Communications Research Centre

TWENTY-SECOND TRI-ANNUAL ISIS PROGRESS REPORT FOR THE PERIOD 1 MARCH TO 30 JUNE, 1970

DEPARTMENT OF COMMUNICATIONS
MINISTÈRE DES COMMUNICATIONS

CANADA

OTTAWA, DECEMBER 1970

COMMUNICATIONS RESEARCH CENTRE

DEPARTMENT OF COMMUNICATIONS
CANADA

NATIONAL SPACE TELECOMMUNICATIONS LABORATORY

TWENTY-SECOND TRI-ANNUAL ISIS PROGRESS REPORT

For the Period

1 March to 30 June 1970

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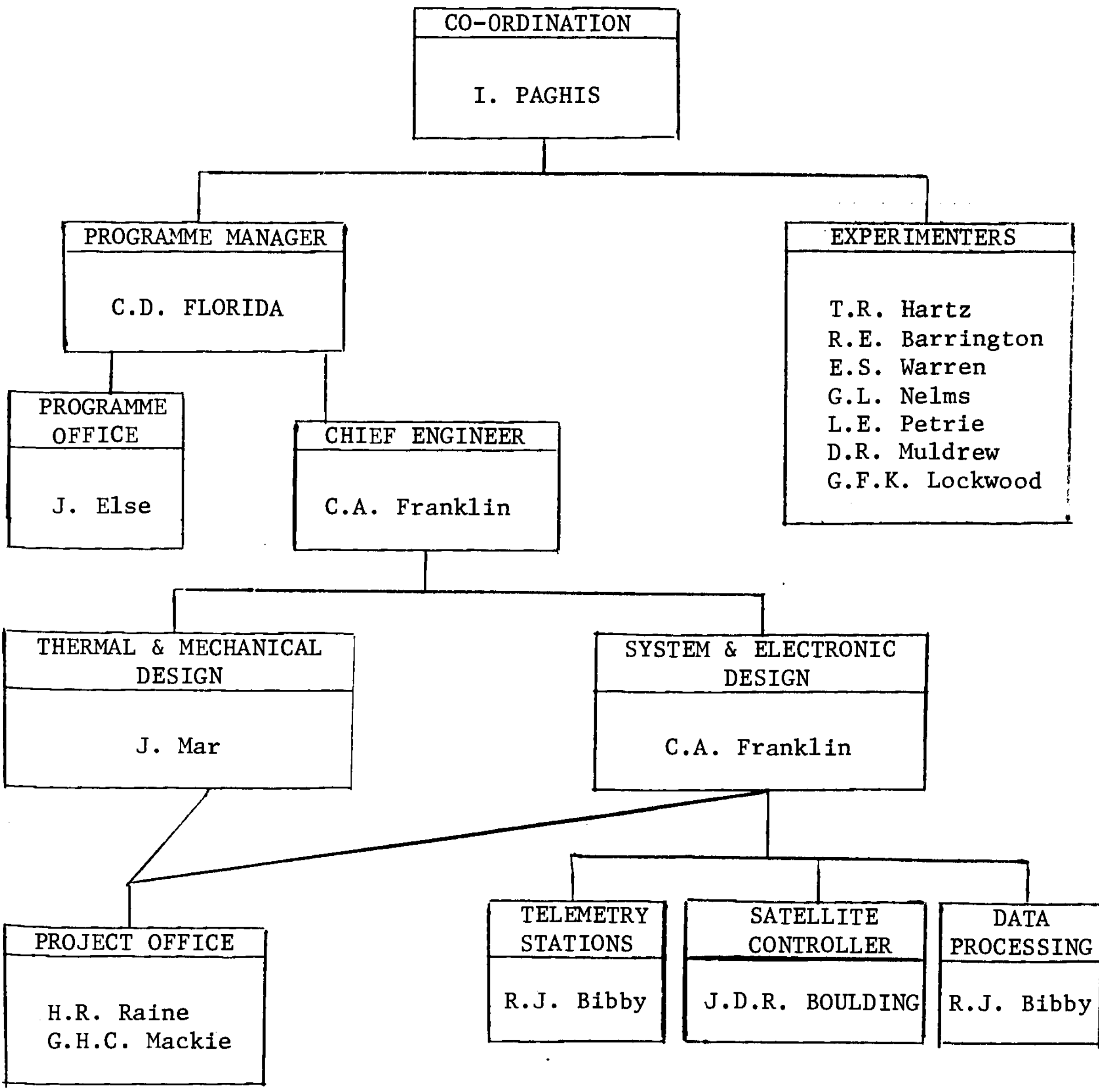
1 March, 1970 to 30 June, 1970

CRC PROGRAMME ORGANIZATION



2. INTRODUCTION AND SUMMARY OF PROGRESS

A change in the power system configuration of Alouette I has resulted in an increase in the operating time of this satellite to 3/4 hour per day. The spacecraft continues to operate in the sounder or VLF mode, with occasional passes being scheduled whilst the spacecraft is in darkness.

No changes in the operation or status of Alouette II have occurred over the reporting period. The spacecraft continues to operate between 4 and 5 1/2 hours per day and the spin rate has reduced to 1.80 rpm.

ISIS-I has been operating between 6 1/4 and 8 1/2 hours per day during the reporting period. The undervoltage cut out operated early 8 June as a result of a low battery 1 voltage and the system was restored later the same day. Both clock and programmers continue to be inoperative and attempts to run the on-board tape recorder were unsuccessful. Command errors resulted in a period of improper operation of the sounder system in mid-April. There have been no changes in the status of either the SPS or the IMS experiments. A functional test of the ASC system is planned for the next reporting period. An attitude changing manoeuvre will be carried out in the next reporting period to verify the capability of the ASC system for the ISIS-B mission requirement.

Integration and checkout of the ISIS-B flight model spacecraft has been the major activity during this reporting period. Power, command, VHF telemetry, sounder, VLF systems, and all experiments except the optical experiments have been installed and checked out. An extensive review of the quality of the transistors used in RCAL manufactured units has been carried out and the decision taken to replace, where possible, all questionable devices in flight boxes. This decision has resulted in some slow down of integration, but the revised schedule is being maintained by substituting prototype units whilst rework is in progress. The flight tape recorder has been received and checked out. Extensive rework of the clock and programmer flight units is planned including the installation of a new clock oscillator in the back-up clock and programmer. This, together with modifications to the ATO and magnetometer oscillator, should avoid the possibility of operational difficulties in ISIS-B similar to those experienced in ISIS-I. The modification to improve the sounder receiver AGC characteristic has been successful and the sensitivity of the system is now improved for both the sounder and the cosmic noise experiments. The lowest fixed frequency for sounding has been changed from 0.250 MHz to 0.120 MHz to allow VLF propagation studies in the 0.100 MHz region. The latest estimated weight of the flight model spacecraft is 559.6 lbs. Significant milestones of the revised programme schedule are: Contractor's in-house spacecraft thermal test-July; commencement of environmental tests at GSFC - mid-October, 1970, commencement of range operation - February, 1971. Every effort is being made to maintain this new schedule consistent with achieving a high confidence in overall spacecraft reliability.

J. Else

3. ISIS-I

3.1 Satellite Characteristics

Orbit

Apogee	3522
Perigee	574
Inclination	88.42° prograde
Spin	2.939 rpm
Period	128.3 mins.

Spacecraft Stabilization

Spin stabilized 1 to 3 rev/min.

