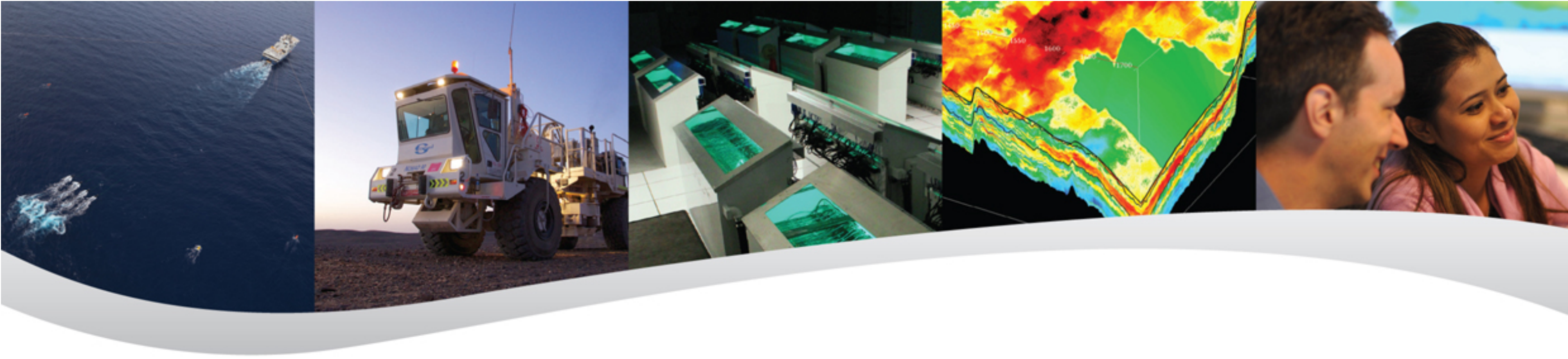

Geoscience Australia

TEMPEST Geophysical Survey

Capricorn Regional Survey, Western Australia

Project Number: CGG Job # 2446
GA Job # 1265

Logistics and Processing Report

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1 SURVEY OPERATIONS AND LOGISTICS

1.1 Introduction

Between the 14th of October 2013 and the 10th of January 2014, CGG Aviation (Australia) undertook an airborne TEMPEST electromagnetic and magnetic survey for Geoscience Australia. The survey area covered the Capricorn region of Western Australia, with a total coverage of the survey amounting to 30,119 line kilometres flown within 60 flights. The survey was flown using a CASA 212 aircraft, registration VH-TEM owned and operated by CGG. This report summarises the procedures and equipment used by CGG in the acquisition, verification and processing of the airborne geophysical data.

1.2 Survey Base

The survey was based out of Newman and Paraburdoo, Western Australia. The survey aircraft was operated from Newman Airport and Paraburdoo Airport respectively, with the aircraft fuel available on site. A temporary office was set up at the Seasons Hotel in Nemwan and Rocklea Palms in Paraburdoo, where all survey operations were run and the post-flight data verification was performed.

Base	Date	Flight Range	Accommodation
Newman, WA	14/10/2013 – 12/11/2013	1 – 18	Seasons Hotel
Paraburdoo, WA	13/11/2013 – 10/01/2014	19 – 60	Rocklea Palms

Table 1: Survey Bases

1.3 Survey Personnel

The following personnel were involved in this project:

Project Supervision – Acquisition	Richard Butterfield, Peter Johnson
Project Supervision – Processing	Denis Cowey
On-site Crew Leader	Ben Riggs, Terry Mondon
Pilot/s	Grant Hamilton, Mark Harradence, Peter Hiskins, Wayne Saunders, Troy Wilhelmi
System Operator/s	Ben Riggs, Terry Mondon
Field Data Processing	Mohamed Abubeker, Matthew Wheeler-Carver
Office Data Processing	Mohamed Abubeker, Matthew Wheeler-Carver

