

DEPARTMENT OF MINES & ENERGY

NORTHERN TERRITORY

OPERATIONAL REPORT

OF

AIRBORNE GEOPHYSICAL SURVEY TB 1531/80

*Witchfield Province*

*Ramon Creek*

BY

AUSTIREX INTERNATIONAL LTD

CONTENTS

	<u>Page No.</u>
1. <i>STATISTICS</i>	1
2. <i>SURVEY SPECIFICATIONS</i>	2
<i>Area</i>	
<i>Flight</i>	
<i>Instrumentation</i>	
3. <i>EQUIPMENT SPECIFICATIONS</i>	3
<i>Aircraft</i>	
<i>Altimeters</i>	
<i>Doppler Navigation System</i>	
<i>Magnetometer - Airborne</i>	
- Ground	
<i>Spectrometer</i>	
<i>Crystal Detectors</i>	
<i>Calibration Sources</i>	
<i>Data Acquisition System</i>	
<i>Recorders</i>	
<i>Tracking Camera</i>	
4. <i>SURVEY PROCEDURES</i>	4
<i>Operations</i>	
<i>Logistics</i>	
<i>Instrument Calibrations</i>	
5. <i>DATA REDUCTION</i>	5
<i>Flight Path Recovery</i>	
<i>Flight Path Control and Digitising</i>	
<i>Magnetic Data Processing</i>	
<i>Radiometric Data Processing</i>	6
<i>Field Data Tape Format</i>	7 - 8
<i>Corrected Located Data Tape Format</i>	9 - 10
<i>Line number structure</i>	11
<i>ILLUSTRATIONS:</i>	
<i>Nomad Geophysical/Navigation System</i>	12
<i>Austirex Data Processing System</i>	13

1. STATISTICS

Contract: TB 1531/80, dated March 23, 1981

For: Department of Mines & Energy,  
Northern Territory of Australia

Contractor: Austirex International Ltd  
621 Pacific Highway,  
St. Leonards, New South Wales

Type of Survey: Airborne geophysical for acquisition  
of magnetic and radiometric data

Prospects: Litchfield Province Area covering 1:100,000  
map sheets; Anson, Bynoe, Darwin, Fog Bay,  
Koolpinyah, Noonamah and Reynolds River.

Barrow Creek Area covering 1:100,000 map  
sheets; Barrow, Crawford, Home of Bullion,  
Larapulla, Murray Downs and Taylor.

Aircraft: Nomad N22B's  
Registration numbers VH-CPZ, VH-FZP

Personnel: Pilots:- W. Hay  
D. Gibson  
M. Howell  
K. Fitzmaurice  
J. Morton

Navigators:- G. MacDonald  
R. McLernon  
W. Edwards  
G. Atkinson

Engineers:- S. Buswell  
R. Breheny  
R. Jordan  
F. McGrath  
D. McLernon  
J. Robins

Technicians:- J. Boyd  
M. Lissiman  
J. McKenzie  
D. Morrison  
C. Rowlands  
K. Walsh

Duration: Litchfield Province - 19 May to 17 July 1981  
Barrow Creek - 7 March to 25 June 1981

Climatic conditions: All acceptable data was acquired during  
dry weather periods

Geo-magnetic conditions: Minor diurnal disturbances were  
recorded on April 12, 13, 21, 22 and June 8. The  
activity precluded normal data acquisition.

2. SURVEY SPECIFICATIONS

Area:

Litchfield Province: approximately 15,080 square kilometres  
Flight lines: 317 lines spaced at 500 metre intervals  
Direction north - south  
Tie lines: 23 lines spaced at 5 kilometre intervals  
Direction east - west  
Linear distance surveyed: 35,026 kilometres

Area:

Barrow Creek: approximately 17,050 square kilometres  
Flight lines: 310 lines spaced at 500 metre intervals  
Direction north - south  
Tie lines: 33 lines spaced at 500 metre intervals  
Direction east - west  
Linear distance surveyed: 39,478 kilometres

Flight:

Aircraft/detector elevation: average 100 metres terrain clearance.  
Navigation: Visual from aerial photo assemblage with doppler guidance.