Spacecraft Attitude Sensing

Six-probe flux-gate magnetometer	Four probes, range -600 to +600 millioersteds: x-y-z orthogonal set, and s probe along spacecraft x direction. Two probes, range -200 to +200 millioersteds: along spacecraft x and z directions.
Digital solar aspect sensor	Two sensors, each with 180° fan field of view; storage register in electronics.

Spin and Attitude Control System

Spin rate change capability 0.1 rpm/orbit.
Spin axis attitude manoeuvring capability 3°/orbit.

Power System

11,136 n-on-p 10-1/4% (A.M.O.) efficiency solar cells will charge 3 Ni-Cd batteries.
Six main system DC to DC converters.
Operational time after 1 year, minimum of 4 hours per day.
Continuous operation: Two consecutive pole-to-pole passes.

Command System

Command

Multiple tone-digital AM AVCO system.
2 receivers operating 148 MHz; 1 redundant.
Decoder capability--216 commands.

Programmer and Clock

Stored commands for remote turn-on execution.
Capability--5 remote turn-on from 10 commands.
Loading time 5 minutes.
Programme monitoring facility (readout time 3 secs.)
Clock output--serial time code BCD format 69 bps, once per second.
Ground correction capability.
Stability and accuracy 1 sec/week.

Automatic Turn-Off

Normal turn-off - after 16 mins.
Special turn-off - after 8 or 24 mins.
Programmed turn-off - after 16 mins.
Back-up - after 30 mins. unconditionally.
Spin and attitude control - 1^{+0}_{-1} and 5^{+0}_{-1} hours, selectable by command.

Tape Recorder

Record Time - 65 mins.
Playback - 4 times record speed.
Data channels - 4.
(a) FM data - sounder output FM bandwidth 1 Hz to 9 KHz.
(b) Ref. Frequency 11.52 KHz + AM Time Code.
(c) Digital data 11,520 bits per sec.
(d) Analog data - VLF output bandwidth 50 - 20,000 Hz.

Telemetry

Transmitter No. 1

Frequency		136.080 MHz: bandwidth 100 KHz
Power		4 Watts
Modulation	FM	Sounder
	PAM/FM	SCO essential housekeeping and clock
	FM	VLF

Max. range for 10 dB S/N 3500 miles with 19 dB ground antenna gain,

Transmitter No. 2

Frequency		401.750 MHz: bandwidth 500 KHz
Power		4 Watts
Modulation	FM	Sounder
	PCM/FM/PM	SCO experimental data and housekeeping
	FM	VLF
	AM/PM	SCO satellite clock

Max. range for 10 dB S/N 3500 miles with 19 dB ground antenna gain.

Transmitter No. 3

Frequency	136.59 MHz: bandwidth 50 KHz
Power	2 Watts
Modulation PCM/PM	Experimental data and house-keeping

Beacon

Frequency	136.410 MHz
Power	100 mw
Unmodulated	

Experiments

(1) Swept Frequency Sounder

Power output	400W at PRF 30/sec. 100W at PRF 30/sec.
Antennas	240' and 61.5' tip-to-tip
Flyback	3 secs.

Frequency Range

(a) Normal Sweep 0.1 to 10 MHz

Frequency Range	Sweep Rate	Time to Cover Frequency Range
0.1 to 2.0 MHz	0.25 MHz/s	7.6 seconds
2.0 to 5.0 MHz	0.75 MHz/s	4.0 seconds
5.0 to 10.0 MHz	1.0 MHz/s	5.0 seconds
	Total time	16.6 seconds

Distance travelled about 75 Km at Apogee
about 125 Km at Perigee
Maximum change of height about 18 Km

(b) Extended Sweep 0.1 to 20 MHz

Frequency Range	Sweep Rate	Time to Cover Frequency Range
0.1 to 2.0 MHz	0.25 MHz/s	7.6 seconds
2.0 to 5.0 MHz	0.75 MHz/s	4.0 seconds
5.0 to 20.0 MHz	1.0 MHz/s	15.0 seconds
	Total time	26.6 seconds

Distance travelled about 120 Km at Apogee
about 200 Km at Perigee
Maximum change of height about 20 Km

(c) Sweep Law - Linear in all ranges.

(d) Frequency Markers

0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0 MHz.

(2) Fixed Frequency Sounder

The six frequencies selected for the fixed frequency sounder are 0.25, 0.48, 1.0, 1.95, 4.0, and 9.303 MHz

Sounder Receiver Characteristics

Pre-amp. and filter No. 1, seven bands	(a)	0.1 - 1.0 MHz
	(b)	1.0 - 2.0 MHz
	(c)	2.0 - 3.0 MHz
	(d)	3.0 - 5.0 MHz
	(e)	5.0 - 8.0 MHz
	(f)	8.0 - 13.0 MHz
	(g)	13.0 - 20.0 MHz

Pre-amp. and filter No. 2 wideband 0.1 - 2.0 MHz.
Linear - logarithmic receiver with AGC loop characteristics.
Rise time 60 msecs. Fall time 12 msecs.

(3) VLF Receiver

0.05 - 30 KHz
Monitored AGC voltage

A VLF swept frequency exciter	Range 500-0-9500 Hz
	Sweep rate at 50 Hz is 2 KHz/s
	Sweep rate at 9500 Hz is 20 KHz/s
	Sweep duration 1 second
	Frame period 1.5 seconds
	Output automatically sequences through two 20 dB steps.

(4) Energetic Particle Detectors (NRC)

Parallel to satellite axis

Detector G_1	> 40 KeV Electrons
	>500 KeV Protons
G_2	> 20 KeV Electrons
	> 0.3 MeV Protons

Perpendicular to spin axis

Detector G_3	> 40 KeV Electrons
	>500 KeV Protons
G_4	> 80 KeV Electrons
	>110 KeV Electrons
G_5	>200 KeV Protons
	>140 KeV Electrons
	200 KeV - 770 KeV Electrons
G_6	>400 KeV Protons
	> 25 KeV Electrons

Scintillation photomultiplier

S_1	Current mode	> 8 KeV Electrons
	Pulse mode	> 40 KeV Electrons
		> 60 KeV Electrons
	Current mode	> 50 KeV Protons
	Pulse mode	50 - 70 KeV Protons

Proton detector (not sensitive to electrons)

D_1	0.15 - 25 MeV
D_2	0.5 - 4 MeV
D_3	3.4 - 12 MeV
D_4	12 - 30 MeV
$D_{background}$	12.5 - 20 MeV

(5) Soft Particle Spectrometer (Heikkila)

Electrons 10 - 10,000 eV

(6) Ion Mass Spectrometer (Narcisi)

1 - 20 A.M.U.

(7) Cylindrical Electrostatic Probe (Langmuir Probe) (Brace)

Ne and Te

(8) Spherical Electrostatic Analyzer (Spherical Probe) (Sagalyn)

Measures:

(a) Protons 10 to 6 x 10^6 particles/cm^3
(b) Thermal ion kinetic temperatures 700 to 4000°K.
(c) Proton Flux and Energy 0 to 2 KeV
(d) Potential of satellite to undisturbed plasma

(9) Beacon (Forsyth)

136.410 MHz, 137.950 MHz, 100 mw beacons
Measures:

(a) Ionosphere total electron content
(b) Small-scale variations of electron content
(c) Ionic inhomogeneities responsible for amplitude and angular scintillations

(10) Cosmic Noise (Hartz)

From AGC of sounder receiver 0.1 to 16 MHz

(11) Antenna Bias

A negative bias may be switched on to both sounder dipole antennas on command; current will be monitored.