Table 2: Survey Personnel

1.4 Area Map

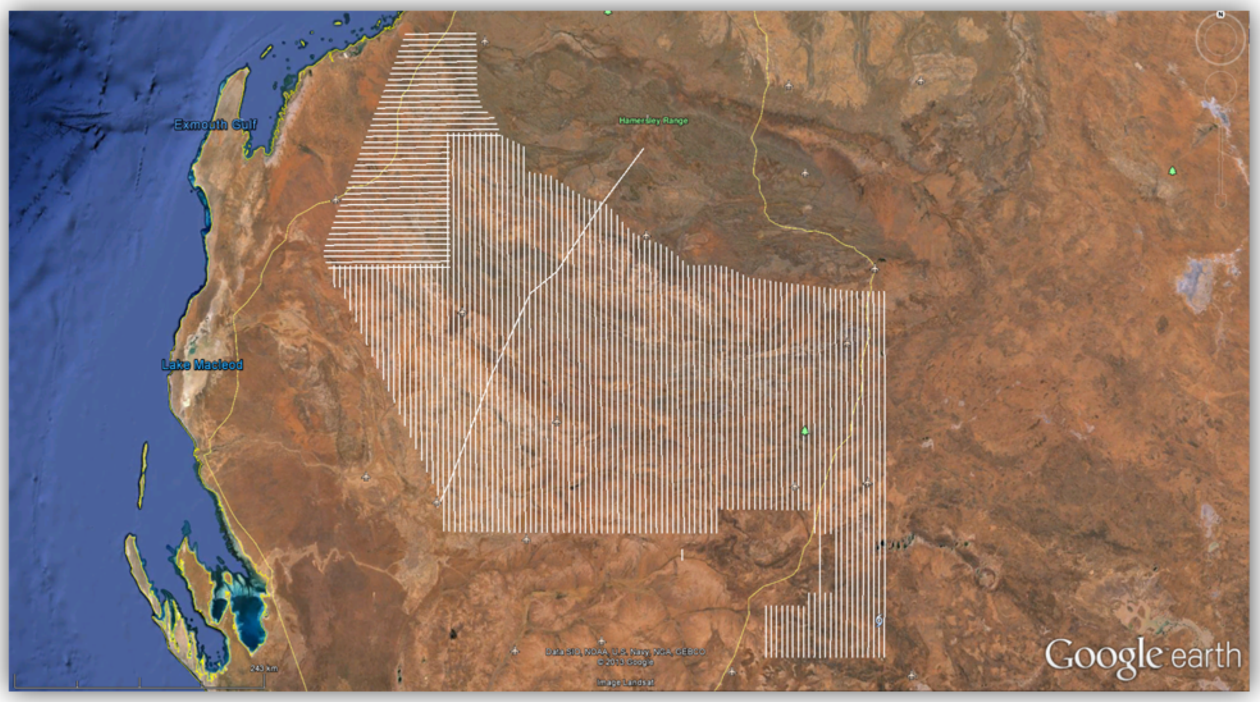


Figure 1: Capricorn Survey Area – The survey area is located within MGA zone 50.

1.5 General Disclaimer

It is CGG Aviation's understanding that the data and report provided to the client is to be used for the purpose agreed between the parties. That purpose was a significant factor in determining the scope and level of the services being offered to the client. Should the purpose for which the data and report is used change, the data and report may no longer be valid or appropriate and any further use of, or reliance upon, the data and report in those circumstances by the client without CGG Aviation's review and advice shall be at the client's own and sole risk.

The services were performed by CGG Aviation exclusively for the purposes of the client. Should the data and report be made available in whole or part to any third party, and such party relies thereon, that party does so wholly at its own and sole risk and CGG Aviation disclaims any liability to such party.

Where the services have involved CGG Aviation's use of any information provided by the Client or third parties, upon which CGG Aviation was reasonably entitled to rely, then the services are limited by the accuracy of such information. CGG Aviation is not liable for any inaccuracies (including any incompleteness) in the said information, save as otherwise provided in the terms of the contract between the Client and CGG.

2 SURVEY SPECIFICATIONS AND PARAMETERS

2.1 Area Coordinates

The survey area is located within the MGA zone 50S projection, GDA94 datum.

Easting	Northing	Corner Number
465000	7514755	1
470000	7492695	2
475000	7491627	3
480000	7490881	4
485000	7490134	5
490000	7489221	6
520000	7469698	7
530000	7467411	8
535000	7466278	9
540000	7463841	10
545000	7459896	11
550000	7454320	12
560000	7443168	13
565000	7438408	14
580000	7432664	15
595000	7426908	16
615000	7410723	17
640000	7410377	18
645000	7409767	19
650000	7409157	20
655000	7406764	21
670000	7399701	22
690000	7397056	23
755000	7388677	24
770000	7387865	25
797000	7387439	26
797000	7065516	27
685000	7067455	28
685000	7113252	29
725000	7112742	30
725000	7124263	31
730000	7124238	32
730000	7175168	33
730000	7196674	34
645000	7197687	35
640000	7197730	36
640000	7176897	37
480000	7178197	38
390000	7179426	39
385000	7211116	40
375000	7231333	41
360000	7261660	42
345000	7291986	43
295000	7393074	44
287500	7393074	45
285500	7408000	46
281717	7415000	47
280000	7420000	48
280000	7425000	49
281117	7430000	50
283121	7435000	51
285124	7440000	52
287128	7445000	53
289132	7450000	54
291136	7455000	55
293139	7460001	56
295143	7465000	57
297147	7470000	58
299151	7475000	59
301154	7480000	60
303158	7485000	61
305162	7490000	62
307165	7495000	63
309169	7500000	64
311173	7505000	65
313177	7510000	66
315180	7515001	67
319188	7525000	68
321192	7530000	69
323195	7535000	70
325199	7540000	71
327203	7545000	72
329207	7550000	73
331210	7555000	74
333214	7560000	75
335218	7565000	76

337221	7570001	77
339225	7575000	78
341229	7580000	79
343233	7585000	80
345236	7590000	81
347240	7595000	82
349244	7600000	83
351248	7605000	84
353251	7610000	85
355255	7617000	86
355255	7617000	87
421213	7617000	88
421300	7610000	89
421387	7605000	90
421475	7600000	91
421562	7595000	92
421649	7590000	93
421736	7585000	94
421823	7580000	95
421911	7575000	96
421998	7570000	97
422085	7565000	98
423560	7560000	99
425035	7555000	100
426509	7550000	101
432366	7545001	102
438223	7540001	103
440169	7535000	104
442116	7530000	105
444062	7525001	106

Table 3: Survey Boundary Coordinates

2.2 Survey Area Parameters

CGG Job Number	2446
Survey Company	CGG
Date Flown	October 14th 2013 to January 10th 2014
Client	Geoscience Australia
EM System	25 Hz TEMPEST
Navigation	Real-time differential GPS
Datum	GDA94
Projection	MGA Zone 50S
Area Name	Capricorn, WA
Terrain Clearance (Nominal)	120 m
Line Spacing	5000 m
Line Direction	000 – 180 degrees (L10001 – L100102, L10166)
	090 – 270 degrees (L10116 – L10157)
	031 – 211 degrees (L10167)
Line Numbers	10001 – 10102
	10116 – 10157
	10166 – 10167
Total Survey Line Kilometres	30,119 km

Table 4: Survey Parameters

2.3 Repeat (Calibration) Line Co-ordinates

There were 27 repeat line attempts in total at two different locations within the survey area. At a minimum of 5 km's for each attempt, the total length of lines amounted to167 line kilometers. The tables below list the co-ordinates, line numbers and flights of the repeat lines.