Instrumentation:

Flight path: Vertical tracking camera film record. Fiducial recovery on to aerial photographs at an average interval of 10 kilometres.  
Magnetic data: Airborne and ground station proton precession magnetometers for recording of total field intensity magnetics.  
Radiometric data: Gamma-ray spectrometer for total radiation intensity measurement. Spectrum windows set 0.4 - 3.0 Mev. for Total Count, 1.37 - 1.57 Mev. for potassium, 1.66 - 1.86 Mev. for uranium, 2.40 - 2.80 Mev. for thorium and 3.0 - 6.0 Mev. for cosmic background.  
Data Acquisition: Digital recording of all sensor and doppler information onto 9 track 800 b.p.i. magnetic tape. Sample interval at 0.8 seconds. Analogue recording of all magnetic and spectrometer data onto multi-channel records.

3. EQUIPMENT SPECIFICATIONS

Aircraft: Government Aircraft Factories NOMAD, Model 22B.  
Twin turbo-prop engines.

Altimeters: Radar altimeter - Collins, model ALT-50.  
Range 0-610 metres.  
Barometric altimeter - Penny and Giles

Doppler System: Sperry Decca, type 72 with Tactical Air  
Navigation System computer, model 9447D. Navigation  
in metric grid mode and digital recording in Lat. and  
Long. coordinates.

Airborne Magnetometer: Varian, model V-85 and Sonotek Proton  
precession magnetometers. Sensitivity 0.1 nT.,  
auto tuning. The sensors are mounted in a tail  
stinger installation.

Ground Magnetometer: Geometrics, model G826A proton precession  
magnetometer. Sensitivity 1.0 nT. Time controlled  
total field recording at 10 second intervals on to  
analogue charts and 30 second intervals onto digital  
printout.

Spectrometer: Geometrics, model GR-800. Multichannels of  
256 for the main downwards detector and 128 channels  
for the upward detector. Energy level windows set  
at selected gamma-ray spectrum.

Crystal detectors: Geometrics, model 3072/512R. Sodium  
iodide crystals, 50.340 litres main packs and 8.340  
litres for the upward packs.

Calibration Sources: Standards of Cesium, Uranium, and Thorium  
used for daily pre and post flight ground calibrations.

Data acquisition system: Sonotek Integrated Geophysical System,  
model IGSS-1. Fabritek, model MP-12 computer and  
two Digi Data 9 track tape decks.

Analogue Recorders: Exploranium, model MARS-6, a six channel  
recorder for magnetic, radiometric, radar altimeter  
and fiducial data. Hewlett-Packard, model 7155, a  
dual channel recorder for radiometric calibrations  
and spectral plots.

Tracking Camera: Geocam 35 mm, model 75SF, fitted with a  
17 mm wide angle lens. Continuous strip mode with  
fiducial numbers imposed on film exposures.

4. SURVEY PROCEDURES

*Operations:* For the Litchfield Province area Darwin was used as the base for flight and field operations. For the Barrow Creek area Tennant Creek was selected as the prime base for aircraft and personnel and the landing field at Barrow Creek was utilised for mid-day refuelling. At both bases all accumulated flight and sensor data was subjected to infield quality control for verification of validity and specification tolerances. A subsequent office computer evaluation of all digital data was made to ensure that all systems and information were recorded properly and as a final acceptance of the raw data.

*Logistics:* Aviation turbine fuel in 200 litre drum containers was supplied from Darwin and road freighted to the landing field at Barrow Creek.

*Instrument calibrations:* Prior to survey commencement and at the conclusion a magnetic value comparison was performed between the airborne and ground magnetometers. Also airborne tests were conducted for magnetic heading calibrations, systems parallax and height attenuation coefficients at multiple level altitudes of 100, 150, 200, 250, 300, 400 and 500 metres. The radar altimeters were calibrated weekly by reference to barometric altitudes of 40, 60, 80, 100, 120 and 150 metres over the airfields.

During the course of the survey ground pre and post flight spectrometer calibrations were performed to ensure the systems stability and response to be within normal tolerance limits.

Airborne pre and post flight tests were conducted over a 5 kilometre length line at survey altitude to confirm all systems repeatability and for the assessment of ground water conditions. All data was recorded digitally and graphically and noted on the calibration logs.

5. DATA REDUCTION

*Flight Path Recovery:* The flight path was recovered both in the field and in the office as flying proceeded. The techniques used were:- (a) visual comparison of detail in the aircraft tracking film with that of the recovery photographs, marking equivalent points and recording the relevant fiducials, (b) visual comparison of tracking film for the traverses with that of the ties, marking the exact crossover point and recording the relevant fiducials on the ties and the traverse films.

