One Black Brant IIA, upper atmosphere research launch: vehicle no. AA-II-103

National Research Council of Canada. Radio and Electrical Engineering Division

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A. Stanifortl

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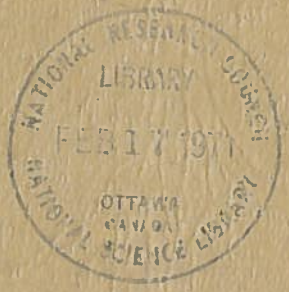

OPERATIONS REQUIREMENT FOR BLACK BRANT ROCKET AA-II-103

PREPARED BY

RADIO AND ELECTRICAL ENGINEERING DIVISION

O.R. 170

OTTAWA

OCTOBER 1965

UNCLASSIFIED

ANALYZED

OPERATIONS REQUIREMENT NO. 170

One Black Brant IIA, Upper Atmosphere Research Launch

Vehicle No. AA-II-103

ABSTRACT

This OR is for the launching of one Black Brant IIA rocket at night during a period of enhanced auroral activity. The vehicle will carry an auroral photometer, plasma probe, a soft electron spectrometer, a photoionization chamber and photometer, a cosmic ray experiment and will eject an ionospheric inhomogeneities experiment during the flight. Ground station recording of three telemetry links is required together with radar tracking. A special ground station for User equipment is required at the former SHC Alert area. Mr. E.E. Budzinski is the Project Scientist. The vehicle has been instrumented by the Radio and Electrical Engineering of the National Research Council and contains experiments by the Upper Atmosphere Research Section, Cosmic Ray Section, DRTE, University of Saskatchewan and University of Western Ontario.

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OR ANNEX CONTROL SHEET

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1 October 1965 OR 170

TEST SECURITY CLASSIFICATION

The security classification of information in this OR is UNCLASSIFIED.

1.0 GENERAL INFORMATION

1.1 Operations Command

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

Project Coordinator:	A. Staniforth, NRC
Project Scientist:	E.E. Budzinski, NRC
Mission Controller:	Capt. E.W. Rance, NRC
Payload & Ground Instrumentation:	NRC personnel to be named.

Additional personnel from the Universities of Alberta, Western Ontario and Saskatchewan will be present at Fort Churchill in connection with this program. Names of such personnel will be advised later.

It is expected that Mr. W.L. Haney of NRC will be present as an observer during this test.

Times and dates of arrival of all personnel will be passed to CRR approximately two weeks prior to the arrival of the team at the Range.

1.2 Range Time Utilization

1.2.1 Test Duration and Frequency

This OR requests range time and range support to launch one Black Brant IIA rocket into the upper atmosphere under specific (see 1.3.1) conditions of weather and auroral activity to satisfy the requirements of several upper atmosphere experiments. The duration and frequency of the tests required to meet this objective cannot be predicted and day-to-day rescheduling will be required until the desired conditions are met. This launching will be nighttime launching.

Range User equipment and personnel will be at CRR for approximately one month to carry out this test and, also, launchings under OR's 171 and 172.

1.2.2 General Countdown

TIME	FUNCTION/SERVICE
Preparation Phase:	
F-5 day (approx.)	Nose cone, nose cone instrumentation, check-out equipment and nose cone control unit arrive at Fort Churchill.
	Range User personnel arrive at Fort Churchill.
F-4 day (approx.)	Range User personnel begin setting up check-out equipment and preparation of nose cone instrumentation.
F-1 day	Nose cone preparation complete. Move nose cone, payload control console, power supplies, etc., to blockhouse if not moved before. Battery charging complete. Install all batteries to payload. Complete instrumentation check-out with nose cone shroud off.

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE	RESP.
F-1 day (cont'd.)	Range install radar beacon and check operation. Magnetometer check. Check complete length of umbilical cable from console in blockhouse to vehicle 50-pin connector with test box.	Range
Launch Phase:		
T-360	Final visual inspection of payload and battery check.	User
	Assemble nose cone shroud to payload.	User
T-250	All Range User personnel on station.	MC
T-240	Move nose cone to Hazardous Assembly.	User
T-220	Obtain weight and C. of G. of nose cone.	User/LS
	Assemble nose cone to motor.	User/LS
	Obtain weight and C. of G. of complete vehicle.	User/LS
	Remove strippable paint and clean nose cone.	User
T-180	Vehicle brought to Launch Bay.	LS/TC
	Range begin count with Range User.	All
T-170	Install vehicle on launcher.	LS/TC
	Check that payload control console is disconnected from umbilical cable.	MC/TC
	Connect umbilical to vehicle.	User/MC/TC
	Connect radar beacon batteries.	User/MC/TC

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE	RESP.
T-170 (cont'd.)	Install access hatch in forward body temporarily.	User/MC/TC
	Clean nose cone.	User/MC/TC
T-140	Clear Launch Bay for Horizontal Instrumentation Checks.	LS/TC
	Connect control console to umbilical.	MC/TC
T-135	Begin horizontal instrumentation checks.	All
T-95	Horizontal checks completed. Stations report results of checks.	
T-90	Disconnect BH control console from umbilical.	MC/TC
T-60	Arm vehicle.	TC/LS
T-30	Elevate launcher.	TC/LS
T-20	BH control console connected to umbilical.	MC/TC
T-15	Begin Vertical Instrumentation checks.	All
T-8	Vertical checks complete.	MC/TC
T-5	Voice count at 1-minute intervals to T-2 minutes	TC
T-3.5	Hold for aurora, resumption of count on 30 seconds notice.	All
	Radar interrogate beacon continuously for remainder of test, unless hold occurs.	RDR

1.2.2 General Countdown (cont'd.)

TIME	FUNCTION/SERVICE	RESP.
T-2.5	MC advise TC of intentions regarding hold at T-90 seconds for aurora.	MC/TC
T-2	If hold at T-90 seconds is <u>not</u> being called:	
	TLM paper recorders on at slow speed.	TLM
	TLM magnetic tape recorders on high speed.	TLM
	TLM acknowledge recorders on.	TLM
	Payload latch power on and commence 2.5V (midband) calibration.	User
T-110 sec.	5-volt calibration (lower edge).	User
T-100 sec.	0-volt calibration (upper edge).	User
T-90 sec.	Hold for aurora, resumption of count on 30-seconds notice. After 1/2 hr. re-cycle to 3.5 min.; PS may request re-cycle at less than 1/2 hr. to allow 1/2 hr. hold at T-90 sec. at more opportune time.	All
	<u>Note:</u> Telemetry real time and magnetic recorders and payload T/M links to come on prior to resumption of count as soon as warning given by TC that count is to be picked up.	
	Voice count at 10-second intervals to T-10 seconds.	TC
	Radar beacon to internal power.	RD
	Link No. 1, 3 cycles of 11-step (0 to 5 volts) calibration.	User
	Multiplex relays to transfer position.	User

1.2.2 General Countdown (Cont'd.)

TIME	FUNCTION/SERVICE	RESP.
T-75 sec.	T/M Link No. 1 to signal inputs and in-flight calibrator on.	User
T-40 sec.	T/M real time recorders to flight speed.	TLM
	Payload multiplex relays to flight position.	User
	Remove latching power.	User
T-30 sec.	Payload status light to "GO"	MC
T-10 sec.	Voice count at 1-second intervals to T+10 seconds	TC
T-0 sec.	Black Brant motor ignites.	
T+10 sec.	Voice count at 10 sec intervals to impact.	TC
T+15.5 sec.	Rocket motor burns out.	
T+30 sec.	Multiplex relay transfer.	
T+50 sec.	Nose cone tip ejects.	
	1/4" dia. Probe projects.	
T+55 sec.	Ionospheric Inhomogeneities package ejects (Link 3, 108 mc)	
T+197 sec.	Apogee (approximately 545,000 ft.)	
T+400 sec.	Impact.	
T+10 min.	Radar AGC, Telemetry AGC, 30 mc Riometer calibration.	

1.3 Test Objectives

1.3.1 Primary

The upper atmosphere experiments and measuring devices carried on this vehicle require that it be launched during a period of solunar darkness when wind conditions are acceptable and;

a. An auroral event exists, as follows, either one being sufficient to justify a launching:

(1) Absorption, 2 db, plus visual intensity I on the trajectory; or

(2) Aurora intensity III on the trajectory.

b. After two days on launcher without satisfying the above minimum conditions, when all other requirements were in "GO" configuration, conditions will be relaxed to accept;

Absorption 1 db. plus

Visual Intensity II on trajectory.

1.3.2 Secondary

To monitor and record the trajectory and performance of vehicle AA-11-103. Magnetometer, accelerometer and temperature measurements will be taken to assist in the evaluation of vehicle performance and attitude.