Weight Breakdown

Structure	96 lbs.
Experiments	125 lbs.
Telemetry & Command	100 lbs.
Power	150 lbs.
Attitude Sensing & Control	23 lbs.
Cable Harness	38 lbs.
Total	532 lbs.

4. ISIS-B

4.1 Satellite Characteristics

Orbit

1400 Km minimum circular
Inclination - not yet resolved.

Spacecraft Stabilization

Spin stabilized.

Spacecraft Attitude Sensing

Six-probe flux-gate magnetometer	Four probes, range -600 to +600 millioersteds; x-y-z orthogonal set, and s probe along spacecraft x direction. Two probes, range -200 to +200 millioersteds: along spacecraft x and z directions.
Digital solar aspect sensor	Two sensors, each with 180^{o} fan field of view; storage register in electronics.

Spin and Attitude Control System

The system capability is designed to be as follows:

(1) Spin axis in the orbit plane:

- Spin change capability of 0.10 to 0.12 rpm/orbit.
- Attitude control (precession) capability of 2.0 to 2.5^{o} per orbit at a spin rate of 3 rpm.

(2) Spin axis in cartwheel configuration:

- Spin change capability of 0.15 rpm per orbit averaged over one day of operation.
- Precession capability of 0.5^{o} per orbit at spin rate of 3 rpm averaged over one day of operation.

Power System

11,008 n-on-p 10-1/4% (A.M.O.) efficiency solar cells will charge 3 Ni-Cd batteries.
Six main system DC to DC converters.
Operational time after 1 year, minimum of 4 hours per day in 70% sun condition.
Continuous operation: Two consecutive pole-to-pole passes.

Command System

Command

Multiple tone-digital AM AVCO system.
2 receivers operation 148 MHz; 1 redundant.
Decoder capability - 216 commands.

Programmer and Clock

Stored commands for remote turn-on execution.
Capacity - 5 remote turn on from 10 commands.
Loading time 5 mins.
Programmer monitoring facility (readout time 3 secs.).
Clock output - serial time code BCD format 60 bps, once per second.
Ground correction capability.
Stability and accuracy 1 sec/week.

Automatic Turn Off

Normal turn off - after 16 mins.
Special turn off - after 8 or 24 mins.
Programmed turn off - after 16 mins.
Backup - after 16 or 30 mins. selectable by command.
Spin and attitude control - 3^{+1}_{-0} and 11^{+1}_{-0} hours, selectable by command.

Tape Recorder

Record time - 64 mins.
Playback - 4 times record speed.
Data channels - 4
(a) FM data - sounder output FM bandwidth 1 Hz to 9 KHz.
(b) Ref. frequency 11.52 KHz + AM time code.
(c) Digital data 11,520 bits per sec.
(d) Analog data - VLF output bandwidth 50 - 20,000 Hz.

Telemetry

Transmitter No. 1

Frequency	136.080 MHz: bandwidth 100 KHz
Power	4 watts.
Modulation FM	Sounder
PAM/FM	SCO essential housekeeping & clock.
FM	VLF

Max. range for 10 dB S/N 3500 miles with 19 dB ground antenna gain.

Transmitter No. 2

Frequency	401.75 MHz: bandwidth 500 KHz
Power	4 watts
Modulation FM	Sounder
PCM/FM/PM	SCO experimental data & housekeeping.
FM	VLF
AM/PM	SCO satellite clock.

Max. range for 10 dB S/N 3500 miles with 19 dB ground antenna gain.

Transmitter No. 3

Frequency	136.59 MHz: bandwidth 50 KHz.
Power	2 watts
Modulation PCM/PM	Experimental data and housekeeping.

Tracking Beacon

Frequency	136.410 MHz
Power	100 mw.
Unmodulated	

Experiments

(1) Swept Frequency Sounder

Power Output	400 W at PRF 45/sec.
Antennas	240' and 61.5' tip-to-tip.
Automatic ionogram transmission	

Frequency Range

(a) Normal sweep 0.1 to 10 MHz. Sweep duration 10 secs.
(b) Extended sweep 0.1 to 20 MHz. Sweep duration 20 secs.
(c) Sweep law - linear in all ranges.
(d) Frequency markers:
0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0 MHz.

(2) Fixed Frequency Sounder

The six frequencies selected for the fixed frequency sounder are:
0.12, 0.48, 1.0, 1.95, and 9.303 MHz.

Sounder Receiver Characteristics

Pre-amp. and filter No. 1 seven bands	(a)	0.1 - 1.0 MHz
	(b)	1.0 - 2.0 MHz
	(c)	2.0 - 3.0 MHz
	(d)	3.0 - 5.0 MHz
	(e)	5.0 - 8.0 MHz
	(f)	8.0 - 13.0 MHz
	(g)	13.0 - 20.0 MHz

Pre-amp. and filter No. 2 wideband 0.1 - 20.0 MHz
Linear - logarithmic receiver with AGC loop characteristics
Rise time 60 msecs. Fall time 12 msecs.

(3) VLF Experiment

VLF Receiver	
	0.05 - 39 KHz
	Monitored AGC voltage
A VLF swept frequency exciter	Range 500-0-9500 Hz.
Antenna impedance measurement	

Antenna bias. A D.C. bias can be applied to the antennas by command.

(4) Energetic Particle Detector (I. McDiarmid, J.R. Burrows)

Gieger counters	
Parallel to spin axis	
G1	>40 KeV electrons
	> 5 MeV protons
G2	>20 KeV electrons
	>.3 MeV protons
Perpendicular to spin axis	
G3	>40 KeV electrons
	>.5 MeV protons
G4	>20 KeV electrons
	>.3 MeV protons
Solid-state silicon junction detectors	
G5 Energy thresholds of:	80 and 100 KeV electrons
	.2 MeV protons
G6 Energy thresholds of:	120 and 200 KeV electrons
	.4 MeV protons
Proton detectors	
D_1, D_2, D_3, and D_B	0.15 - 55 MeV protons
Scintillation photomultiplier	
Sc Current mode total energy	> 3 KeV electrons
	>20 KeV protons
Sp Pulse mode particles at	40 and at 60 KeV electrons
	50 KeV protons

(5) Soft Particle Spectrometer (W.J. Heikkila)

Electrons 10 - 10,000 eV.

(6) Ion Mass Spectrometer (J. Hoffman)

Direct measurement of positive ion density mass numbers.
1 - 64 amu.

(7) Cylindrical Electrostatic Probe (Langmuir Probe) (L. Brace, J. Findlay)

Direct measurement of electron density and electron temperatures using two Langmuir probes at opposite ends of the spacecraft.

(8) Ion Temperature (J. Donley, E. Maier)

Direct measurement of electron temperature, ion temperature, ion composition, and charged particle density by retarding potential analyzer.

(9) Beacon (P.A. Forsyth, G.F. Lyon, E.H. Tull)

136.410 MHz, 137.950 MHz, 100 mW beacons.

(10) Cosmic Noise (T. Hartz)

From AGC of sounder receiver 0.1 to 16 MHz. Monitors background radio noise levels due to galactic, solar, and ionospheric sources.

(11) Oxygen Red-Line (6300Å) Photometer (G. Shepherd)

Direct measurement of oxygen red-line emission from aurora and from night, twilight, and air-glow sources.

