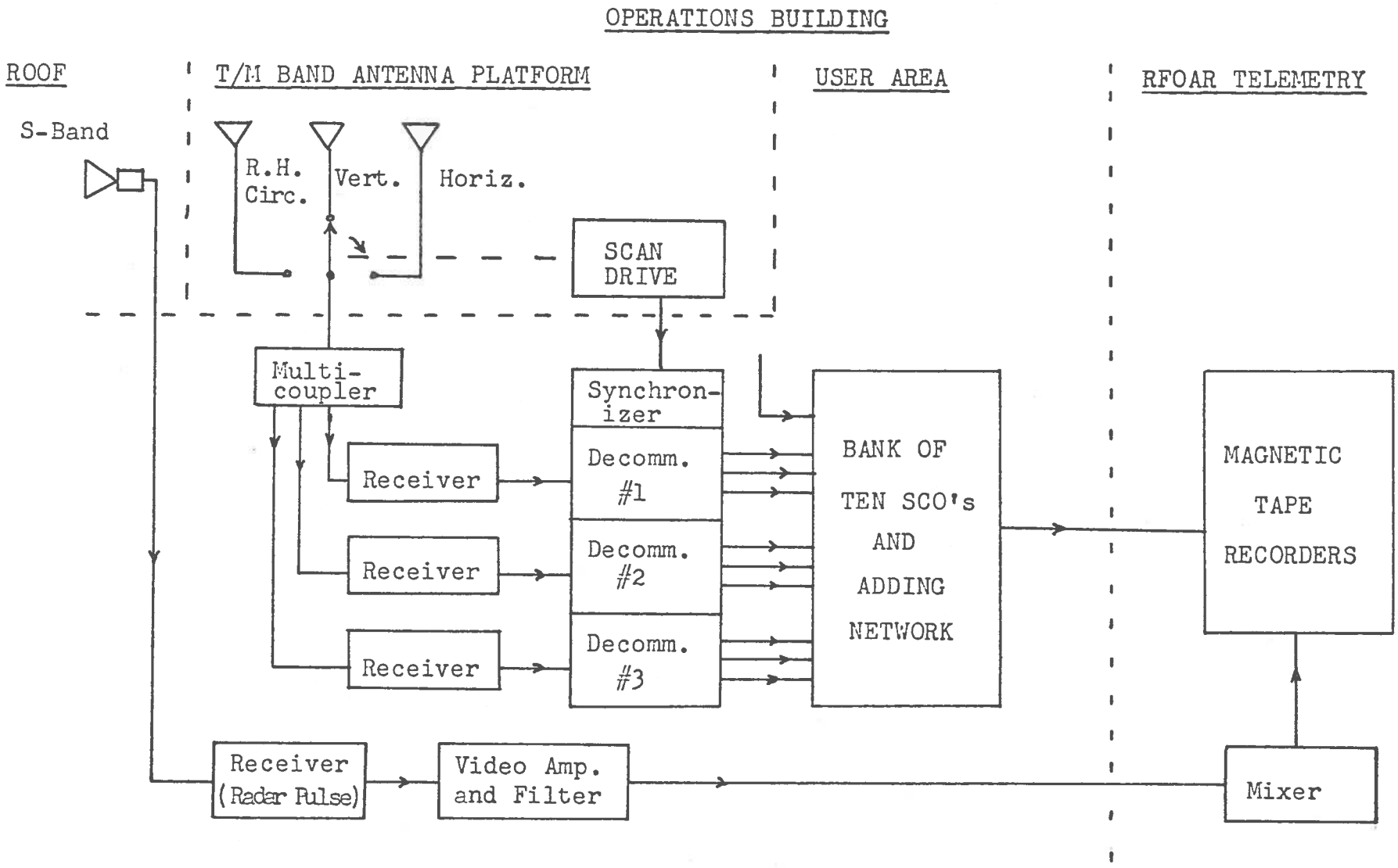
Subcarrier Oscillators, antennas S-band receiver, camera, etc.	Range User Support Instrumentation
Control & Monitor Console, Meter Bank, etc.	Range User Control and Monitor Instrumentation