1.4 Test Description

1.4.1 General

Black Brant IIA rocket AA-11-103 will carry several experiments in its nose cone for scientific investigation of the upper atmosphere. It is desired that this vehicle be launched from the universal launcher to obtain an effective elevation of 85°. There is no preferred azimuth and recovery is not required.

1.4.2 Experiments

The experiments, as detailed below, require that this vehicle be launched when specific geophysical conditions exist along the trajectory. These conditions are specified under para. 1.3.1. The experiments to be flown are;

a. An auroral photometer for evaluation as a rocket borne instrument. This photometer is a four channel instrument containing filters to separate specific wavelength in the visible spectrum. It is similar to the photometer flown under OD152 in March 1965 and is again mounted looking forward at the front end of the nose cone. The photometer will be exposed by blowing off the nose cone tip, at about station 30, when the vehicle is at approximately 210,000 ft. However, for this test the basic unit has been improved by the addition of two more photomultipliers to give four wavelength channels all having identical fields of view. The two channel photometer will be used to get temperatures, as was attempted in March 1965, and the other two channels to detect brightness fluctuations (U. of S.);

b. Plasma probe measurements of the fine structure of electron density and electron energy spectrum inside and outside auroral formations (NRC);

c. A soft electron spectrometer that will measure the spectrum of electrons in the range between approximately 40 ev and 10 Kev; this energy range is of special importance in producing optical aurora. (DRTE);

d. A photoionization chamber and a photometer. The object of this particular experiment is to measure the intensity of vacuum ultraviolet bands of nitrogen in aurora using a photoionization chember and to compare it with the visible intensity of the aurora as measured with a photometer (DRTE);

e. Cosmic ray experiments concerned with the study of particules associated with auroral activity (NRC);

f. A measurement of ionospheric inhomogeneities using an ejected package carrying a CW transmitter (UWO).

1.4.3 Performance and Timings

In addition this vehicle will carry a photometer to indicate periods during which the vehicle is within an auroral formation plus magnetometers, accelerometers and altitude switches for vehicle altitude and performance evaluation. Events of primary importance during the flight are;

a. Multiplex reply transfer at T+30 seconds;

b. Nose cone ejection at T+50 seconds;

c. Extension of plasma probes at T+50 seconds;

d. Ejection of the ionospheric inhomogeneities package at T+55 seconds;

e. Motor burnout, apogie and impact are other items of interest.

1.4.4 Personnel

Range User personnel will attend to all details of the payload and nose cone assembly, check-out and monitoring and will;

a. Man the NRC nose cone instrumentation console in the blockhouse;

b. Monitor equipment in the nose cone assembly area of the operations building;

c. Man the ionospheric inhomogeneities ground station;

d. Monitor equipment in, and upper atmosphere conditions from, the scientists' observation platform;

e. Require access to the nose cone in the launch bay during the horizontal instrumentation checks.

1.5 Test Vehicle Description

The Black Brant IIA is a single stage, solid propellant, unguided sounding rocket developed by the Canadian Armament Research and Development Establishment. The rocket for this test will use a 15KS25000 motor filled at Bristol Aerospace Limited, Winnipeg and airlifted to

1.5 Test Vehicle Description (Cont'd.)

Churchill together with motors for ORs 171, 172, 173 and 174. The stabilizer unit will be the standard Black Brant II, four fin unit. This unit will be shipped to Churchill from Montreal by rail and is to be assembled, aligned and trimmed at Churchill. The Range User will arrange for a factory representative to align and trim the stabilizer, and the stabilizer units for the other ORs, to produce a vehicle roll rate of approximately 0.75 rps maximum stabilizing to approximately 0.65 rps.

Operation and handling instructions for the 15KS25000 motor are detailed under CARDE TN 1528/63 copies of which are held by the Range.

Length	-	330.5 inches (approx.)
Diameter	-	17.2 inches
Launch Weight	-	2700 lbs. approx.
Weight at Burnout	-	920 lbs. approx.
Propellant	-	Aluminized single grain polyurethane-ammonium perchlorate
Total Impulse (sea level)	-	380,000 lbs.
Motor Burning Time	-	15.5 seconds
Guidance	-	None. 4 fixed-fin stabilization
Cut-down System	-	None

Final weighing of the vehicle prior to launch may require minor corrections to performance predictions based on actual vehicle all up weight. All performance calculations quoted are based on a vehicle all up weight of 2,680 lbs.