Line Number	Locality	Easting	Northing	Easting	Northing
910	Newman	730000	7391900	730000	7385711
911	Paraburdoo	550000	7448622	550000	7455979

Table 5: Repeat lines co-ordinates

Line Number	Flight Number
9100201	2
9100301	3
9100501	5
9100601	6
9100701	7
9101001	10
9101201	12
9101301	13
9101501	15
9101801	18
9111901	19
9112001	20
9112101	21
9112201	22
9112301	23
9112901	29
9113201	32
9113601	36
9113801	38
9114101	41
9114201	42
9114501	45
9114701	47
9115001	50
9115301	53
9115701	57
9116001	60

Table 6: Repeat lines number and flight

2.4 Job Safety Plan

A Job Safety Plan was prepared and implemented in accordance with the CGG Occupational Safety & Health Management System.

3 AIRCRAFT EQUIPMENT AND SPECIFICATIONS

3.1 Aircraft

Manufacturer	CASA
Model	C212-200
Registration	VH-TEM
Ownership	CGG Aviation (Australia) Pty Ltd

Table 7: Aircraft information

3.2 TEMPEST System Specifications

Specifications of the TEMPEST Airborne EM System (Lane et al., 2000) are shown below:

Base frequency	25 Hz
Transmitter area	244 m^2
Transmitter turns	1
Waveform	Square
Duty cycle	50%
Transmitter pulse width	10 ms
Transmitter off-time	10 ms
Peak current	280 A
Peak moment	68,320 Am^2
Average moment	34,160 Am^2
Sample rate	75 kHz on X and Z
Sample interval	13 microseconds
Samples per half-cycle	1,500
System bandwidth	25 Hz to 37.5 kHz
Flying height	120 m (subject to safety considerations)
EM sensor	Towed bird with 3 component dB/dt coils
Tx-Rx horizontal separation	117 m (nominal)
Tx-Rx vertical separation	41.5 m (nominal)
Stacked data output interval	200 ms (~12 m)
Number of output windows	15
Window centre times	13 µs to 16.2 ms
Magnetometer	Stinger-mounted cesium vapour
Magnetometer compensation	Fully digital
Magnetometer output interval	200 ms (~12 m)
Magnetometer resolution	0.001 nT
Typical noise level	1.0 nT
GPS cycle rate	1 second

Table 8: TEMPEST Airborne EM system specifications

3.2.1 EM Receiver and Logging Computer

The EM receiver computer was an EMFASDAS. The EM receiver computer executes a proprietary program for system control, timing, data acquisition and recording. Control, triggering and timing is provided to the TEMPEST transmitter and Digital Signal Processing (DSP) boards by the timing card, which ensures that all waveform generation and sampling is accomplished with high accuracy. The timing card is synchronised to the Global Positioning System (GPS) through the use of the Pulse per Second (PPS) output from the system GPS card. Synchronisation is also provided to the magnetometer processor card for the purpose of accurate magnetic sampling with respect to the EM transmitter waveform.

The EM receiver computer displays information on the main screen during system calibrations and survey line acquisition to enable the airborne operator to assess the data quality and performance of the system.

3.2.2 TEMPEST Transmitter

The transmitted waveform is a square wave of alternating polarity, which is triggered directly from the EM receiver computer. The nominal transmitter base frequency was 25 Hz with a pulse width of 10ms (50 % duty cycle). Loop current waveform monitoring is provided by a current transformer located directly in the loop current path to allow for full logging of the waveform shape and amplitude, which is sampled by the EM receiver.

3.2.3 TEMPEST 3-Axis Towed Bird Assembly

The TEMPEST 3-axis towed bird assembly provides accurate low noise sampling of the X (horizontal in line), Y (horizontal transverse) and Z (vertical) components of the electromagnetic field. The receiver coils measure the time rate of change of the magnetic field (dB/dt). Signals from each axis are transferred to the aircraft through a tow cable specifically designed for its electrical and mechanical properties.

3.3 FASDAS Survey Computer

The Survey computer executes a proprietary program for acquisition and recording of location, magnetic and ancillary data. Data are presented both numerically and graphically in real time on the Video Graphics Array (VGA) Liquid Crystal Display (LCD) display, which provides an on-line display capability. The operator may alter the sensitivity of the displays on-line to assist in quality control. Selected EM data are transferred from the EM receiver computer to the SURVEY computer for quality control (QC) display.

3.3.1 Cesium Vapour Magnetometer Sensor

A cesium vapour magnetometer sensor is utilised on the aircraft and consists of the sensor head and cable, and the sensor electronics. The sensor head is housed at the end of a composite material tail stinger.

3.3.2 Magnetometer Processor Board

A FASDAS magnetometer processor board is used for de-coupling and processing the Larmor frequency output of the magnetometer sensor. The processor board interfaces with the survey computer, which initiates data sampling and transfer for precise sample intervals and also with the EM receiver computer to ensure that the magnetic samples remain synchronised with the EM system.

3.3.3 Fluxgate Magnetometer

A tail stinger mounted Bartington MAG-03MC three-axis fluxgate magnetometer is used to provide information on the attitude of the aircraft. This information is used for compensation of the measured magnetic total field.