Decommutator, Arnoux Type TDS-300



APPENDIX VI

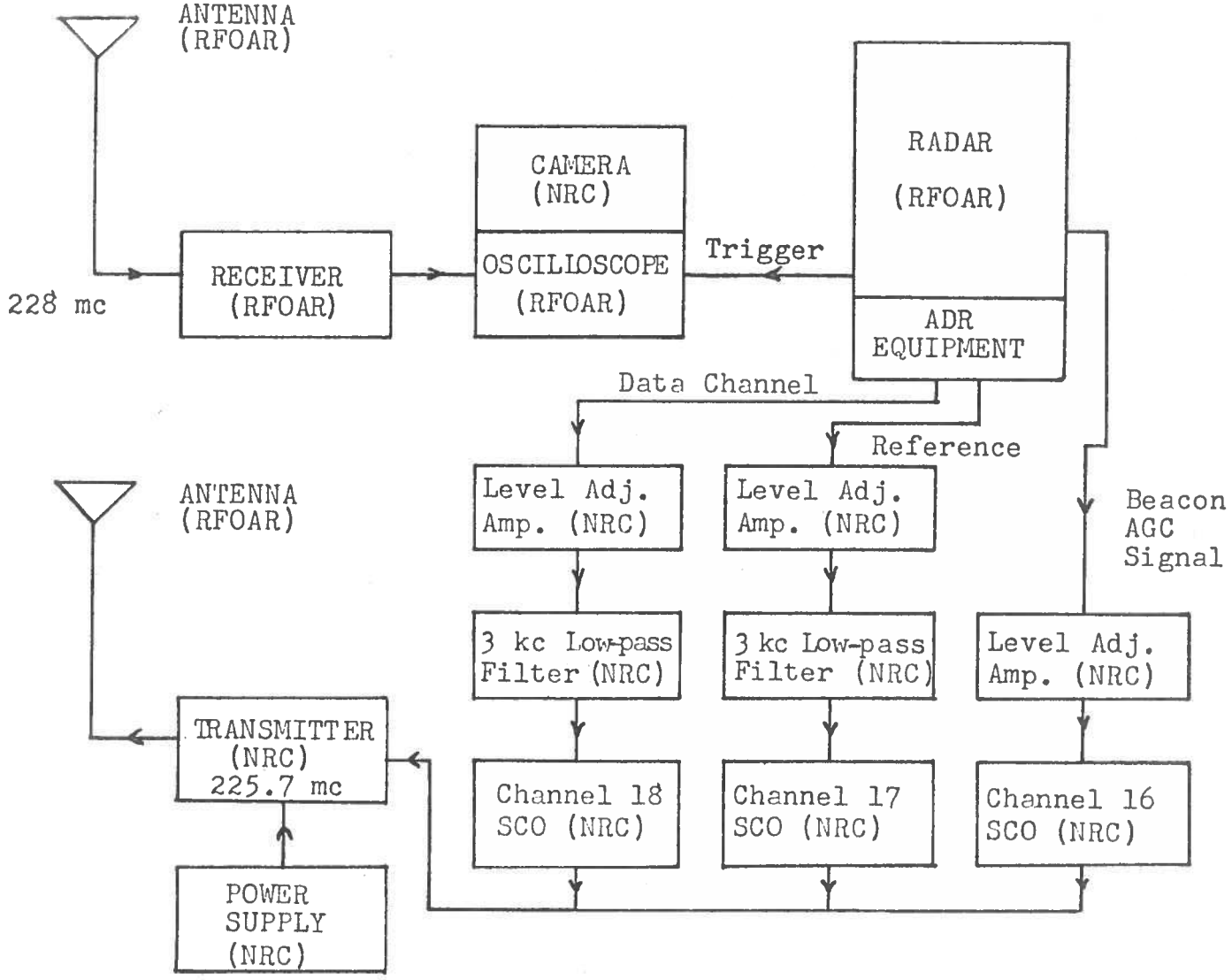
MONITOR AND CONTROL SYSTEM



APPENDIX VII (Sheet 1)

RANGE USER SUPPORT INSTRUMENTATION

RADAR SITE



APPENDIX VII (Sheet 2)

RANGE USER SUPPORT INSTRUMENTATION