(12) Auroral Scanner (3914Å/5577Å) (C. Anger)

Direct measurement and mapping of intensity of emissions at two wavelengths.

Weight Breakdown

Structure	102 lbs.
Experiments	150 lbs.
Telemetry & Command	100 lbs.
Power System	142 lbs.
ASC System	25 lbs.
Wiring Harness	41 lbs.
Total	560 lbs.

4.2 Project Office Report

Spacecraft Testing

Emphasis remains on keeping the flight spacecraft operative, using flight units as they become available, and prototype or engineering model units as necessary. Flight units not available include the optical experiments, the SPS, the IMS, the RCAL magnetometers and SCO's, and the 400 MHz transmitter. The second lot of Ni-Cd cells will probably yield two flight quality battery packs; it will be necessary to obtain lot #3 cells before the full flight complement is available.

Some systems have been kept complete on the prototype spacecraft to aid in autocheck development. This spacecraft is not being used for any other purpose at this time.

Environmental Testing

It is planned to conduct the thermal test at RCAL in mid-July, using as complete a flight spacecraft as possible. The main flight items expected to be missing are the batteries, tape recorder, and the optical experiments' optics. The ISIS-A engineering model tape recorder may be used in order to save the prototype tape recorder for thermal-vacuum tests; the optical experiments will have flight electronics for this test.

The planning for the environmental testing to be carried out at GSFC is proceeding. The test plan and specification are essentially finalized, and detailed test procedures are being worked out. A meeting to discuss the tests was held at GSFC on the 5, 6 and 7 of May.

Transistor Review

A thorough review of all transistors used in ISIS-B electronic units has resulted in a decision to replace devices of questionable quality.

Generally, the suspect transistors were made in 1965-66, the most serious devices being 2N2219A's, 2N3251A's and 2N2905's bearing '65-'66 date codes.

The clock and programmer is of particular concern; this unit has many questionable device types in it, and replacement of all appears impracticable. An effort will be made to enhance the reliability of the back-up clock, and as well, two system changes are being made to avoid the operational difficulties that arose in ISIS-I after its clock failures.

a) The back-up ATO will operate after 16 min. or 30 min., selectable on command.

b) The RCAL magnetometer will have a back-up clock to ensure its operation.

Spacecraft Systems

a) The redesigned sounder receiver system has been completed and calibration is underway. A more desirable a g c characteristic is now available in the flight unit and the sensitivity of the system seems to be improved both for the sounder and cosmic noise experiments.

b) The lowest fixed frequency for sounding has been changed from 0.250 MHz to 0.120 MHz. The frequency change was made to allow studies on VLF propagation in the region of 0.100 MHz; with the sounder at 0.120 MHz, the bandwidth of the receiver should allow observation of signals down to 0.100 MHz.

c) In the integration of the spin and attitude control system, it was found that the null-field location required by the control magnetometer probes was less critical than in ISIS-I. This improvement has been attributed to the bifilar winding used to make the flight torquing coils.

J.S. Matsushita
for G.H.C. Mackie

4.3 Spacecraft Operations

4.3.1 Electrical Summary

Following the failure, in February 1970, of both clock and programmers in ISIS-I there has been a re-evaluation of all transistors in ISIS-B. Numerous manufacturing defects have been found and at least eleven transistor types and 19 date codes are involved. Nearly all the devices were manufactured before 1967 and most carry 1966 date codes.

The position is serious and there is little doubt that the reliability of the spacecraft has been comprised. Every effort is being made to replace transistors having reject date codes. Some units and subsystems will have to be recalibrated. In most cases the recalibration is slight but in the case of the sounder subsystem there may be changes which could involve several weeks of additional testing. It is too early to say whether the March 1971 launch date will be delayed by these activities.

Similar problems occurred shortly before the launch of ISIS-A, and it is unfortunate that experience gained on the ISIS-A program did not result in more effective measures being taken to screen transistors for ISIS-B.

On future programs more rigorous parts procurement procedures must be established to try and eliminate such problems as defective lead bonds, poor metallisation, formation of intermetallics at gold-aluminum interfaces etc. For example, taking a X200 to X300 optical photograph of each transistor, after lead bonding but before encapsulation, would have been extremely helpful.

Diodes have not been examined for manufacturing defects. Some digital integrated circuits have been examined (using CRC's SEM facility) and all devices examined appeared acceptable. There have been some linear integrated circuit failures, however, no systematic attempt has been made to sample date codes.

C.A. Franklin

4.4 Mechanical Design

Thermal

The outer surfaces of the heatshields have received a coating of vacuum deposited aluminum at GSFC.

Solar Cell Panels

Emissivity measurements of the materials used in the manufacture of ISIS-I and ISIS-B solar cell panels have been made at GSFC.

Environmental Testing

GSFC have issued the ISIS-B Environmental Test Plan No. S-8-555.

Details pertaining to the Environmental Test Specification and Test Schedule have been discussed.

N.A. Harrison

4.5 Other Satellite Electronics and Experiments

4.5.1 VLF Receiver

There are no significant design changes to report during this period.

T. Nishizaki

4.5.2 Converter 6 (Spin and Attitude Control System)

The switching transients in the input and output lines of this unit have been reduced to an acceptable level by replacing the main connector with an EMI suppression filter type connector.

The load power requirement for this converter has increased to a maximum of 3W. The unit was originally designed for an output load power of 2W with a 30% transformer saturation margin. Because of this 50% increase in power requirement, the following recommendations have been made:

(a) Transformer be redesigned for higher flux level.

(b) All stress levels, especially in the switching transistors and the series transistors and its driver in the current and voltage limiter, be closely examined.

(c) Current limiting sense resistor values be recalculated.

However, the unit with only a minor change in the feedback circuit has been thermally tested over the qualification range at the 3 watt level and found to perform satisfactorily within specifications.

T. Nishizaki

4.5.3 DC to DC Power Converters
Main Clock and Programmer
Back-Up Clock and Programmer

There are no further design changes to report on these units. For details on the progress of the flight units, refer to the RCA contribution to this progress report.

T. Nishizaki

4.5.4 RCA Magnetometer

The design review of the ISIS-B RCA magnetometer was held at RCA Montreal on the 28th of April, 1970. A number of design points were discussed. The points which were not satisfactorily rectified at the time were delegated as action items for further examination.

The feasibility of including a back-up oscillator to provide the magnetometer with a 23.04 kHz frequency in event of a failure in both the primary and back-up Clock and Programmer was discussed.

It was generally agreed that the best approach would be to incorporate the ISIS-I proven oscillator from the PCM Encoder. This oscillator and associated electronics would be enclosed in a small box attached to the magnetometer unit.

T. Nishizaki

4.5.5 Primary Clock and Programmer

Replacements for the PNP "ZERO Pf" transistors in the HF scaling stages of the ISIS-B unit were found to have emitter and base leads positioned dangerously close to the guard ring (field relief electrode). Another 200 of this transistor type were ordered and inspected by A.R. Molozzi on-line at Motorola. They have now been delivered and are presently undergoing screening and burn-in at CRC. Two of these devices were selected for SEM studies.

SEM inspections have indicated that FM3304 transistors in the ISIS-B unit are also reliability hazards. It has been decided, therefore, to replace all FM3304 units with the PNP devices described above.