3.3.4 GPS Receiver

A Novatel GPS card 951R is utilised for airborne positioning and navigation. Satellite range data are recorded for generating post processed differential solutions.

3.3.5 Differential GPS Demodulator

The OMNISTAR differential GPS service provides real time differential corrections.

3.4 Navigation System

A FASDAS Navigation Computer was used for real-time navigation. These computers load a pre-programmed flight plan from disk which contains boundary co-ordinates, line start and end co-ordinates, local co-ordinate system parameters, line spacing, and cross track definitions. The World Geodetic System 1984 (WGS84) latitude and longitude positional data received from the Novatel GPS card contained in the SURVEY computer is transformed to the local co-ordinate system for calculation of the cross track and distance to go values. This information, along with ground heading and ground speed, is displayed to the pilot numerically and graphically on a two line LCD display, and on an analogue Horizontal Strip Indicator (HSI). It is also presented on a LCD screen in conjunction with a pictorial representation of the survey area, survey lines, and ongoing flight path.

The Navigation computers are interlocked to the SURVEY computer for auto selection and verification of the line to be flown. The GPS information passed to the navigation computer is corrected using the received real time differential data from the OMNISTAR service, enabling the aircraft to fly as close to the intended track as possible.

3.5 Altimeter System

3.5.1 Radar Altimeter

- Model: Sperry RT200 radio altimeter system
- Sample interval: 0.2 second
- Accuracy: +/- 1.5 % of indicated altitude.

The Sperry RT200 altimeter is a high quality instrument whose output is factory calibrated. It is fitted with a test function which checks the calibration of a terrain clearance of 100 feet, and altitudes which are multiples of 100 feet. The aircraft radio altitude is recorded onto digital tape as well as displayed on the aircraft chart recorder. The recorded value is the average of the altimeters output during the previous second.

3.5.2 Laser Altimeter

- Model: Riegl LD90-3300
- Sample interval: 0.2 second
- Accuracy: ± 0.05m at survey altitude

3.5.3 Barometric Altimeter

Output of a Digiquartz 215A-101pressure transducer is used for calculating the barometric altitude of the aircraft. The atmospheric pressure is taken from a gimbal-mounted probe projecting 0.5 metres from the wing tip of the aircraft and fed to the transducer mounted in the aircraft wingtip.

3.6 Video Tracking System

The video file recorded by the digital video system is synchronised with the geophysical record by a digital fiducial display. It is also labelled with GPS latitude and longitude information and survey line number.

3.7 Data Recorded by the Airborne Acquisition Equipment

With the FASDAS acquisition system the raw EM data including fiducial, local time, X and Z axis sensor response, current monitor and bird auxiliary sensor output are recorded on the EM receiver computer as "*.raw" EM files. Logging to the files is continuous, however, a new *.raw EM file is created when the size of the previous one reaches 1GB.

The FASDAS Survey computer records a continuous MSD file which contains all other ancillary data including magnetic, altimeter, GPS and analogue channels.

4 GROUND DATA ACQUISITION EQUIPMENT AND SPECIFICATIONS

4.1 Magnetic Base Station

Two CF1 magnetometers were used to measure the daily variations of the Earth's magnetic field. The base stations were established in an area of low gradient, away as much as possible from cultural influences. The base stations were run continuously throughout the survey flying period with a sampling interval of 1 second, at a sensitivity of 0.01nT. The base station data were closely examined after each day's production flight to determine if any data had been acquired during periods of out-of-specification diurnal variation. The base stations were at some distance apart both at Newman and Paraburdoo Airports.

Figure 2: GPS and Magnetic base station locations for Newman

Figure 3: GPS and Magnetic base station locations for Paraburdoo

4.2 GPS Base Station

A GPS base logging station was set up at Newman and Paraburdoo Airports. The sensor was contained in the CF1 unit.

The GPS base station position was calculated by logging data continuously at the base position over a period of approximately 24 hours. These data were then statistically averaged to obtain the position of the base station using the GrafNav software. A list of each of the base locations is detailed below:

The calculated GPS base position for Newman (in WGS84):

Latitude:	23° 25’ 6.79631” S
Longitude:	119° 48’ 5.32692” E
Height:	520.661 m. (WGS84 Ellipsoidal Height)

The calculated GPS base position for Paraburdoo (in WGS84):

Latitude:	23° 10’ 19.27944” S
Longitude:	117° 44’ 56.56023” E
Height:	414.367 m. (WGS84 Ellipsoidal Height)

5 CALIBRATIONS AND MONITORING

5.1 EM Calibrations

At the beginning and end of each individual survey flight, the EM system is checked for background noise levels and performance. All of these checks are conducted at a nominal terrain clearance of 600 m (2000 ft) to eliminate ground response.

5.1.1 GPS Repeat Point

Where possible, the aircraft is parked in the same position after every flight and the GPS position recorded pre and post flight, to allow for checks on GPS quality and repeatability. *Note: FFFF is the flight number and PP is the attempt number for the FASDAS.*

Pre-Flight GPS Repeat Point: line 505FFFFPP

Post-Flight GPS Repeat Point: line 605FFFFPP

5.1.2 Transmitter-off

These lines are recorded in straight and level flight with the system in standard survey geometry, with the transmitter turned off and bird response turned on to observe ambient noise and to check for noise in the receiver system (bird/coils → tow cable → winch → computer). *Note: FFFF is the flight number and PP is the attempt number.*

Post-Flight Transmitter-off: Line 906FFFFPP

5.1.3 Noise Additive

These lines are recorded in straight and level flight with the system in standard survey geometry, with the transmitter on and the bird response turned off at the tow cable winch. This is to check the noise contribution from the acquisition system and is used in deconvolution of survey line data. *Note: FFFF is the flight number and PP is the attempt number.*

Pre-Flight Noise Additive: Line 901FFFFPP

Post-Flight Transmitter-off: Line 904FFFFPP

5.1.4 Zero

These lines are recorded in straight and level flight with the system in standard survey configuration with transmitter and receiver turned on. This is used to determine the system's response in the absence of ground signal and is used to determine a standard waveform for deconvolution of survey lines. *Note: FFFF is the flight number and PP is the attempt number.*

Additionally, through all these calibrations the airborne operator can assess the system and ambient noise levels.