*Flight Path Control and Digitising:* Both photographs and control points (from aerial triangulation) for each survey area were obtained from Natmap. The control points on each photograph were digitised and then transformed using a least square fit (Helmert Transformation) to obtain photograph coordinates.

The individual photographic recovery points were then digitised and transformed using a perspective transformation determined by the control points. The recovery was checked for gross errors by a simple speed check and then by a doppler comparison to check on smaller errors.

*Photography used:-* Barrow Creek area -  
Orthophotomaps based on 1969 photography  
(scale 1:100,000), RC9 photographs 1971  
(nominal scale 1:84,000)  
Litchfield Province area - RC9 photographs  
1969 (nominal scale 1:84,000)

*Magnetic Data Processing:* A very light filter based on fourth differences was applied to the raw data to remove any high frequency instrumental noise. System parallax, a dynamic correction, based on the following three components (a) time offset (b) distance offset (c) fiducial offset, was removed. Note: No parallax correction is applied to multiplots. Every two nanoTesla diurnal variation was recorded and removed. For regional field removal the 1975 IGRF model, with secular variation, was computed for each individual fiducial and removed from the magnetic value recorded on that fiducial. Tie line levelling was used to remove any linear variations between traverse lines.

Radiometric Data Processing: the following reduction procedures were applied to the data:-

- (1) Dead Time - fixed for our system at 8 microseconds.
- (2) Aircraft background and cosmic correction factors - computed from high altitude test lines over water (greater than 1000 m amsl) above the influence of ground generated radon gas. There is a linear relationship between observed count rates in each window to be corrected and the cosmic window count. The slope of this line represents the cosmic correction factor and the intercept at zero cosmic counts represents the aircraft background in each window.
- (3) Spectral reduction - a matrix operator reduces the data to Compton stripped K, U, Th and Total Count. The operator was determined using calibration data and further refined using test range data.
- (4) Atmospheric correction for Uranium and Total Count and altitude attenuation corrections:- computed from altitude stacks (usually from 50m to 400m amsl) over a land-water interface and test range data.
- (5) Conversion to ground concentration: Element sensitivities are computed from test area of known concentrations. This enables us to convert count rates to percentages of relevant elements. For U and Th  $e_U$  and  $e_{Th}$  are computed. The "e" is used to denote "equivalent" in recognition of the fact that these analyses have been made on radiation emitted from daughter products in a series. Total Count data are expressed as "ur" units. This unit is defined as the concentration of uranium in the sample (ground) which would generate the measured count rate if all the counts were originating from uranium series radiation in equilibrium.



Raw Field Data Tape Format:

- (1) One (1) type of Block containing:-
  - A: Data Block Header
  - B: Three (3) Data Scans
- (2) The data block header contains the following information (in four (4) bit units) in either BCD or BIN as set out below:-

<u>No. of 4 bit units</u>	<u>Code</u>	<u>Meaning - Content</u>
4	None	Marker - 2 bytes of HEX FF
2	BCD	DAY
2	BCD	MONTH
2	BCD	YEAR (last 2 digits)
2	None	MARKER (HEX FF)
4	BCD	SCAN TYPE
2	None	MARKER
2	BCD	Operator Identification No.
2	None	MARKER
4	BCD	TAPE NUMBER
2	None	MARKER
4	BCD	BLOCK NUMBER
2	None	MARKER
6	BCD	LINE NUMBER
2	None	MARKER 1 byte of HEX FF
4	BCD	FLIGHT NUMBER
2	None	MARKER
<hr/>		
40		

- (3) Each of the Three Data Scans contains the following information.

<u>No. of 4 bit units</u>	<u>Code</u>	<u>Meaning - Content</u>
6	BCD	FIDS
2	None	MARKER
6	BIN	24 bit count of acquisition period of spectrometer, for this scan in units of 1/10th of a millisecond.
6	BIN	24 bit count COSMIC, DOWN
6	BIN	" " " K - 40, "
6	BIN	" " " Bi-214, "
6	BIN	" " " Tl-208, "
6	BIN	" " " TOTAL, "
6	BIN	" " " 1.0 - 2.3 MeV UP
6	BIN	" " " TOTAL UP
1024	BIN	256 x 16 bit counts, channels 0 - 255, Spectrometer, DOWN.
256	BIN	128 x 8 bit counts, channels 0 - 127, Spectrometer, UP.
2	BIN	8 bit checksum for all Spectrometer channels, excluding itself, (subtotal = 1330 four bit units).