N.S. Hitchcock

4.5.6 Back-Up Clock and Programmer

PNP "ZERO Pf" replacements will be substituted for FM3304 transistors in the ISIS-B unit.

N.S. Hitchcock

4.5.7 Semiconductor Evaluation for Clock and Programmer

Procurement action was initiated for replacement of the SL65 PNP "ZERO Pf" transistors which themselves were replacements for original transistors. Motorola Semiconductor, Phoenix, Arizona, was visited by CRC Personnel for the purpose of pre-cap visual inspection.

The first two lots were rejected because of insufficient wire lift and other defects while the third lot was accepted. These units have now been received at CRC and are being subjected to selected conditioning and screening tests.

These units exhibit an unusual electrical characteristic for PNP transistors. The low voltage C_{ob} decreases with gamma radiation. Also for moderate doses (eg. equivalent to 1-2 years in the ISIS-B orbit), the low current h_{FE} does not degrade. Further investigation of these characteristics is planned.

A.R. Molozzi

4.6 RCA Ltd. Status Report

4.6.1 Management

4.6.1.1 Subcontracts

Seven coulometers were delivered and are undergoing screening and conditioning. The remaining eight coulometers have been promised for August 1970.

All other subcontracted items have been received and are ready for flight use.

4.6.1.2 G.F.E. Items

Forty-two battery cells have been received and tested. The yield for flight use is thirty-eight cells.

The fifty remaining cells have been promised for August, 1970.

The Solar Aspect sensor units have been reworked and tested, and they have been integrated on the flight spacecraft.

Flight experiments units have been received and integrated with the exception of the Soft Particle Spectrometer, which has been promised for early July, 1970.

4.6.1.3 CPM Planning and Scheduling

Monthly CPM have been made. The present shipping date to Goddard Space Flight Center is 15 October, 1970, and a launch date in early March, 1971 has been tentatively set.

The temperature tests of the completed flight spacecraft will take place at RCA Limited during July, 1970.

4.6.1.4 Reliability

4.6.1.4.1 Design Reviews

A total of two formal design reviews were held during this period:

Unit	Type of Review
Sub-carrier Oscillators (BV)	Preliminary
Magnetometer (JH)	Final

4.6.1.4.2 Components

The investigation to replace 2N4040/2N4041 transistors in the 400 MHz Transmitter (Unit BG) by 2N5635/2N5636 has shown the latter to be satisfactory. They were inspected and photographed before capping by RCA Limited personnel, and sent to Philco-Ford for further screening. At completion of screening a small sample will be decapped, and the effect of screening on the devices will be evaluated both optically and using SEM methods.

The new procedure of using RCA personnel to assist in failure analysis at CRC has proven highly successful, and a quick turn-around has been the result of this practice.

As a result of doubts raised about the reliability of certain transistor batches used on the project, an extensive and comprehensive investigation was undertaken of all transistors used in the flight and prototype spacecraft. On the basis of results to date, certain batches have been ruled not acceptable for flight, while other batches cannot be examined as no devices from them remain in stock. A general policy has been evolved of replacing transistors from both types of batches so as to give one complete set of units containing acceptable transistors only. These will be the prime flight units. The investigation is continuing as units are being reworked.

4.6.1.5 Quality Assurance

During the reporting period Material Review Boards were attended and dispositions made for 52 items on incoming inspection, 9 items on metal fabrication, and 10 items on aerospace assembly. Quality Assurance Engineering carried out follow-up action on all of the non-conformaties.

Malfunction Review Boards were attended and 155 malfunction reports were closed out. 52 malfunction reports are still open. These should be closed out as soon as the failure analysis findings on the failed components and the disposition on the ISIS "B" transistor evaluation is made available.

Five Quality Control Notices were issued covering various aspects of quality improvement for the Manufacturing and Assembly Area, Engineering Laboratory and the Integration Laboratory.

Quality audits were carried out in the Aerospace Assembly Area, Engineering Lab., Integration Lab, and the Aerospace Flight Stores. All four areas were given a satisfactory rating after action had been taken in response to Quality Assurance Engineering observations.

A Procedure for processing malfunction reports occurring during the Test & Evaluation phase at G.S.F.C. and at the launch site is being prepared. This procedure will be released shortly in the form of a Q.C.N.

4.6.2 Project Engineering

4.6.2.1 Autocheck

Final details of computer program requirements were worked out and preparation of detailed Step Instructions for the Minor Autocheck program was started. Step Instructions for the following have been written and passed to the programmers for coding and assembly:

- Spacecraft Initialization steps
- Telemetry System test steps
- Power System test steps
- Command System test steps
- ASCS System test steps
- Thermistor Calibration steps

A Check Table Specification drawing (2515304) has been prepared and quantities of check table blank forms prepared. Check table limits will be entered after completion of the temperature tests.

4.6.2.2 Spacecraft Systems

System changes and/or spacecraft wiring changes arising from unit changes, design reviews or investigation of integration problems have included the following:

- filter type connector fitted to the ASCS converter (Unit JC) to reduce the chance of RFI problems,

- back-up ATO circuit (Unit CD) modified so that ATO time may be selected as either 16 $\pm$ 2 minutes or 30 $\pm$ 3 minutes after receipt of the last command which resets the ATO. The choice is made by commanding either an 8 minute or a 24 minute interval for the Main ATO.

- an isolating diode was inserted in the input line to Converter 3 from the AIT control (Unit AQ).

- Sounder Receiver Cosmic Noise Output was added to the 136 MHz FM link by connecting it to an available EHC channel.

- Spacecraft wiring changes to accommodate installation of the new design SCO's BV1 and BV3 has been completed.

- Current sensing resistor in Unit DQ was halved to improve monitoring of torquing coil currents.

4.6.2.3 Telemetry Calibration Data

Calibration master forms have been prepared and calibration data is being collected for all channels for which it is required. A preliminary issue of these calibration data charts will be available for the spacecraft Temperature Tests in July.

4.6.3 Electrical Equipment Engineering

4.6.3.1 Sounder System

Most sounder units have been completed and installed on the prototype and flight spacecraft. The voltage regulators in the flight model sounder receiver unit and the receiver input unit have been modified to improve reliability. These modifications will be incorporated in the prototype units as soon as the flight model units have been completed. The gain of the receiver input unit has been increased and that of the sounder receiver unit has been decreased in order to reduce system noise. The prototype amplitude calibrator unit has been observed to generate spurious output signals when operating in the low-level calibration mode. This problem is currently under investigation. Recent analysis has cast suspicion on certain types of transistors used in various sounder units. In order to increase confidence in the probability of mission success, suspect transistors in one of the 400-watt power amplifiers and in the flight models of the antenna interface unit, the sounder receiver and the receiver input unit will be replaced. It is expected that this work can be performed without adversely affecting the program schedule.

The sounder receiver subsystem, which includes the antenna interface unit, the sounder receiver unit and the receiver input unit, has been checked out and calibrated. The calibration will have to be rechecked following the rework mentioned above. The prototype sounder system has been integrated on the flight spacecraft and, in general, has performed satisfactorily. The prototype units will be remounted onto the prototype spacecraft as the flight units become available. It is anticipated that the flight system will be completely integrated on the flight spacecraft during the month of July.

4.6.3.2 VLF System

All VLF prototype units have been completed. The flight model VLF exciter unit has also been completed and the flight model VLF receiver unit is presently undergoing final acceptance tests. Recent analysis has cast suspicion on certain types of transistors used in the VLF exciter unit. In order to increase confidence in mission success, the suspect transistors in the flight model VLF exciter unit will be replaced.