Pre-Flight Zero: Line 902FFFFPP

Post-Flight Zero: Line 905FFFFPP

5.1.5 Swoops

This line is recorded immediately after the pre-flight zero. During this manoeuvre the pilot conducts a series of 'swoop' manoeuvres (pitch up/pitch down) over approximately 30-40 seconds to vary the position of the towed sensor relative to the aircraft. The EM data are monitored by the airborne operator to confirm correct operation of the system during the manoeuvre. This data is used to determine coefficients used in the processing to compensate for such variations in the survey data. *Note: FFFF is the flight number and PP is the attempt number.*

Pre-Flight Swoop: Line 903FFFFPP

5.2 Parallax Checks

Due to the relative positions of the EM towed bird and the magnetometer instruments on the aircraft and to processing / recording time lags, raw readings from each vary in position. To correct for this and to align selected anomaly features on lines flown in opposite directions, magnetics, EM data and the altimeters are 'parallaxed' with respect to the position information. System parallax is checked by flying in opposing directions over known geophysical features. This is also monitored routinely during processing of jobs and specifically checked following any major changes in the aircraft system which is likely to affect the parallax values.

Parallax values for the X and Z EM components are normally chosen to optimise the gridded display and for aligning, from line to line, the EM response amplitudes for horizontal or broad steeply dipping conductors, which account for the majority of responses in regolith-dominated terrains such as this. However, for this survey the only value applied to the data is a system parallax to account for an induced recording lag caused by real time windowing of data for operator display and airborne quality control.

Variable	Parallax Value (Seconds)
GPS	0
Radar Altimeter	0
Laser Altimeter	0
EM – X component	- 6.0
EM – Z component	- 6.0

Table 9: Parallax Checks

Note the negative parallax value, which indicates that the samples on the data stream are moved to a higher fiducial number.

5.3 Dynamic Magnetometer Compensation

To limit aircraft manoeuvre effects on the magnetic data that can be of the same spatial wavelength as the signals from geological sources, compensation calibration lines are flown as high as practical in a low magnetic gradient area close to the survey. This involves flying a series of tests at 2500m or higher on the survey line heading and approximately 15 degrees either side to accommodate small heading variations whilst flying survey lines. The data for each heading consists of a series of aircraft manoeuvres, including pitches, rolls and yaws. This is done to artificially create the most extreme possible attitude the aircraft may encounter whilst on survey. Data from these lines are used to derive compensation coefficients for removing magnetic noise induced by the aircraft's attitude in the naturally occurring magnetic field.

Compensation data was acquired on the following date:

Aircraft	Date	Flight
VH-TEM	17/10/2013	1

Table 10: Magnetometer compensation acquisition details

Compensation data acquired the following statistics:

Standard Deviation (Uncompensated)	1.628239
Standard Deviation (Compensated)	0.0462705
Improvement Ratio	35.190