1.5.1 Complete Vehicle Drawing

1.5.1.1 Vehicle Drawing

See Figure 1

1.5.1.2 Nose Cone Drawing

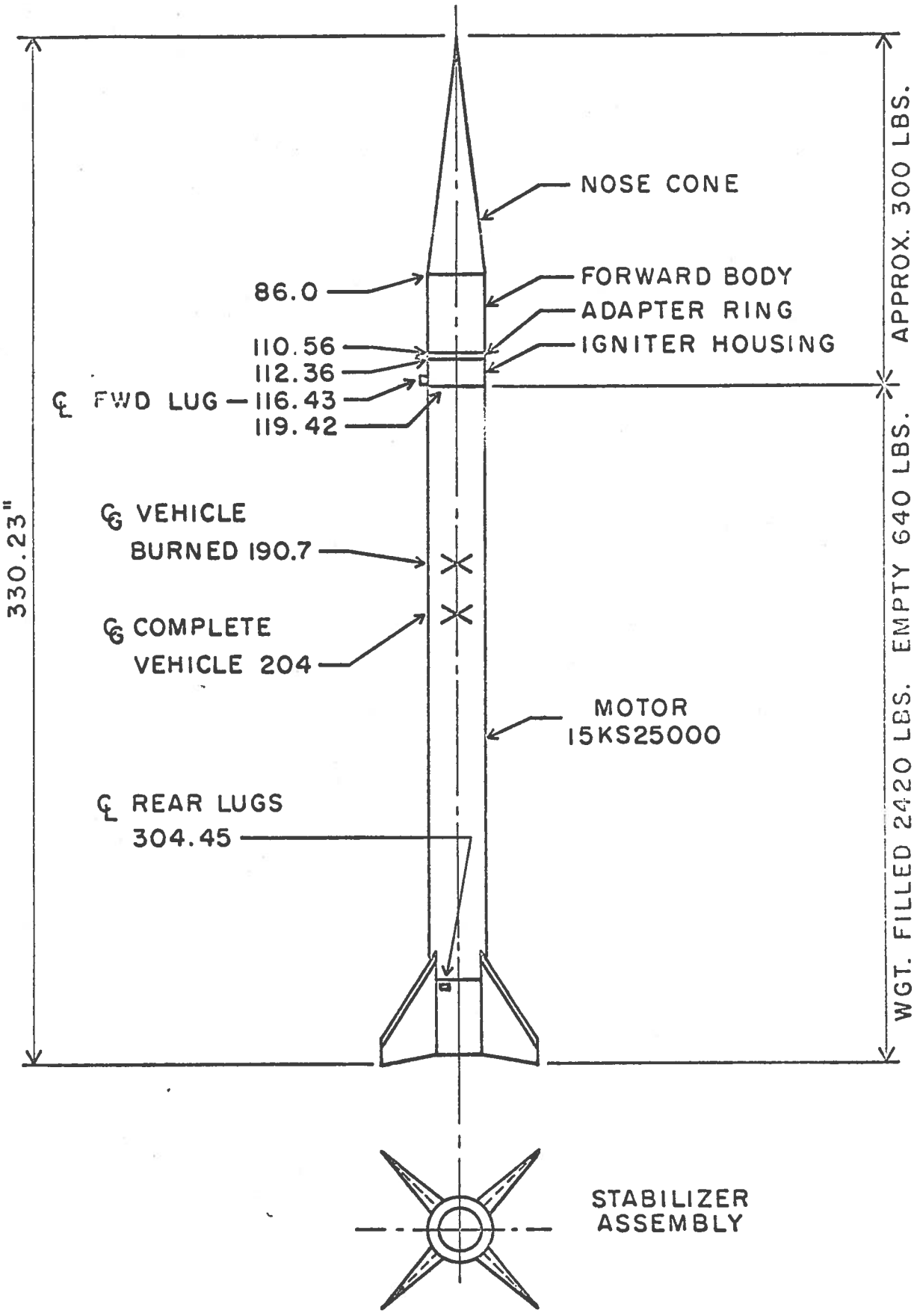
See Figure 2

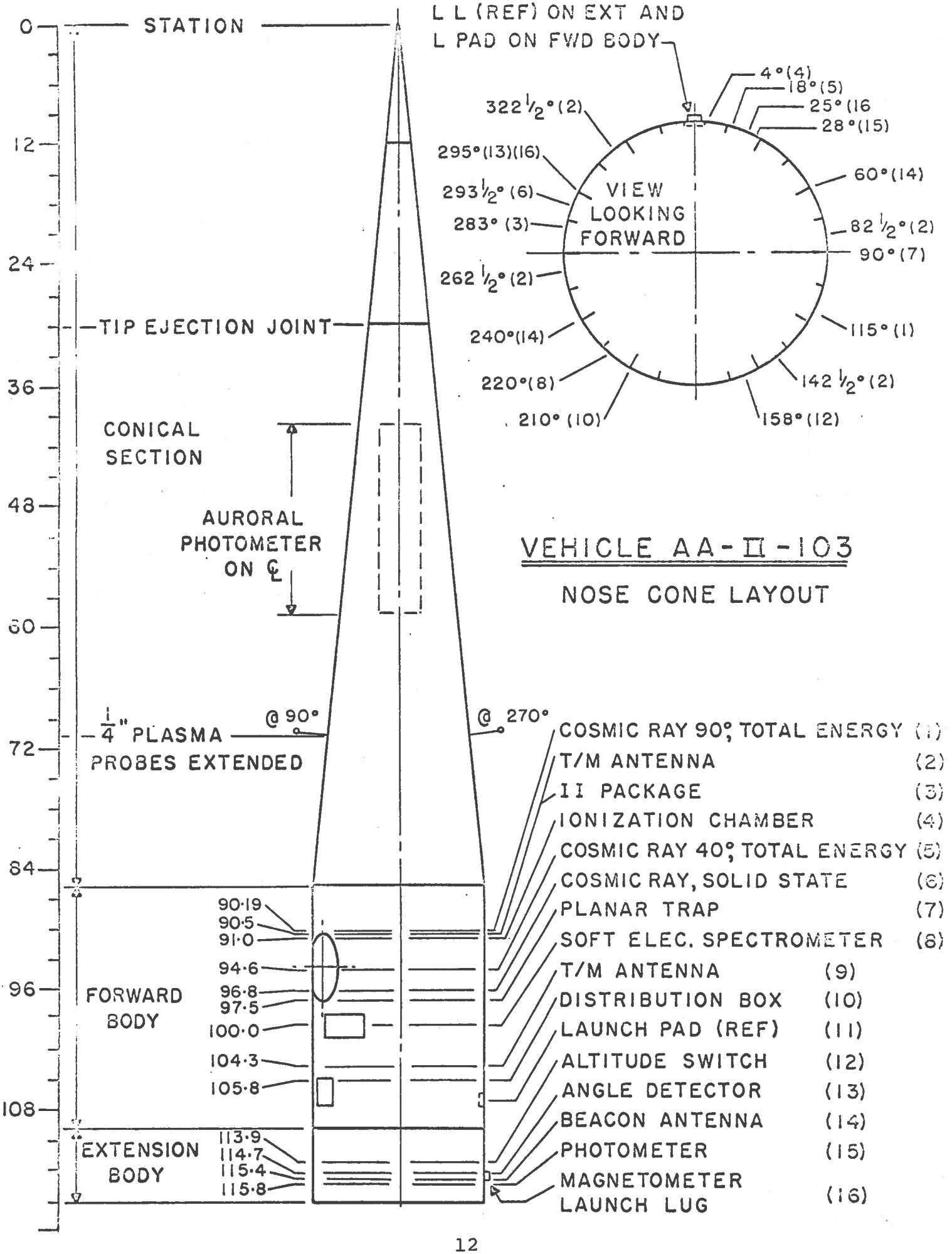
1.5.2 Telemetry Systems

Link No. 1: The primary nose cone telemetry

FIGURE 1

Vehicle AA-II-103




0
STATION
12
24
TIP EJECTION JOINT
36
CONICAL SECTION
AURORAL PHOTOMETER ON ℄
48
60
¼" PLASMA PROBES EXTENDED
@ 90°
@ 270°
72
84
96
FORWARD BODY
108
EXTENSION BODY
90·19
90·5
91·0
94·6
96·8
97·5
100·0
104·3
105·8
113·9
114·7
115·4
115·8
L L (REF) ON EXT AND L PAD ON FWD BODY
4°(4)
18°(5)
25°(16
28°(15)
322½°(2)
295°(13)(16)
293½°(6)
283°(3)
60°(14)
VIEW LOOKING FORWARD
82½°(2)
90°(7)
262½°(2)
240°(14)
115°(1)
220°(8)
142½°(2)
210°(10)
158°(12)
VEHICLE AA-II-103
NOSE CONE LAYOUT
COSMIC RAY 90°, TOTAL ENERGY (1)
T/M ANTENNA (2)
II PACKAGE (3)
IONIZATION CHAMBER (4)
COSMIC RAY 40°, TOTAL ENERGY (5)
COSMIC RAY, SOLID STATE (6)
PLANAR TRAP (7)
SOFT ELEC. SPECTROMETER (8)
T/M ANTENNA (9)
DISTRIBUTION BOX (10)
LAUNCH PAD (REF) (11)
ALTITUDE SWITCH (12)
ANGLE DETECTOR (13)
BEACON ANTENNA (14)
PHOTOMETER (15)
MAGNETOMETER (16)
LAUNCH LUG

CMR

1.5.2 Telemetry Systems (Cont'd.)

is a PAM/FM/FM system operating at 219.5 mc 1 watt nominal. The antenna system consists of two quadraloop radiators mounted 180° apart on the surface of the nose cone at station 88. The polarization is linear.

Link No. 2: Additional nose cone telemetry is by an FM/FM system operating at 240.2 mc, 1 watt nominal. The antenna system for this link also consists of two quadraloop radiators mounted 180° apart approximately 90° to the antennas for link 1, on the surface of the nose cone at station 104. The polarization is linear.

Link No. 3: The ionospheric inhomogeneities package is to be ejected at T+55 seconds and contains a 1/4 watt CW transmitter operating at 108/mc/s. The antennas uncoil and extend as the package is ejected. The polarization is linear. The transmitter will be turned on at ejection from the nose cone.

1.5.3 Beacon

CRR is requested to provide a DPN-41 radar beacon. Range user will provide space and mounts for the beacon, a box for holding five Yardney Type HR-3 batteries, wiring from the beacon to the batteries and to the umbilical connector (seven conductors), and a pair of quadraloop beacon antennas with coaxial cable to the beacon. Range User will also provide a directional coupler for monitoring incident power to the antenna system. The coupling will be 20 db down. User will monitor beacon functions on Link No. 1; see Appendix I for monitor circuit.

The beacon antennas will be tuned for a beacon transmitter frequency of 2900 mc and beacon receiver frequency of 2800 mc.

It is understood that operation, control, and check-out of the beacon is to be the responsibility of CRR.

1.6 Range User's Instrumentation

The Range User will supply all equipment for check-out and assembly of the nose cone payload and to equip a ground receiver station for the ionospheric inhomogeneities experiment. This instrumentation will consist of;

1.6.1 Users' Room - Blockhouse

A control console unit (the same unit as used in previous tests) will be used to control the payload and to monitor the launch. Channels IRIG Nos. 1 - 6 and Nos. 9 - 18 inclusive of TLM link 1 and IRIG 9, 10, 11, 15, 16 and 17 of TLM link 2 from this console. Discriminator outputs from main telemetry are, therefore, to be displayed on the meters in the blockhouse. An NRC selector will be connected to the meter display panel to allow selected channels to be displayed on oscilloscope in the control console. Receivers for the 219.5 mc and 240.2 mc links will be included with the console together with a tunable discriminator and a 17-inch display oscilloscope. A telemetry antenna, as provided by CRR in April 1965, is required on the roof of the blockhouse for this equipment.

1.6.2 Nose Cone Assembly Area - Operations Building

High impedence instruments will be installed in this room to monitor discriminator outputs from channels IRIG 9 - 17 inclusive, of TLM link 1 and 2. Outputs from main telemetry are to be provided at the RF/Real Time patch panel. See Appendix V for details.

An auroral status indicator unit will be installed to enable auroral status reports received on Telex to be relayed to, and displayed in, the scientists observation platform.

1.6.3 Ionospheric Inhomogeneities Ground Station

Receivers, antennas and recorders will be supplied by the User and installed in, and adjacent to, the trailer provided by CRR for this station. This equipment will be used to monitor the 108 mc link, link no. 3.

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

1.6.4 Scientists Observation Station

An auroral status indicator unit will be installed. This unit will be driven by a similar unit in the nose cone assembly area of the operations building and will keep the scientist posted on the status of radar aurora as reported by PARL. An auroral photometer, similar to the photometer in the nose cone, will be installed in this station in support of the U. of S. experiment.

1.7 Range User's Responsibilities

1.7.1 Countdown

A general countdown is detailed under 1.2.2. A detailed Range User's Countdown will be mailed so as to arrive at CRR no later than T-5 days.