The prototype VLF system has been integrated on the flight spacecraft and has performed satisfactorily. This system will be transferred the prototype spacecraft when the flight units become available. The VLF excitation subsystem, consisting of the flight model VLF exciter and parts of the sounder antenna interface unit, will be calibrated following the transistor replacement mentioned above.

4.6.3.3 Telemetry System

All prototype telemetry system units have been completed except the 400 MHz telemetry transmitter and the 30 kHz and 93 kHz subcarrier oscillator units. The transmitter has been modified to accommodate the new 93 kHz S.C.O. interface, but is held up by late delivery of new transistors for the RF output stage. These transistors are expected to become available shortly. The three subcarrier oscillators are presently undergoing calibration and pre-acceptance testing, and are expected to become available in early July. All flight model telemetry system units are available except the 400 MHz telemetry transmitter, the two 30 kHz subcarrier oscillators, the 93 kHz subcarrier oscillator and the flight model tape recorder. The transmitter is held up by late delivery of new transistors for the RF output stage. These are expected to become available shortly. The three subcarrier oscillators are currently in the final stages of assembly and are expected to be completed and ready for integration by mid-July. Some problems were encountered during acceptance tests of the flight model tape recorder. These are currently under investigation.

4.6.3.4 Command System

The "backup" timer in the prototype A.T.O. unit has been modified to permit selection, by command, of either a 16-minute or a 30-minute turn off period. The unit has been retested and reintegrated. A similar modification is being incorporated on the flight model A.T.O. unit. All other prototype and flight model command system units have been completed except for the flight model clock and programmer, which is presently undergoing final acceptance tests. Recent analysis has cast suspicion on certain transistor types used in the A.T.O. unit (CD), the command switching unit (CE) and the "backup" clock and programmer (CF). In order to increase confidence in mission success, suspect transistors in the flight models of these units will be replaced. A decision is pending as to whether similar transistor changes will be necessary in the flight model clock and programmer unit.

4.6.3.5 Power System

Measurements taken on the prototype spacecraft indicate that overall power requirements (in mode A1) will be 127 watts, which is higher than anticipated. The increased power requirement is due to numerous small increases in several units. All flight model DC converter units have been retested at the new load levels. Analysis of the test results indicates that no design changes will be required. The first lot of nickel-cadmium battery cells has been received from the supplier and are currently undergoing screening tests at RCA. All other prototype and flight model units have been completed. Recent analysis has cast suspicion on certain types of transistors used in the experiments limiter unit (DJ). In order to increase confidence in mission success, the suspect transistors in the flight model of this unit will be replaced.

4.6.3.6 Attitude Sensing and Control System

The circuit design of converter No. 6 (JC) has been revised in order to reduce line ripple and to increase its power handling capability. In addition, new connectors containing integral RFI filters are to be installed. Rework on both the prototype and flight models of this unit is now in progress. Both the prototype and the flight model spin and attitude control unit (JD) have been completed. Design work on the new magnetometer electronics unit (JH) has been completed and the prototype and flight versions of this unit are both in the final stages of assembly. These units are expected to be ready for integration in July.

The prototype and flight model solar aspect sensors (JJ) and associated electronics units (JK) have been returned by the supplier following rework to correct workmanship defects. These units are currently undergoing retest at RCA.

4.6.3.7 Auroral Scanning Photometer Experiment

All parts for the optical assembly have been fabricated and shipped to the Space Engineering Division of the University of Saskatchewan, where the optical system is presently being assembled and aligned. The optical system is expected to become available by early July. The prototype and flight model photomultiplier tubes are currently undergoing acceptance tests and are also expected to become available by early July. Most of the boards for the prototype and flight model electronics units have been assembled and tested. Late delivery of certain components has delayed the completion of some boards, but all shortages are expected to be cleared by the end of June. Work is currently underway on the assembly of the prototype electronics unit, and testing is expected to commence in early July.

4.6.3.8 Oxygen Red Line Photometer Experiment

All parts for the optical assembly have been fabricated and shipped to the Space Engineering Division of the University of Saskatchewan, where the optical system is presently being assembled and aligned. The optical system is expected to become available by the end of June. Most of the boards for the prototype and flight model electronics units have been assembled and tested, although a few of the boards are incomplete owing to late delivery of certain components. It is expected that all component shortages will be cleared by the end of June. The prototype electronics unit has been assembled, except for the aforementioned missing components, and preliminary unit tests have begun. It is anticipated that prototype unit tests will be completed by late July. Assembly of the flight electronics unit has begun, and this unit should be available for preliminary tests by early July.

4.6.3.9 Main Ground Support Equipment

The main GSE has been in regular use over the current reporting period. Work has consisted mainly of routine maintenance and repairs, but minor modifications have been incorporated to improve performance and reliability. At the present time the main GSE in undergoing a major realignment and calibration in preparation for use by the Autocheck system during spacecraft thermal tests. Hardware documentation is continuing and is expected to be complete by mid-July.

4.6.3.10 Auxiliary Ground Support Equipment

The auxiliary GSE has been in regular use throughout the current reporting period and has performed satisfactorily. Work has been limited mainly to routine maintenance and repairs.

4.6.3.11 Off-line Computer

The off-line PDP8 computer has been in regular operation, 8 to 10 hours per day, throughout the current reporting period and has performed satisfactorily.

4.6.3.12 Software

The ISIS "B" ACE program has been completely debugged and is now available for use by spacecraft integration personnel. ACE program documentation is continuing. This is expected to be complete by the end of July. Most of the common routines and functions required by the Autocheck system have been coded, assembled and debugged, and work has begun on the assembly of steps for the minor Autocheck program. It is anticipated that the minor Autocheck program will be complete, except for check tables, in time for the spacecraft thermal tests in late July.

4.6.4 Mechanical Equipment Engineering

4.6.4.1 Prototype Spacecraft Integration

Integration of the prototype spacecraft was given second priority concerning integration activities because many prototype units were required to be used for flight spacecraft integration and debugging. Integration of the prototype spacecraft will resume when the workload on the flight spacecraft slackens.

4.6.4.2 Flight Spacecraft Integration

Integration of the flight spacecraft continues as units become available and systems are checked out. Hardware kitting is proceeding and is approximately 95% complete. Quality of delivered Nylok screws has been poor in many cases requiring return to vendor of unacceptable parts.

There have been no mechanical integration problems to report during this period. The equatorial panels of sectors #1 and #3 have been drilled to accommodate the relocated and redesigned S.C.O.'s and the thrust tube mounted AQD diode and mounting bracket have been designed and installed.

Polishing of the separation plane and auxiliary heat shield was done during April 1970 and aluminizing of thermal control surfaces has been completed at GSFC.

Flight hardware has been manufactured for the upper CEP tiedown and will be assembled to the 400 MHz antenna assembly in the near future.

Preparation of the spacecraft is continuing for the temperature test scheduled for mid July-1970. Thermistor blocks have been installed per requirements of thermistor location drawing EE 1089953, and thermistors and thermocouples will be installed early in July 1970.

4.6.4.3 Mechanical Systems

Weight reports now issued represent the current weight of the flight spacecraft, which is 559.6 pounds, made up of 55.4 pounds estimated; 198.6 pounds based upon weighed units combined with estimated encapsulant weights; and 305.6 pounds actual, as of 26 May, 1970.