Table 11: Magnetometer compensation statistics

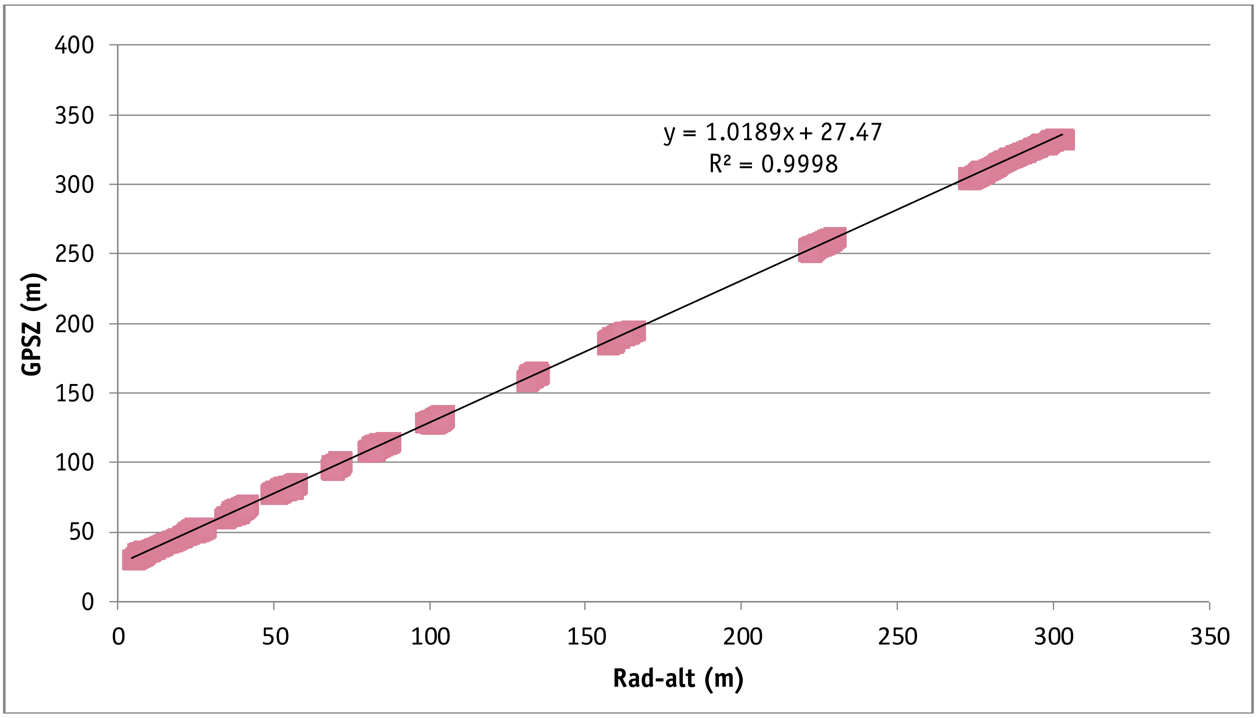
5.4 Radar Altimeter Calibration

The radar altimeter is checked for accuracy and linearity every 12 months or when any change in a key system component requires this procedure to be carried out. This calibration allows the radar altimeter data to be compared and assessed with other height data (GPS and barometric) to confirm the accuracy of the radar altimeter over its operating range.

Absolute radar and barometric altimeter calibration was carried out prior to job commencement at a Rottnest Island Airstrip in Western Australia, on the 9th of October 2013. The flight results were successful in calibrating the radar altimeter to information provided by the GPS and barometer instrument. Calibration factors were also as expected. The calibration procedure also provides parallax information required for positional correction of the radar and GPS altimeters.

The following graph shows the results of these calibrations as Radar Altimeter output (m) versus the GPS height normalised to altitude above the airstrip (based on the average GPS height along the lowest altitude pass). This chart shows the linear behaviour of the radar altimeter in each range.

Comparison of Radar Altimeter and GPSZ – 9th of October 2013



5.5 Laser Altimeter Calibration

The Laser altimeter was checked based on the same process as that described for the radar altimeters. The data used was from the same flight. The following plots show the laser altimeter heights compared to normalised GPS heights (GPSZ), as well as radar altimeter (Rad-alt) flying heights.

Pitch and roll manoeuvres were also conducted to determine coefficients to verify and/or correct for the laser's deviation from the vertical.

The following equation was used to correct the laser altimeter for changes in pointing direction:

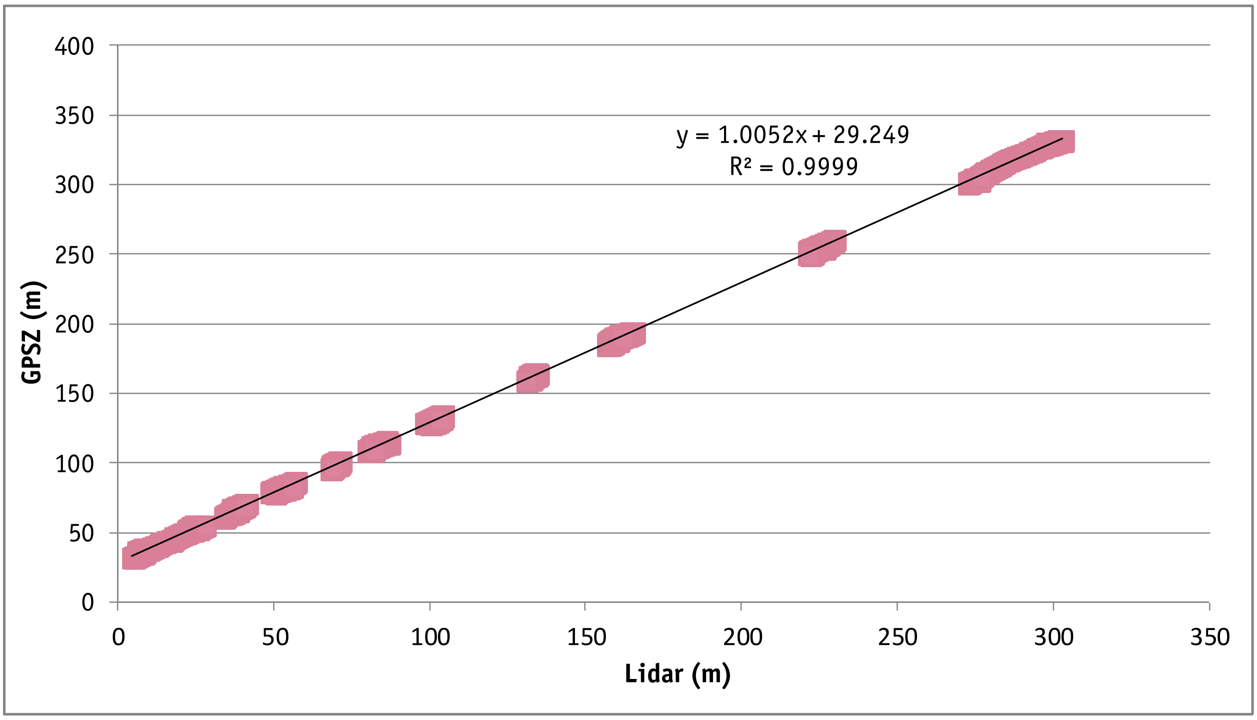
$$l_c = l_m \cos(p_m + p_0)\cos(r_m + r_0) - h_l \sin(p_m + p_0)$$

Where l_c is the corrected altimeter value, l_m the raw measured altimeter value, p_m and r_m are the measured transmitter loop pitch and roll respectively, p_0 and r_0 are the laser altimeter pointing pitch and roll offsets relative to the transmitter loop orientation respectively, and h_0 is the horizontal offset between the laser altimeter and the aircraft's centre of rotation. Based on the data acquired during the calibration flights, the following values for p_0, r_0 and h_0 were used for corrections throughout the survey.