1.7.2 Telemetry

Changes in telemetry details, frequencies or SCO's, are not expected. Should such changes be required CRR will be advised of all details prior to T-5 days. Completed forms PAA23-240 detailing real time playback requirement for pen and oscillograph recordings will be mailed so as to arrive at CRR no less than five (5) working days prior to the scheduled test.

1.7.3 Vehicle Trajectory Information

Performance predictions and wind weighting information for this vehicle are detailed under the CARDE Data Booklet for Black Brant Vehicles AA-II-37, 58, 59 and 60. Copies of this booklet were supplied to CRR in 1965.

1.7.4 RF Usage and Clearance

The two main telemetry frequencies used for this payload are 219.5 and 240.2 mc/s as assigned to NRC.

1.7 Range User's Responsibilities (cont'd.)

The University of Western Ontario has obtained Department of Transport clearance for the use of 108.0 mc/s in the Ionospheric Inhomogeneities package.

1.7.5 Ordnance Items

Characteristics of propellant, igniter, and squib are available in the CARDE Technical Note on the Black Brant 15KS25000 rocket, T.N.1528/63. The igniter squib is an M.56 mod. VI.

Bellows actuators (squib) are used in the ejection mechanisms of the nose cone tip, and the Ionospheric Inhomogeneities package; also in the probe extension mechanism, nose tip ejection and lateral velocity inducer. Two types of these devices, both made by the Hercules Powder Company of Wilmington, Delaware, are used. The characteristics are:

	Type BA 31D2	Type BA31K2
Bridge Resistance:	5-9 ohms	4-5 ohms
Mixiumum Non-fire:	50 ma., one 30 sec. pulse	50 ma., one 30 sec. pulse
Minimum Fire:	0.3 amp.	0.3 amp.
Recommended Fire:	1.0 amp.	1.0 amp.
Ignition Time	0.25 milliseconds (at 1.0 amp.)	0.6 milliseconds (at 1.0 amp.)

The nose cone tip release mechanism uses four type BA31K2; the ionospheric inhomogeneities package release mechanism uses one type BA31D2 and one type BA31K2 while the two 1/4 inch plasma probe extension mechanisms use one BA31D2 each. The nose cone tip is given a lateral velocity by firing four type BA31K2 actuators which eject a four pound weight. The location of these items is shown under Appendix II; the firing circuit under Appendix III.

1.7.6 Payload Handling

The Range User will assemble the nose cone to the motor in Hazardous Assembly. Assistance by CRR personnel is requested for this operation.

1.7 Range User's Responsibilities (cont'd.)

1.7.7 Material and Services

Range User personnel authorized to request material and services support from CRR are Mr. A. Staniforth, the Project Coordinator, and Capt. E.W. Rance, the Mission Controller.

1.8 N.R.

1.9 Summary of Frequency Utilization

Link No.	Frequency	Class	Equipment	Location
1	219.5 mc	U	Telemetry	Nose Cone
2	240.2 mc	U	Telemetry	Nose Cone
3	108 mc	U	Telemetry	Ionospheric Inhomogeneities ejected package

1.10 Scheduling Responsibilities

The normal impact area will suffice for this vehicle. Detailed scheduling will be requested following the arrival of the test team at the Range.

2.0 DATA

2.1 Metric Data

Tracking radar only is required for this test. DOVAP is not required.

Launch to Impact:

Item	Data	Interval	Data Points/Sec.	Reduced Data Accuracy Class I	Class II	Class III
1.	Position (X,Y,Z)	Throughout Flight	1 per sec. T-0 to T+100 sec.; 1 pt per 5 sec. T+105 sec. to T+290 sec.; 1 pt per sec. T+291 to impact.	Plotting Board Data to best possible accuracy		

Magnetic tape recording of metric data with IRIG "B" timing is required; data reduction by the Range is not required. A copy of the record from the radar function recorder is required to obtain the AGC data.

2.1 Metric Data (cont'd.)

Impact:-

Impact coordinates are desired by sound ranging equipment.

2.2 Engineering Photography - NR

2.3 Telemetry

2.3.1 Equipment and Data

The primary telemetry station will satisfy telemetry ground station requirements for this test with Twin Lakes station operating as a 'back-up' station. Range User will supply and operate the special equipment required for the ground station in support of the Ionospheric Inhomogeneities experiment, Link No. 3.

2.3.3 Recordings

2.3.3.1 Magnetic Tape Records

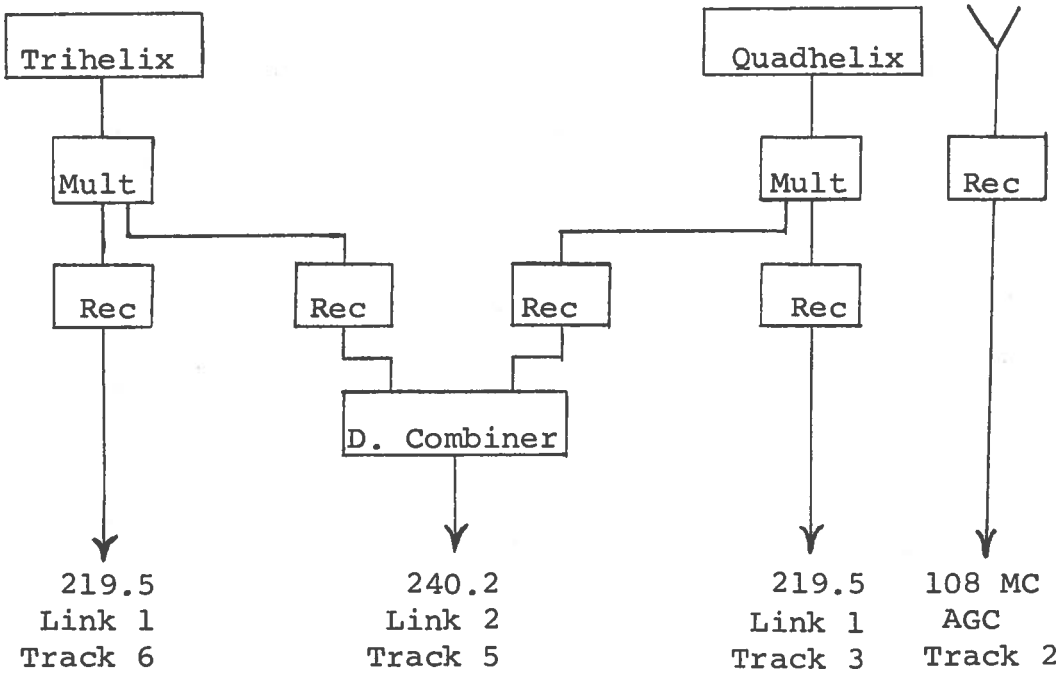
Magnetic tape recordings of telemetry are requested for approximately one minute during the horizontal instrumentation checks, for approximately two minutes during the vertical instrumentation checks (TLM to be notified of times by MC) and from T-2 minutes to impact plus post flight for AGC calibration. Track assignments requested are;

Track	Record
1	IRIG Timing, Format "B"
2	Receiver signal strength and lift-off data, 100 Kc reference and Freq. Signal Link #1
3	Nose cone telemetry, Link No. 1 (219.5 mc/s) and 100Kc reference
4	Voice countdown, 17Kc tape servo reference
5	Nose cone telemetry, Link No. 2 (240.2 mc/s) and 100Kc reference
6	Nose cone telemetry, Link No. 1 (219.5 mc/s) and 100Kc reference
7	IRIG Timing, Format "C"

2.3.3.1 Magnetic Tape Records (cont'd.)

The output from the receiver with the quad-helix antenna should be recorded on Track 3; the output from the receiver with the trihelix antenna should be recorded on Track 6; 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 Tracks 3,5 and 6 with the nose cone telemetry signals. Tape recorder bandwidth allocations are detailed under Appendix IV.