The moment of inertia ratio is 1.05.

A protective cover has been manufactured for the RPA experiment; the solar cell panel protective covers have been modified to accommodate this installation as well as the fitting of protective covers for the RLP and Soft Particle Spectrometer experiments.

Methods of forming the biphenyl in the release blocks of the CEP tiedown hardware have been investigated. Compression molding appears to produce a slug of superior qualities compared to slugs made by casting. A lateral pull of 9 pounds in the direction of probe release failed to produce any yielding of the biphenyl.

A test plan for the temperature test scheduled for July, 1970 has been prepared.

The shroud to spacecraft orientation drawing #E1089793 has been updated and now gives shroud port requirements.

Storage and transportation cases have been prepared for the Aurora Scanner, Red Line Photometer and 400 MHz antenna.

A thermal design analysis has been completed on the top end of the spacecraft (the only major change from ISIS "I"). This analysis shows that the Auroral Scanning Photometer experiment could experience temperature variations from $-12^{\circ}C$ to $+52^{\circ}C$ under extreme conditions.

A review of the stresses associated with the 400 MHz antenna has also been completed.

J.L. McNally

5. SATELLITE CONTROL

5.1 General

Work continued on the development and refinement of satellite orbital computer programs during this period. All programs, with one exception, have been converted from the CDC 3200 to the new CRC Sigma 7 computer, but a few refinements still have to be done.

Scheduling of special passes to acquire data for backscatter comparison was started again at the end of April. Special scheduling to acquire simultaneous data from two satellites is still awaiting program development for the CRC computer.

Many non-unique ISIS-I passes were scheduled for Ahmedabad, India during this period. CRC have evaluated the magnetic tapes for some of these passes. Some changes to their recording system must be made before they will be allowed to acquire unique data. The ISIS-I magnetic tapes recorded at Kashima, Japan are satisfactory. Kashima will start to acquire unique ISIS-I data as soon as command arrangements have been finalized.

Special arrangements were made to have St. Johns, Newfoundland record Alouette/ISIS solar eclipse data up to 9 March, ten days after official station closing.

5.2 Alouette I

Alouette I is now operating in the sounder or VLF mode for about 3/4 hours per day. Some passes are scheduled while the spacecraft is in darkness. This slight increase in the operating time is a result of a change in the power system configuration made in early March. Batteries 1 and 6 are now the only batteries in service.

5.3 Alouette II

Alouette II continues to operate between 4 and 5 1/2 hours per day. The spin rate is now 1.80 rpm. There have been no changes in the operation or status of Alouette II during this period.

5.4 ISIS-I

ISIS-I operated between 6 1/4 and 8 1/2 hours per day during the reporting period.

The undervoltage cut out operated early 8 June as a result of a low battery 1 voltage. The system was restored at 1300Z on 8 June.

There has been no change in the status of the ISIS-I clock in this period. Neither clock in in service. Recent attempts to operate the on-board tape recorder have failed.

A sounder swept frequency offset command was sent in error on 18 April, forcing the sounder to operate continuously in the fixed frequency (1.95 and 4.0 MHz) mode. This error was corrected on 20 April. Another command error on 15 April left the fixed frequency flag on the 30 kHz subcarrier reading in error. This error was corrected on 21 April. There has been no change in the sounder system during the reporting period.

There has been no change in the status of the Ion Mass Spectrometer or the Soft Particle Spectrometer experiments during this period.

J.D.R. Boulding

6. DATA PROCESSING

Production records for the last period are:

ISIS-I	1934 tapes
Alouette II	1714 tapes
Alouette I	125 tapes
Brace Probe	676 tapes

A tape playback unit has been obtained on loan from another section and will be used for a second Brace Probe data compaction line.

One production model version of the Ionogram Production Unit has been on line during the last period. The wiring of the second unit has been completed and checked. Upon completion of the printed circuit cards it will be placed in service. A card was added to the prototype model to allow the recording of the satellite receiver AGC directly on the ionogram. This mode of production for Alouette II is now considered to be standard practice and upon the completion of a modification to allow multispeed operation will be used on the production units with ISIS-I data.

A successful method of speed compensation for the ISIS-I dump tapes has been evolved. The control loop utilizes the PCM bit synchronizer clock output and is thus limited in use to those tape recorder modes in which PCM is recorded. The time code recorded on the 46.080 kHz carrier periodically is degraded by what appears to be out-of-band signals from the PCM or video formats and thus cannot be used for speed locks. Work is underway to extract as much of this signal as possible in order that a synthetic marker may be produced to give a measure of the speed control achieved. The time code display is also being examined in order that a consistent display may be obtained. It may be necessary to use the clock signal recorded on the PCM.

A test tape has been distributed to data reduction centres. The tape carries a range marker check, a grey scale, and a resolution check. Further work in calibration tapes will be undertaken to permit set-up and diagnostic checks of the CRC processing lines.

The second computer system is nearly on line. Work on the software systems to improve them and to adapt the systems to ISIS-B will be started during the next period.

D.P. Henderson
R.S. Gruno

7. TELEMETRY STATIONS

7.1 Ottawa

The Ottawa Ground Telemetry Station continues to provide routine operations with Alouettes I, II and ISIS-I.

A Transfer Relay has been installed in the feed to the Yagi command antenna to provide selection of either the Right Hand or Left Hand circular polarization of transmitted command signals. This has increased the reliability of the command system except in cases where extraneous signals have blocked the command receiver.

Modifications to the Kennedy 60 foot parabolic dish antenna control system have not been ordered to date and will therefore not be completed prior to the launch of ISIS-B. This will restrict the Ottawa Station to operation of the antenna system from predicted look angle tapes in the programmed mode.

The modifications required to update the Data Control Systems 1000 PCM system have been ordered and should be installed during the next reporting period.

7.2 Resolute Bay

The Resolute Telemetry Station continues to receive telemetered data from Alouettes I, II and ISIS-I. There have been problems, however, due to the large percentage of time during which scintillation of the RF signal carrier is observed. These fades, at rates of 6 to 10 per second and up to 30 dB deep cause noise bursts on both the FM and PM telemetered data even though diversity combining is used on both of the RF links. It is hoped this problem will ease as the sunspot number decreases. An Electrac Solid State Dual Channel Converter has been installed in the PM receive system, replacing the Vitro tube type 1456A receivers.

Two DEI/Vitro/Nems Clarke, 1037G Solid State Telemetry Receivers and a 4503 Post Detection Diversity Combiner have been ordered and will be installed during the next reporting period. Other than some minor changes to the antenna systems this will complete the station update for ISIS-B.

The station was visited during the first half of April 1970.