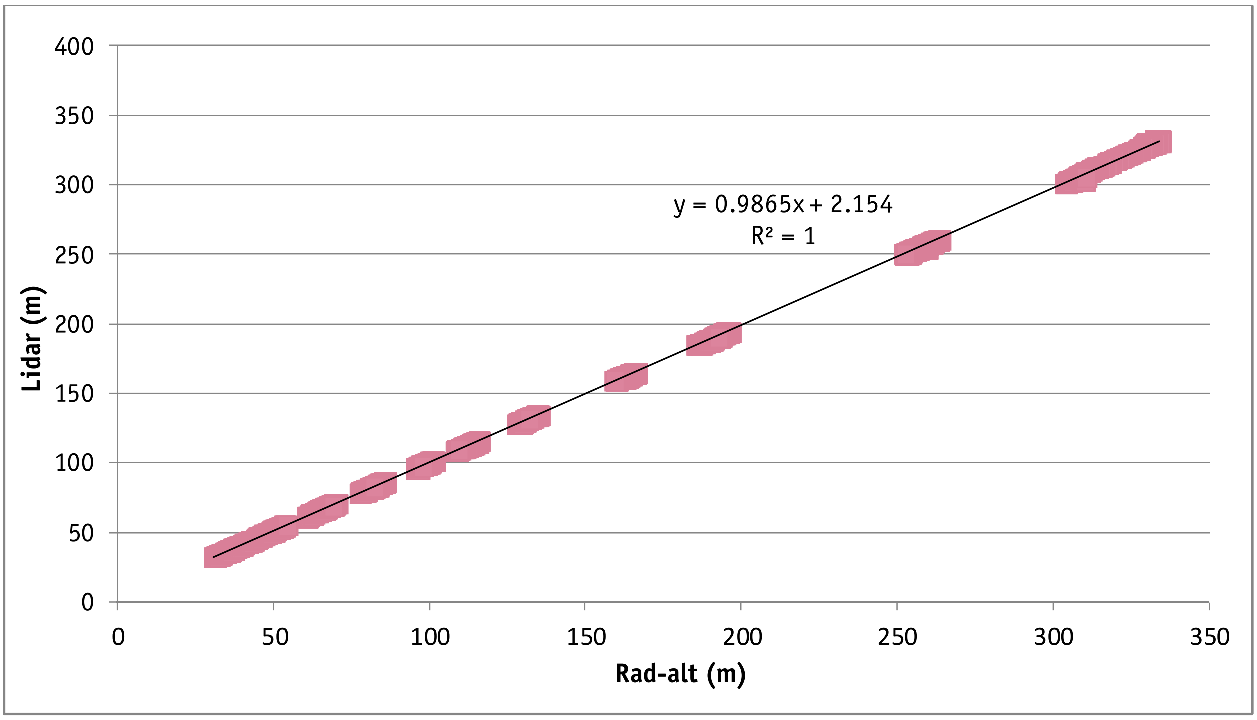
Aircraft	p_0	r_0	h_0
VH-TEM	0.90	-0.10	0.42

Table 12: Laser Altimeter calibration correction parameters

Comparison of Laser Altimeter and GPSZ – 9th of October 2013



Comparison of Laser Altimeter and Radar Altimeter – 9th of October 2013



5.6 Heading Error Checks

Historically, heading error checks have been part of the aeromagnetic data acquisition procedure but they are no longer used. CGG now calculates these effects using the aircraft magnetic compensation system and specially developed software. The precision to which these effects are now calculated and corrected for is far in excess of the manual methods used in the past.