Figure 3



The receiver signal strength to be recorded on Track 2 consists of;

S.C.O. IRIG NO.	FREQ.	SIGNAL
8	3.0 Kc/S	AGC of receiver for Link No. 3 (108 mc/s)
13	14.5 Kc/S	AGC of receiver for Link No. 2 (240.2 mc/s)

2.3.3.1 Magnetic Tape Records (cont'd.)

S.C.O. IRIG NO.	FREQ.	SIGNAL
14	22.0 Kc/S	AGC of receiver for Link No. 1 (219.5 mc/s) on quadhelix antenna
15	30.0	AGC of receiver for Link No. 1 (219.5 mc/s) on trihelix antenna
16	40.0	Igniter flash indicator
17	52.5	Umbilical pull-away indicator

The following details apply to the data to be recorded;

ITEM NO.	LINK FREQ.	IRIG CHANNEL NO.	FREQ.	DEV. ±%	MEAS-URING RATE	CLASS	ACCUR-ACY ±%	REMARKS
1	108.0 mc FM/FM	-	-	-	-	I	-	Except AGC, reception and processing by User only
2	219.5 mc FM/FM	1	400 cps	0	Cont.	I	-	--
3	219.5 mc FM/FM	2	560 cps	0	Cont.	I	-	Tip release
4	219.5 mc FM/FM	3	730 cps	0	Cont.	I	-	NRC Photometer pressure
5	219.5 mc FM/FM	4	960 cps	0	Cont.	I	-	70 k Ft Alt. switch
6	219.5 mc FM/FM	5	1.3 kc	0	Cont.	I	-	I.I. Ejection
7	219.5 mc FM/FM	6	1.7 kc	0	Cont.	I	-	Tip Ejection
8	219.5 mc FM/FM	9	3.9 kc	7.5	Cont.	I	2%	Linear Acc ± 5g 0°/U of S Photometer
9	219.5 mc FM/FM	10	5.4 kc	7.5	Cont.	I	2%	Linear Acc ± 5g, 90° CWLF/cosmic ray

2.3.3.1 Magnetic Tape Records (cont'd.)

ITEM NO.	LINK FREQ.	IRIG CHANNEL NO.	FREQ.	DEV. ±%	MEASURING RATE	CLASS	ACCURACY ±%	REMARKS
10	219.5 mc FM/FM	11	7.35 kc	7.5	Cont.	I	2%	Linear acc + 30 -3g, Z axis/ U of S Photometer
11	219.5 mc FM/FM	12	10.5 kc	7.5	Cont.	I	2%	Cosmic Ray*
12	219.5 mc FM/FM	13	14.5 kc	7.5	Cont.	I	2%	Cosmic Ray*
13	219.5 mc FM/FM	14	22.0 kc	7.5	Cont.	I	2%	Plasma Probe, Sphere DC
14	219.5 mc FM/FM	15	30.0 kc	7.5	Cont.	I	2%	Vibration lateral /Cosmic Ray
15	219.5 mc FM/FM	16	40.0 kc	7.5	Cont.	I	2%	Cosmic Ray*
16	219.5 mc FM/FM	17	52.5 kc	7.5	Cont.	I	2%	Vibration Z Axis/ DRTE spectrometer
17	219.5 mc PAM/FM/FM	18	70.0 kc	7.5	300/sec	I	2%	Commutator 10x30 per sec
18	240.2 mc FM/FM	9	3.9 kc	7.5	Cont.	I	2%	NRC Photometer
19	240.2 mc FM/FM	10	5.4 kc	7.5	Cont.	I	2%	Cosmic Ray
20	240.2 mc FM/FM	11	7.35 kc	7.5	Cont.	I	2%	U of S Photometer
21	240.2 mc FM/FM	15	30.0 kc	7.5	Cont.	I	2%	Plasma Probe, Trap DC
22	240.2 mc FM/FM	16	40.0 kc	7.5	Cont.	I	2%	Plasma Probe, AC Signal
23	240.2 mc FM/FM	17	52.5 kc	7.5	Cont.	I	2%	Plasma Probe, AC Signal, U of S Photometer

* = No in-flight calibration

2.3.3.1 Magnetic Tape Records (cont'd.)

Calibration, 219.5 mc Link: The event channels, IRIG Nos. 1-6 should be set to read zero on the output meter with zero SCO signal, and mid-scale with SCO signal turned on.

The calibration on the subcarrier oscillators, including the 3.9 kc unit and higher, is 0 to 5 volts for a ±6.75% deviation. (Zero level corresponding 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, 22.0 kc, and subcarrier channels by a calibrator unit in the nose cone on Line No. 1 and to the 3.9, 5.4, 7.35, 30, 40 and 52.5 kc SCO's on Link 2.

CRR is requested to provide receiver AGC calibration for the rocket telemetry links at Launch Site and at Twin Lakes. The following calibration ranges are requested at the pre-amplifier input:

For	Link No. 1, 219.5 mc)	0, 1, 2, 5, 10, 20, 50, 100,
	Link No. 2, 240.2 mc)	200, 500, 1000 μvolts.
	Link No. 3, 108 mc)	0, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100 μvolts.

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

2.4.1 Documentary Optics

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. Assembly to motor.
6. Placing complete vehicle on launcher.
7. Launch

2.4 Other Data (cont'd.)

4 x 5 still photography is requested on call throughout the program for coverage of payload assembly, checkout and vehicle assembly. Still photographs, which should 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.

2.4.2 T.S.S. Special Data

Other data collected includes photographs from the parallactic cameras of the star field and aurora, and other records furnished by the Technical Support Section in reduced form. This data will be obtained from special instrumentation in accordance with para. 4.9.

3.0 METEOROLOGICAL SERVICES

3.1 Forecasts

The following information is requested for planning and operational purposes. This information should be presented to the Range User Mission controller who will be responsible for informing all Range User personnel in the Fort Churchill area.

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 Forecasts (cont'd.)

3.1.3 Operational

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

3.2 Observations

Rawinsonde data on wind, temperature, humidity pressure and density are requested as close to the firing time and launch site as possible and to an altitude of 90 to 100K ft. Standard surface measurement of wind velocity, temperature, and pressure are also requested commencing at T-2 hours at 30 minute intervals.

3.3 Impact Prediction

The Range User has supplied the Range with the vehicle data required for impact prediction.

3.4 Minima

This rocket is to be launched into skies sufficiently clear of clouds to ensure radar acquisition; to allow evaluation of visual aurora on the trajectory and for the operation of the auroral height finding stations.

3.5 Consultant Services

It is requested that the CRR meteorologist be available for consultation from T-6 hours to launch.

4.0 SUPPORT INSTRUMENTATION

4.1 Communications - General

4.1.1 Communications Recordings - Standard acceptable.

4.1.2 Communications Plan

The communications plan for this test is the standard networks as detailed under the Range Users Handbook.

4.2 Radio

4.2.1 Frequency Control and Analysis

The assistance of FCA to monitor payload RF may be requested during the preparation phase.

4.3 Wire

4.3.1 Intercom

Standard, plus a station in the trailer at the former SAC alert site for the Ionospheric Inhomogeneities ground station.

4.3.2 Telephone

It is requested that a telephone in the Technical Support Section building be available for Range User use during this test. A telephone is also required at the Ionospheric Inhomogeneities ground station in the trailer at the former SAC "Alert" area.

All long distance charges will be borne by the Range User.

4.3.3 Umbilical Cable

The standard umbilical blockhouse to universal launcher is satisfactory for this test. However, special lines, as follows are also required;

a. One pair terminating at the RF/Real Time patch panel in the users' preparation room and connecting to the scientists' observation platform is required for the user supplied Auroral Status Indicator system;

b. The RF/Real Time patch panel in the users' preparation room is to provide the user with outputs from the telemetry instrumentation room.

4.3.4 Public Address - NR

4.4 Timing

Timing on the magnetic tape records is requested to be:

a. IRIG Format "B", 100 pps with a 1 kc carrier;

b. IRIG Fromat "C", 2 pps with a 100 cps carrier;

c. time signals from WWV;

Item (c) can be recorded during post-flight calibration together with items (a) and (b).

First motion is to be indicated by an increase in the amplitude of the timing pulses. It is assumed that timing equipment is on prior to the start of Horizontal Checks.

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 4 inches per second or higher.

4.5 Sequencer - NR

4.6 Visual Countdown and Status Indicators

4.6.1 Visual Countdown Indicators

NO.	FUNCTION TO BE DISPLAYED	TYPE INDICATOR	INTERVAL START	INTERVAL STOP	REMARKS
1	Range Countdown	Clock, (digital is preferred)	T-180 mins.	T+10 mins.	To be easily viewed from payload control console. Same facility desired in nose cone preparation area in Operations Bldg. and Project Scientists' Station.

4.6.2 Visual Status Indicators

The standard visual status indicators are acceptable for this test.

4.7 Data Handling

Range User will obtain all data produced by the CRR from the official appointed by CRR for data assembly and release. Certain items of "quick-look" data are to be obtained from the originating section direct as arranged at the Pre-Flight briefing.

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.

The support of Prince Albert Radar Laboratory is required to keep the Project Scientist advised of the status of radar aurora over Churchill. PARL support will be arranged for by the Range User.

CRR is requested to operate the 30 mc Riometer at the Blockhouse throughout the period that the NRC team are at the Range. The Riometer antenna is to be directed along the expected vehicle trajectory. Records for the full period are required by the Project Scientist.

It is further requested that support instrumentation as listed below be operated by CRR Technical Support Section. However, in the case of spectrometers and photometers, precise specifications cannot be made because of the variable states of availability and mode of operation of these instruments. For the spectrometer and photometer coverage over as much of the trajectory as possible is required. Due to the limited fields of these instruments, it is suggested that, where redundant instrumentation exists, the major part of the forces should cover the ascending 100 Km point and the others deployed at the descending 100 Km point on the trajectory.