<u>No. of 4 bit units</u>	<u>Code</u>	<u>Meaning - Content</u>
2	None	ALL ZERO MARKER 00
6	None	ALL '1' MARKER (HEX F)
1	BCD	If 1 = WEST, if 2 = EAST
3	BCD	Longitude, degrees
2	BCD	Longitude, minutes
2	BCD	Longitude, seconds
1	BCD	If 4 = SOUTH, if 8 = NORTH
2	BCD	Latitude, degrees
2	BCD	Latitude, minutes
2	BCD	Latitude, seconds
3	BCD	Heading, degrees
2	BCD	Heading, minutes
6	BCD	Unassigned
4	BCD	Doppler along-heading pulse count
4	BCD	Doppler across-heading pulse count, right
4	BCD	Doppler across-heading pulse count, left
2	BCD	TIME HRS
2	BCD	TIME MINS
2	BCD	TIME SECONDS
2	BCD	Identifier 00 - FIXED
4	BCD	DATA from analog channel 00 Temperature in 0° C in format 000.0° C
2	BCD	Identifier 01 - FIXED
4	BCD	DATA from analog channel 01 Altitude in metres in format 000.0m
2	BCD	Identifier 02 - FIXED
4	BCD	DATA from analog channel 02 Air pressure in millibars format 0000 mB
2	BCD	Identifier 03, - FIXED
4	BCD	DATA from analog channel 03 Auxiliary input for channel 02
2	BCD	Identifier 04
4	BCD	DATA from analog channel 04 Unassigned
2	BCD	Identifier 05
4	BCD	DATA - for 05 unassigned
6	BCD	MAGNETOMETER DATA in FORMAT 00000.0 GAMMAS
4	BCD	MARKER all '1' (double)

1436 Four (4) Bit Units, or 718 bytes

Total Record Length

Block header	24 bytes
3 Scans x 715	2154 bytes

TOTAL 2178 bytes

Corrected Located Data Tape Format:

Tapes are 9 track, 800 b.p.i., ASCII  
Each tape has the following structure:

1. Character set record (repeated 3 times)
2. File header (repeated 3 times)
3. Comments header
4. Line data records
5. EOF mark

The format for 1 to 4 above are now given:

- A. Character set record is 50 bytes
- B. File Header: Physical record length =  $170 + n \times 4$  bytes, where  $n$  = no. of 1:100,000 sheets.

The record is made up as follows:

<u>No. of bytes</u>	<u>Data Item</u>
6	File number
25	Survey area name
7	Area size (sq. km)
2	No. of 1:100,000 sheets (n)
n x 4	Sheet numbers
25	Who flew survey
25	Who processed data
25	For whom
1	Digital or analog acquisition (D or A)
20	Flight path control method
3	Traverse line separation (km)
3	Tie line separation (km)
5	Average altitude (m)
5	Nominal ground clearance (m)
3	line bearing from north (degrees)
7	7 zeros
3	No. of records in comments header
3	Length of data records in chars.
2	2 blanks

170 + n x 4 bytes

- C. Comments header; Each record consists of 69 chars + new line
- D. Line data records; Block size = 4230 bytes, consisting of 30 records of length 141 bytes.  
Record format is:

<u>Data Item</u>	<u>Format</u>
Date	I6,1x
Flight number	I3
Time (sec)	I6,1x
Line number	I5,1x
Fiducial number	I6
Recovery point marker	*
Recovery longitude (deg)	F10.5
Recovery latitude (deg)	F10.5
Mag longitude (deg)	F10.5
Mag latitude (deg)	F10.5,1x
Mag intensity (nt)	F7.1
Spectrometer longitude (deg)	F10.5
Spectrometer latitude (deg)	F10.5

Total count (ur)	F8.2
Potassium (per cent)	F7.2
Uranium (eppm)	F7.2
Thorium (eppm)	F7.2
Uranium air (eppm)	F6.2
Terrain clearance (m)	I4
Heading (deg)	I4
	<hr/>
	141 bytes
	<hr/>

Any undefined data is shown as an \*.

An EOF mark is written at the end of all line data.

Line Number Structure: The last digit on all lines is used as an attempt number, --.1 is the first attempt, --.2 is the second and so on.