W.S. Campbell

8. QUALITY ASSURANCE

Since the beginning of April, 1970 when some failed devices date coded 1966 indicated serious defects, an intensive evaluation has been made of all transistor types in ISIS-B flight units. The evaluation consisted of selecting small samples of date coded transistor types for a transistor curve tracer electrical check, an examination by a scanning electron microscope (SEM), a bond pull strength test, and a recommendation on the acceptability of particular date coded device types for ISIS-B use. There were approximately 60 sample batches from 34 different device types evaluated. The device types and date codes which were rejected and therefore recommended for replacement by Dr. V. Sulway/Failure Analysis Group and J.E. Tennuci are as follows:

Device Type	Manufacturer	Date Code
2N3251A	Motorola	6617
2N3251A	Motorola	6628

Device Type	Manufacturer	Date Code
2N2219A	Motorola	6618
2N2905A	Motorola	6626
2N2905A	Motorola	6627
2N2907A	Motorola	6622
2N2907A	Motorola	6619
2N3501A	Motorola	6622
2N3486A	Motorola	6625
2N2501	Motorola	6714
2N2501	Motorola	6814
2N2501	Motorola	6852
2N3300	Fairchild	6641
2N3304	Fairchild	6631
2N3304	Fairchild	6633
2N3304	Fairchild	6644
2N2893	Fairchild	6611
2N2893	Fairchild	6630
2N3504	Fairchild	6615
2N3504	Fairchild	6623

Results of the evaluation indicate that most of the date coded 1966 devices which were sampled, highlight poor metallization, low bond pull strength bonds and in general questionable workmanship.

There are 3 outstanding part failure problems to resolve in the 61 open malfunction reports that are from a total of 291 reported, they are:

Motorola DTL 951 Logic monostable multivibrator (M/R 265),

National Semiconductor LM101 operational amplifier (M/R 296),

and Erie ceramic capacitor type CKR (M/R 298).

Regarding ISIS-B Quality Control planning, a set of inspection check lists and a schedule of spacecraft inspection and test monitoring efforts is documented and will be soon issued by the Contractor as an appendix to the

ISIS-B Quality Program Plan. These check lists and schedule are being used in the spacecraft integration, initial tests, thermal test, pre-GSFC test evaluation (T & E), GSFC T & E and pre-launch activities.

J.E. Tennuci

9. PROJECT SUPPORT

9.1 ISIS Planning and Scheduling

9.1.1 RCA Ltd. Status

Integration of the prototype spacecraft has been held by the need of some prototype units for the flight spacecraft.

Integration of the flight spacecraft is continuing as units become available and systems are checked out.

Thermal testing of the flight spacecraft at RCAL has been scheduled to begin in mid-July.

Monthly CPM runs have been issued during this period and indicate the start of T & E testing at GSFC in mid-October and a launch in early March, 1971.

9.1.2 CRC Status

During this period, an intensive investigation of semiconductor devices used in ISIS-B flight units has been made. This investigation has revealed serious defects in some transistors especially those bearing date codes 1965-66. Further details of this investigation are contained in the Quality Assurance section of this report.

J.A. Moffatt

10. SUPPORTING RESEARCH AND DEVELOPMENT

10.1 Computer-Aided Design

A study is being made of the ways in which computer-graphics could be used in the design of layouts for thin film integrated circuits and microwave circuits. It is hoped to implement a system which will give the designer the ability to draw, modify and dimension a circuit layout on the CRT and then automatically produce the control tape for cutting the necessary artwork to produce the circuit. It is planned to make visits to firms using these techniques in the near future.

A Varian 622I computer has been borrowed from the Computing Centre to form the basis of the low-cost graphics terminal. Detailed design of the display controller has been started.

The equipment for the automated measurement of device parameters has been completed and the necessary programs are now being developed. These are being written in a modular fashion to give as much flexibility as possible in their future use.

The various routines comprising the SCEPTRE program have been separated into files on magnetic tape so that they can be examined in detail for language compatibility with the SIGMA 7 system and for study of the system organization of the program.

M.A. Maclean
H.G. Bown
R.G. Fugaros
H.M. Grant
R. Warburton

10.2 The Soft Electron Spectrometer (SES) Rocket Experiment

In February the project scientist, Dr. D. McEwen, requested the activation and calibration of a 2nd set of dynodes for the ABD-VB-24 rocket payload. Dynodes were activated, assembled in the flight spare detector module, calibrated, sealed and shipped to the Churchill Research Range for flight standby storage under vacuum until the end of the launch window. The calibration data were mailed to Dr. McEwen at the University of Saskatchewan.

Since the launch window was terminated in early April without the VB-24 rocket having been fired, the rocket is to be rescheduled for the winter of 1970-71. The project scientist will carry out any further preparation work for the SES experiment in Saskatoon

No further reporting on this project is anticipated.

G.T. Bird

10.3 Device Failure Analysis

During this period, the device analysis group has been concerned with the quality evaluation of devices for ISIS-B. As far as possible, samples of devices from all batches used in the spacecraft are being evaluated for general quality of workmanship. This work is still in progress, but has already raised questions on a number of device types and batches. These questions are concerned with the quality of metallization, the strength of bonds, formation of intermetallics at Au/Al interfaces and the general appearance of the overall device.

This work has been reported in CRC Serial Documents 03-NSTL-3-29 (April 1970); 03-NSTL-4-31 (May 1970); 03-NSTL-5-34 (June 1970); 03-NSTL-6-36 (June 1970); 03-NSTL-7-38 (June 1970); 03-NSTL-8-39 (June 1970); 03-NSTL-9-41 (June 1970).

D.V. Sulway

11. DISTRIBUTION

Library	15
DSIS/DOC. File/Reference File	2
ADM(R) DOC	1
B.A. Walker DOC	1
TLO/DREO	1
DG/DDG, CRC	1
AD/NRPL	1
D/NCL	1
D/NSTL	1
CDRS(W)	1
CDRS(L)	1
J.E. Jackson (GSFC) Code 615	1
L.H. Brace (GSFC) Code 621	1
E.D. Nelsen (GSFC) Code 620	1
R.G. Sanford (GSFC) Code 513	1
C.H. Freeman (GSFC) Code 565	1
E.J. Maier (GSFC) Code 615	1
E.R. Schmerling (NASA/HQ) Code SG	1
F. Gaetano (NASA/HQ) Code SG	1
D.C. Rose (NRC)	1
I.B. McDiarmid (NRC)	1
J.W. King (RSRS)	2
C.A. Franklin	15
J. Else	1
J. Mar	1
Project Manager (Contractor)	8
T.R. Hartz	1
G.L. Nelms	1
E.S. Warren	1
E. Atkins	1
S.P. Roper (DSS)	1
R.A. Ironside (DSS)	1
W.J. Heikkila (SCAS)	1
R.C. Sagalyn (AFCRL)	1
R.S. Narcisi (AFCRL)	1
P.A. Forsyth (UWO)	1
R.E. Barrington	1
D. Leiulfsrud NTNE Telemetry Station, The Auroral Observatory, Tromsø, Norway	1
J. Frihagen (NDRE) Kejeller, Norway	1
Kurt Melby (NTNF) Space Activities Division, Stasjonvegen 4, Oslo 3, Norway	1
U. of Kansas	1
L.W. Miller (ESSA/RL)	1
E. Schiffmacher (ESSA/RL)	1
W. Calvert (ESSA/RL)	1
G.E. Schlimmer (ULO/WTR)	1
J.H. Hoffman (SCAS)	1
C. Anger (U. of Calgary)	1
G.G. Shepherd (U. of York)	1
Dr. A. Kavadas, Space Engineering Division, U. of Sask.	1

Dr. R. RaghavaRao, Physical Research Laboratory, Navrangpura,
Ahmedabad 9, India ---------------------------------- 1
Centre National D/Etudes Spatiales, 127, 129 de l'Universite,
Paris-VII^{e}, Attention: COBY/F. Pene ---------------- 1
Dr. Y. Ogata, Radio Research Laboratories, Ministry of Posts
and Telecommunications, Kokubunji, P.O.,
Tokyo, Japan --------------------------------------- 1

ISIS PROGRESS REPORT