The details of instrumentation and support requested are:

a. 4" x 5" rapid scan spectrometer, 3000-11000A^{o};

4.9 Other Support Instrumentation (cont'd.)

b. Photometer at 3914A°, H_β, 5577, 6300A°
c. 35-mm All-sky Camera, one frame per minute prior to and after launch with the rate increased to four frames per minute from T-0 to T+6 minutes;
d. Fluxgate magnetometer, three components, for the night of launching;
e. Auroral height finding stations data taken from T-0 to T+6 minutes;
f. Ionosonde, four sweeps per minute from T-0 to T+6 minutes;
g. Auroral activity predictions for 30 days advance warning;
h. Observations and verbal reports on visual aurora (intensities and locations of forms) and magnetometer field variations during the countdown.

5.0 MATERIAL AND SERVICES

5.1 SERVICES

5.1.1 Power

115V,60 cps power is required in the user area of the blockhouse and in the nose cone assembly area of the operations building for user use. These services should consist of a minimum of one 30 amp. outlet and three 15 amp. outlets. Each service is to be independently fused.

A 15 amp. 115V,60 cps outlet is required in the north east corner of the nose cone assembly area of the operations building for the telex equipment.

Two 15 amp. services, 115V,60 cps, are required in the trailer provided for the Ionospheric Inhomogeneities ground station.

5.1.2 Food Services

Eighteen to twenty-two University and NRC personnel will require food services and accommodation for approximately one month. CRR are requested to arrange for these services. Food Services will be required for User personnel at launch. Names of personnel will be notified approximately two weeks prior to arrival.

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

The Universal Launcher is required to be fitted with the CARDE supplied Black Brant 4 fin rocket rail system for this test. Installation and alignment of these rails should be completed by CRR prior to T-1 day.

The assistance of contractor launch personnel will be required for motor assemble and for stabilizer assembly and alignment in the rocket assembly area. A technician from the plant of the manufacturer of the stabilizer will proceed to Churchill immediately prior to the arrival of the NRC team to supervise stabilizer assembly and alignment. The motors for ORs 170, 171 and 172 are to be assembled and aligned at the same time. CRR will be notified by telex of the date it will be required to move the motors from the magazines to the rocket assembly area.

5.1.7 Water - NR

5.1.8 Survey - NR

5.1.9 Other Services - NR

5.2 Vehicles and Ground Handling Equipment

5.2.1 Vehicles

The rocket and all necessary hardware will be supplied to CRR by NRC, by NRC contractors, or has been supplied by CARDE and is held at the Range.

5.2.2 Ground and Heavy Equipment

CRR is to 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

CRR is requested to supply equipment for, and obtain all-up weight and centre of gravity of the nose cone and of the complete vehicle.

5.3 Propellants, Gases, Chemicals - NR

5.4 Chemical and Physical Analysis - NR

5.5 Bioscience - NR

5.6 Test Instrument Maintenance and Calibration - NR

5.7 Climatic Clothing Requirements

Range User personnel will require climatic clothing, parkas, storm pants, flight boots and mitts while at the Range.

6.0 TRANSPORTATION LOGISTICS

CRR is requested to inform W.L. Haney by Telex of the arrival of the shipments at Fort Churchill.

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.

CRR is requested to provide a power wagon and a carryall vehicle for the full-time use of the User personnel attached to this program.

6.1.1 Personnel (cont'd.)

"On-call" transport for Range User personnel for trips between Fort Churchill and the Ionospheric Inhomogeneities ground station at the former SAC Alert Station will be required for two, or three, University of Western Ontario personnel.

6.1.2 Cargo

The motor for this vehicle together with Black Brant motors for ORs 171, 172, 173 and 174 will be airlifted to Churchill from Winnipeg. This flight will be a charter flight, probably Trans Air, and is to be met on arrival. The motors are to be transported to the magazines in a vehicle that will provide weather protection and heat. The periods of exposure of these motors to temperatures below 32°F must be kept to the minimum.

The stabilizer units will be a separate shipment from the motors. Stabilizers will be shipped from Montreal via rail express.

The NRC cargo will be in two shipments, one by rail and one by air. The rail shipment will consist of thirty pieces weighing approximately 4400 lbs; the air shipment twenty-one pieces weighing approximately 3000 lbs. Equipment from the University of Alberta, Calgary and University of Western Ontario will be shipped independently.

All shipments will be addressed to CRR. CRR is requested to have the equipment taken to the launch site when it is received in Churchill.

6.2 Air - NR.

7.0 RECOVERY

No recovery is required.

8.0 AIRCRAFT AND SEACRAFT - NR.

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 and Electrical Engineering Division, Attention: Mr. W.L. Haney).

After 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		4	T+6H	NRC	NRC	R-PLOT	note (a)
			1	T+5CD	NRC	NRC	R-MAGT	note (b)
			1	T+5CD	NRC	NRC	R-GRAF	
	9.2.1.2 Impact							
2	Impact Coordinates		2	T+10	NRC	NRC	F-FRPT	

Note (a) - Real time plotting board data of range, azimuth, and elevation is requested for each radar on valid track.

(b) - Copy of Sandborn Model 150, 6 channel, function recorder for FPG-11 Radar.

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		2	T+15	NRC	NRC	R-PHOTO	4.2.7
	Color Transparencies		1	T+15	NRC			
	Documentary Film		1	T+21	NRC	NRC	R-PHOTO	4.2.5
	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 (4)
			1	T+5 CD	NRC	NRC	R-MAGT	5.2.1.4 (4)
		1		T+5 CD	NRC	NRC	R-MAGT	5.3.1.1 (2)
	9.2.3.2. Special Requirements							
6	Real Time paper records	1		T+1H to T+1	NRC	NRC	R-GRAFT	User will detail by T-14 days
	Playback Paper	1		T+2	NRC	NRC	R-GRAFT	
7	9.3 Meteorological Data - in accordance OD Handbook, Para. 9.3.6							
8	9.4 Support Instrumentation							
	30 Mc Riometer		1	T+2	NRC	NRC	R-GRAFT	
	Magnetic recording of voice countdown, consolidated records and reduced data from TSS1		3	T+15 CD	NRC	NRC	F-FRPT and R-MAGT	

9.3 Meteorological Data (Cont'd.)

ITEM NO.	DESCRIPTION	ORIG.	CYS.	TIME REQUIRED	FINAL RECIPIENT	AGENCY TO PICK UP DATA	TYPE OF PRESENTATION	REMARKS
	9.5 Material and Services Report - NR.							
	9.6 Transportation Reports							
9	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

10.1.1 Hazardous Storage

It is required that the motor, igniter and other pyrotechnic items be stored under conditions of controlled temperature. The preferred storage temperature for these items is 70°F. Motor storage temperature limits are -20°F to +150°F. However, all cases of this motor being subjected to temperature less than 32°F must be recorded, both as to time duration and minimum temperature of each exposure. The Mission Controller shall be advised of all cases of exposure.

10.1.2 Storage

Storage of empty shipping crates is required for the period the equipment is at the Range. An area of approximately 200 sq. ft., 8 ft. high, will be required for this 'dead' storage. The Mission Controller will advise the Range Operations Manager when crates are emptied, ready for storage, and when they are required for re-packing at the completion of the test.

10.1.3 Preparation

An area of approximately 300 sq. ft. is required in the nose cone assembly area of the operations building for nose cone assembly, initial check-out, battery charging and for User instrumentation used in monitoring and recording data during flight. Space, lines, and a suitable cabinet (as supplied in April 1965) are required in this area for the Telex equipment. The same location in the north east corner of the room is requested for this test for the Telex and User Equipment. The RF/Real Time patch panel is required.

10.1.4 Blockhouse

An area of about 100 sq. ft. is required in the User room of the blockhouse for the payload check-out console and associated equipment. This area must be close to the umbilical terminal box and the Range discriminator display console.

10.1.5 Observation Station

The Project Scientist will require access to the observation tower behind the operations building throughout the test. All outside lights in the area of the operations building are to be extinguished at T-60 minutes.

10.1.6 Office Space

It is requested that office space in the Technical Support Section building be made available to this team.

10.1.7 Ionospheric Inhomogeneities Ground Station

The Ionospheric Inhomogeneities experiment will require a space, suitably heated and supplied with communications, in an area relatively free of RF for a ground receiver station. The large trailer supplied in April 1965 is suitable for this test and should again be positioned near the former SAC "Alert" area at the end of the main runway. Heating, lighting and communication services should be connected to be available when the User personnel arrive. Two or three UWO personnel will man this station.