Test Lines: Pre Flight 1.1  
Post Flight 2.1  
High altitude test 3.1

Calibrations: Pre flight Cs 137 10.1  
U 11.1  
Th 12.1  
Background 13.1  
Post Flight Background 17.1  
Th 16.1  
U 15.1  
Cs 137 14.1

Parallax Test: 20.1

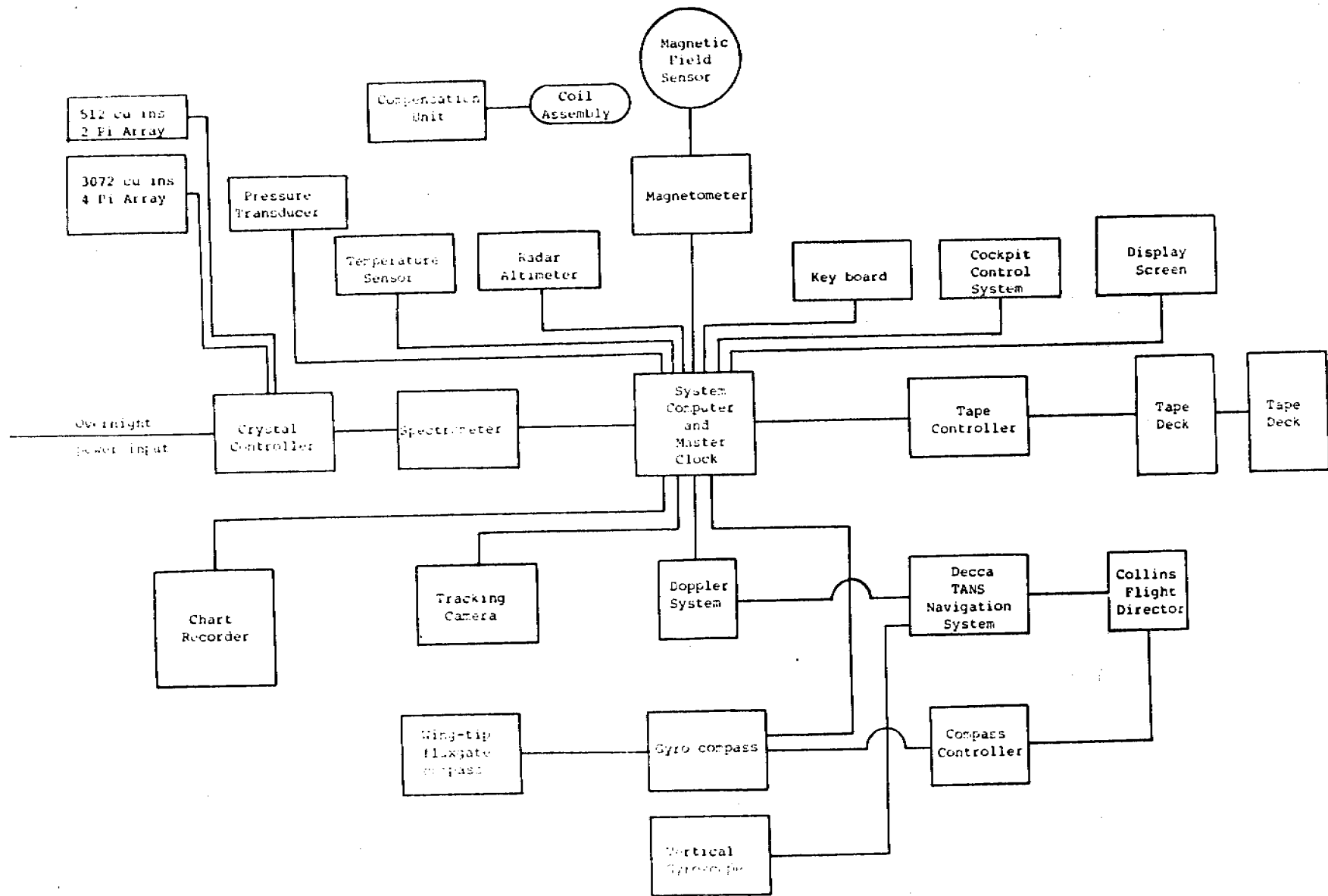
Attenuation Test/Altimeter check:

40 m 50.1  
60 m 51.1  
80 m 52.1  
100 m 53.1  
120 m 54.1  
150 m 55.1

Heading Test: 60.1  
61.1  
62.1  
63.1  
64.1  
65.1  
66.1  
67.1

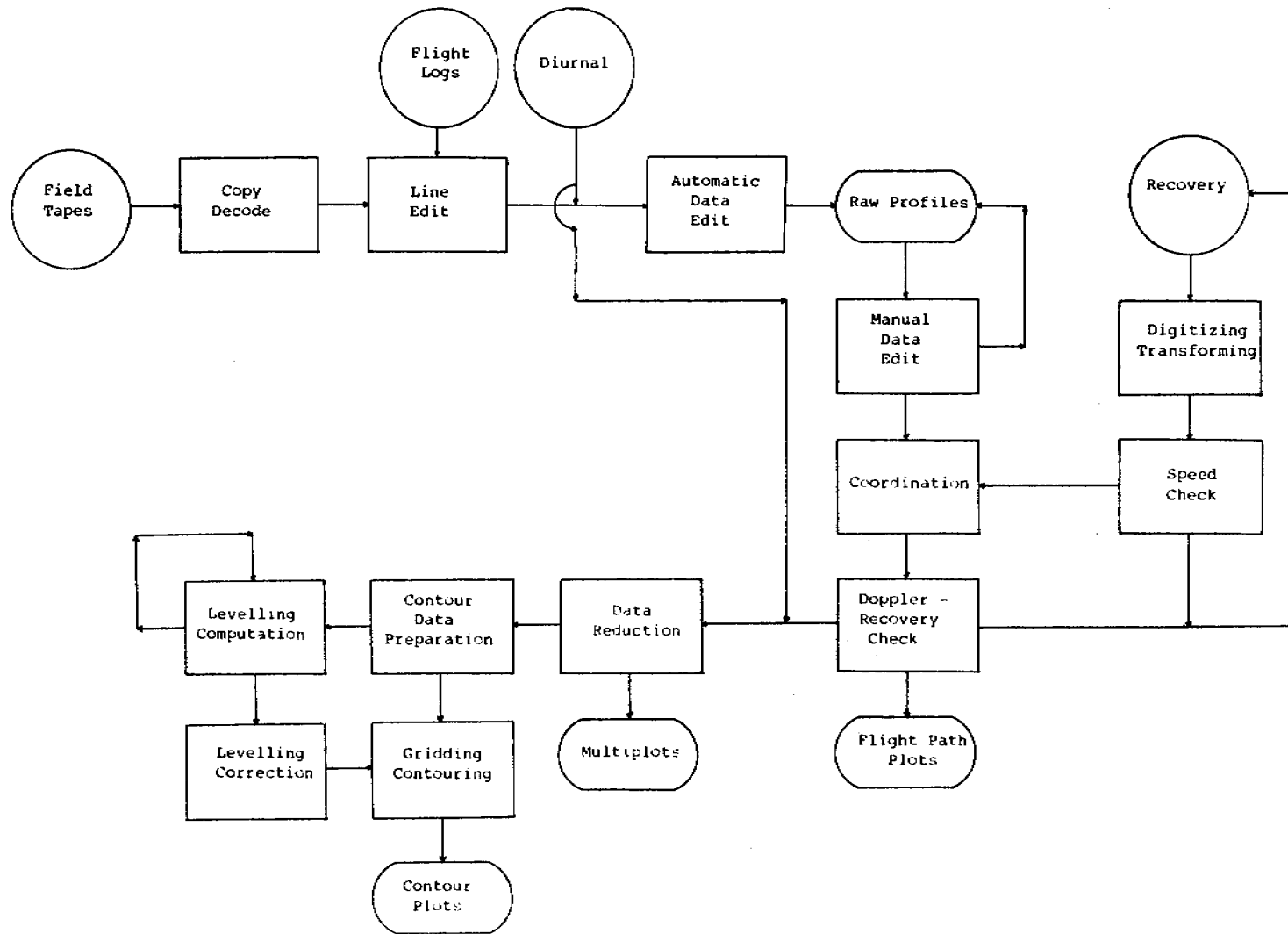
Traverse: 101.1 to 899.1  
Different areas start at  
next 100 ie Area 1 101.1 to 417.1  
2 501.1 to 810.1

Tie lines: 901.1 to 999.1  
Different areas start at  
next 100 ie Area 1 901.1 to 923.1  
Area 2 931.1 to 963.1



Schematic Diagram

Nomad Geophysical/navigation system



Schematic Diagram

Austitex data processing system