10.2 Launch Facilities

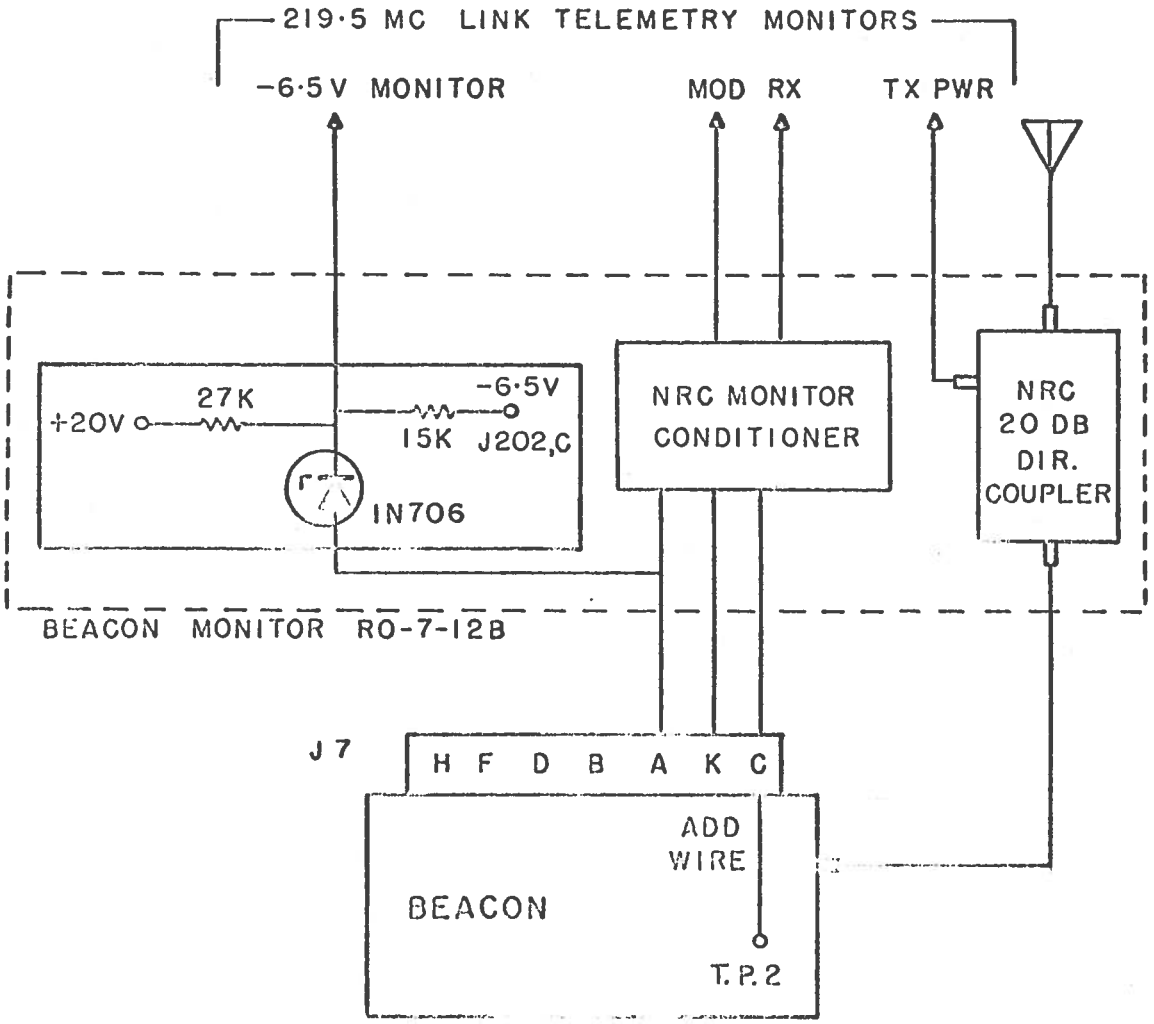
The universal launcher complex is to be used for this operation. Range User personnel will require access to the rocket assembly area for vehicle build up and final assembly of the nose cone also to the launch bay for payload tests during the countdown.

11.0 RANGE SAFETY

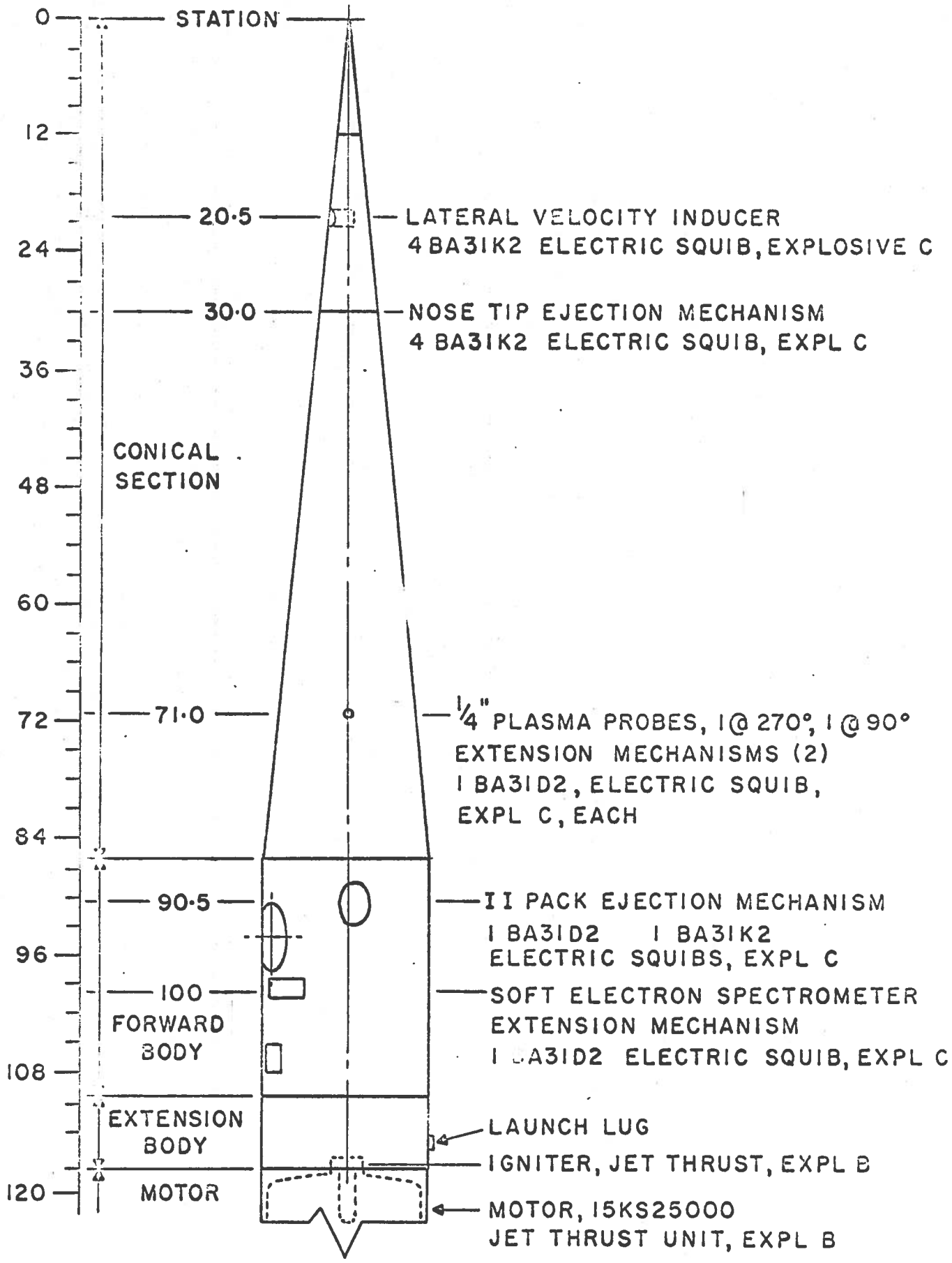
CRR is responsible for all range safety.

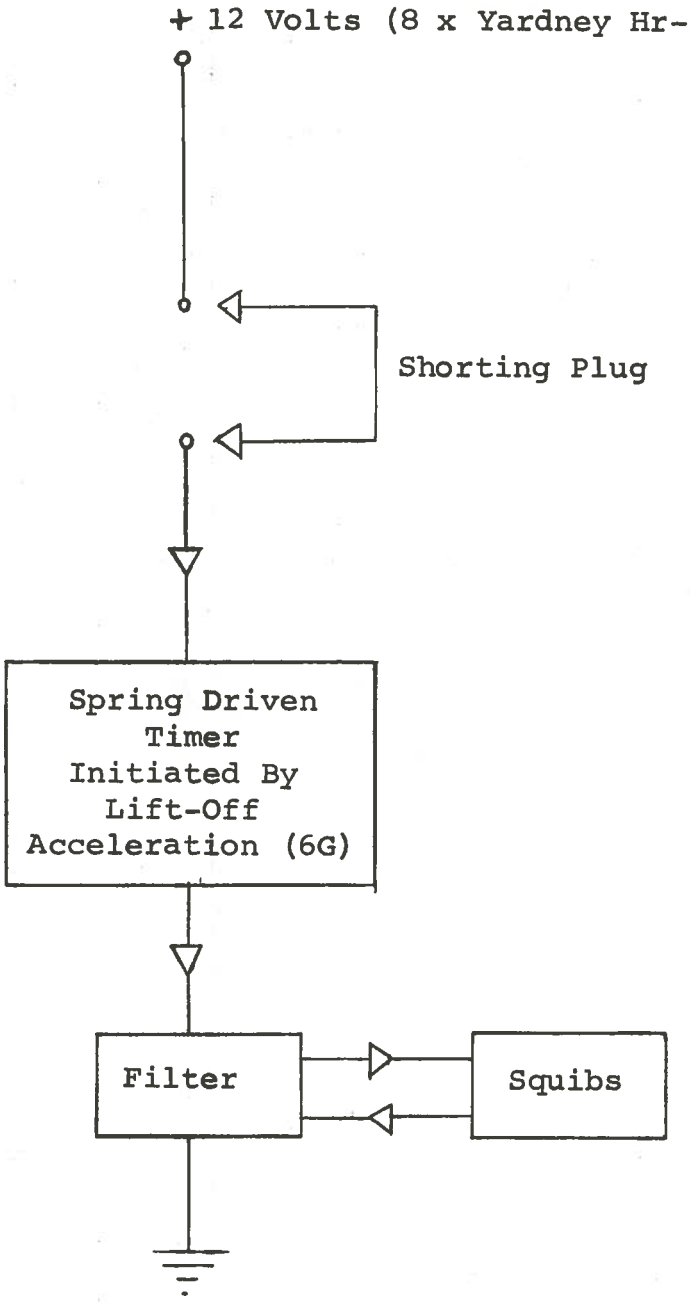
APPENDIX I

DPN-41 RADAR BEACON MONITOR FUNCTIONS



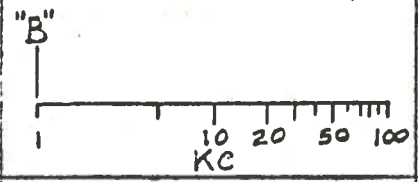
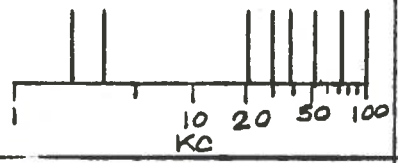
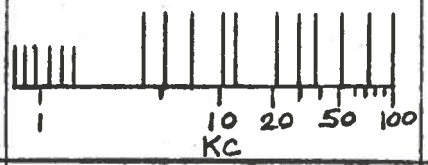
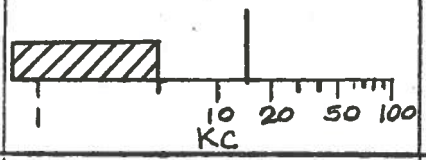
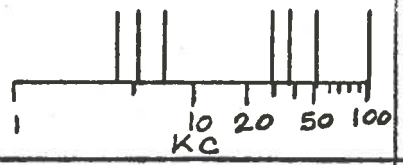
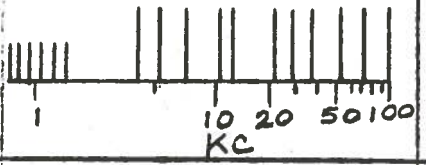
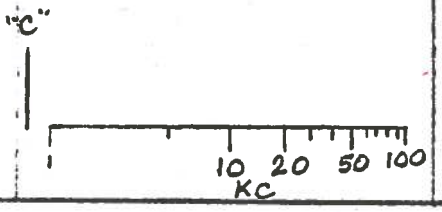
ORDNANCE ITEMS, VEHICLE AA-II-103



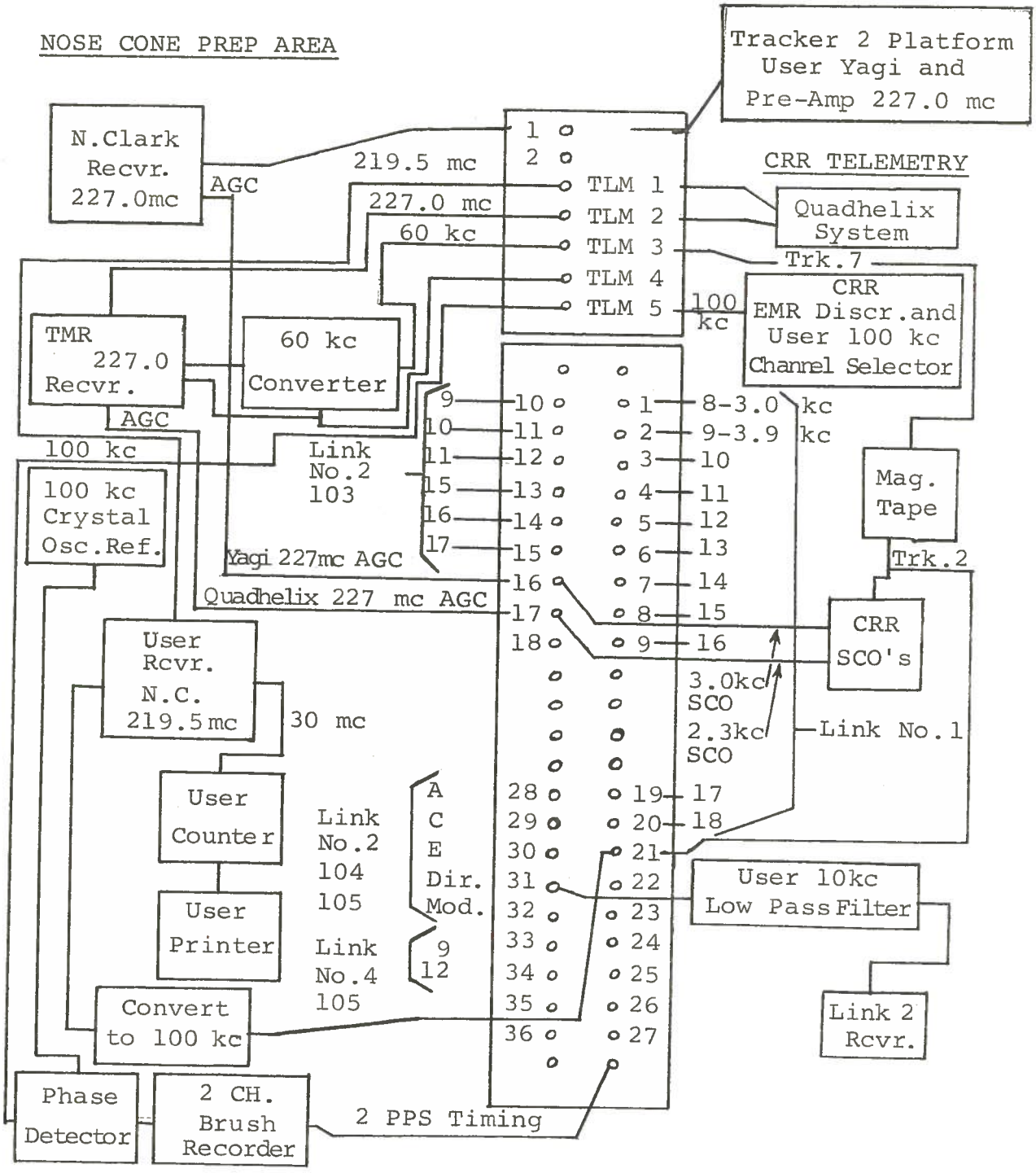


SQUIB FIRING CIRCUIT

Launch T/M Tape Recorder Bandwidth Allocations
Vehicle AA-11-103

Track	Bandwidth	Equipment Supplied By	Data and Source	
1		CRR	Timing "B"	CRR
2		CRR	IRIG #7, 8 and 13, 14, 15, 16, 17 100 kc reference	TLM Rx AGC lift-off data Freq.Sig.Link 1
3		CRR	IRIG #1 to #6 and #9 to #18 100 kc reference	Nose Cone TLM Link #1 219.5 Mc CRR
4		CRR	Voice Count Tape Servo Ref	CRR CRR
5		CRR	IRIG #9, 10, 11 15, 16, 17 100 kc reference	Nose Cone TLM Link #2 240.2 Mc
6		CRR	IRIG #1 to #6 and #9 to #18 100 kc reference	Nose Cone TLM Link #1 219.5 Mc CRR
7		CRR	Timing "C"	CRR

APPENDIX V



RANGE USER INSTRUMENTATION

VEHICLES 103, 104, 105