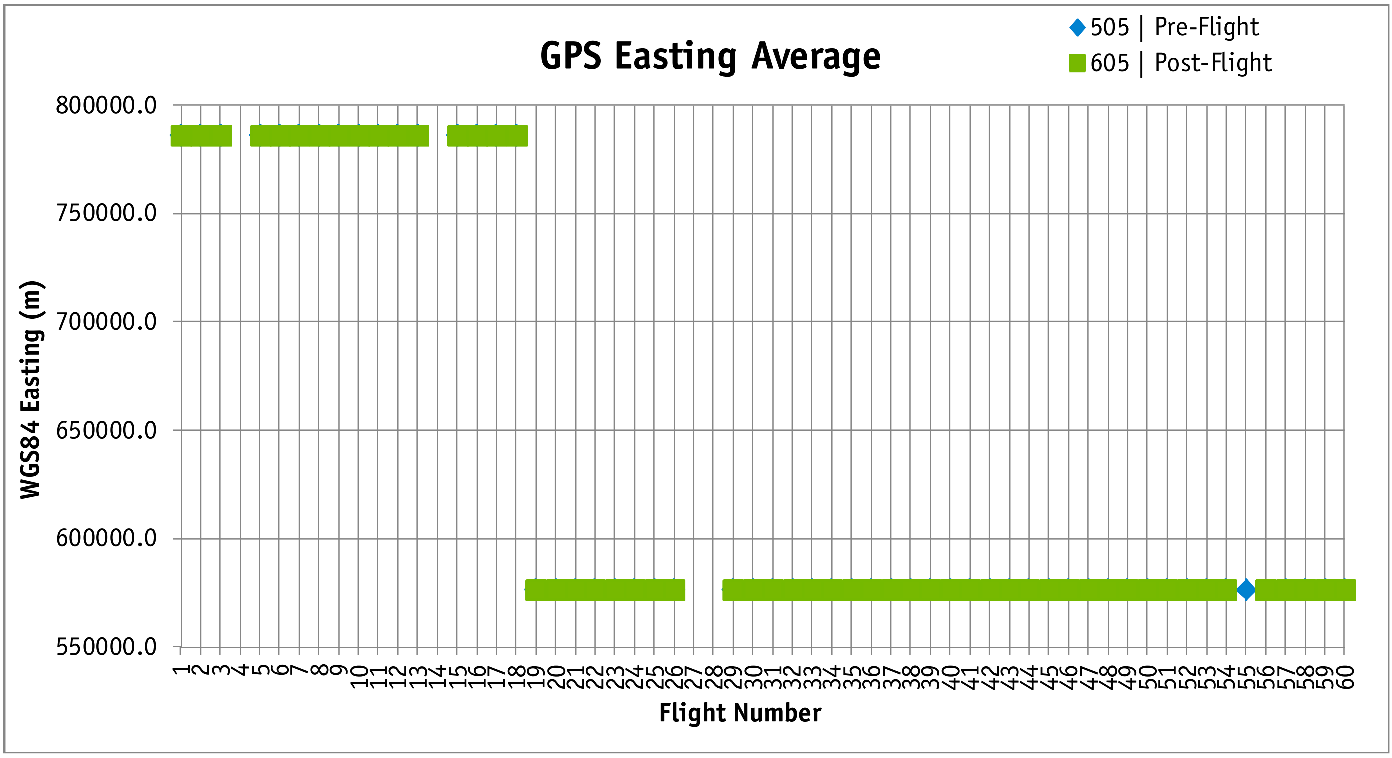
5.7 Repeat Point GPS Check

At the end of each flight the aircraft was parked as close to the same position as possible. Before and after the flight 90-120 seconds of data was recorded in this location to provide a check for consistency in navigation data. The following graphs show plots of the average easting, northing and GPS height for each ground calibration during the survey, note the change of base following flight 18.

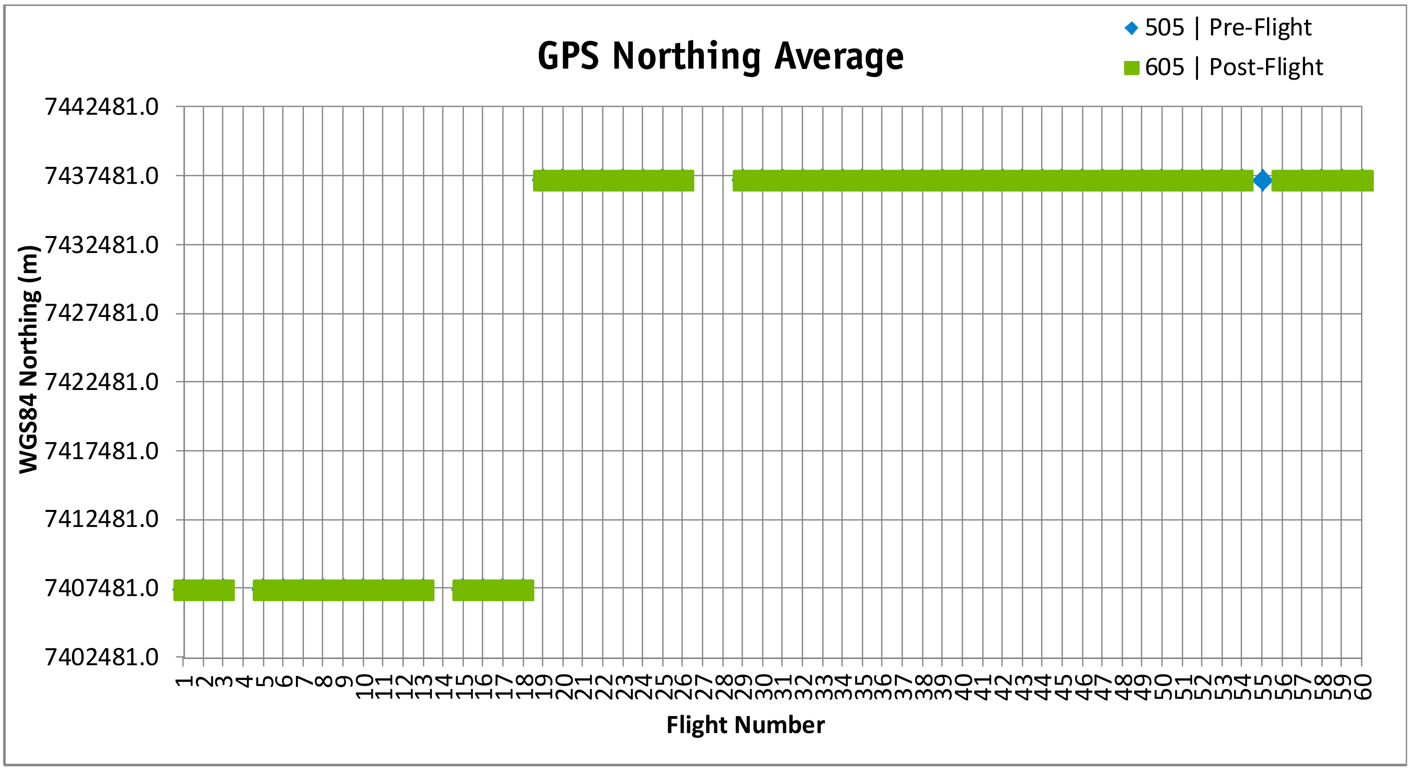
Locality	Flight
Newman	1-18
Paraburdoo	19-60

Table 13: Repeat point locality and flights range

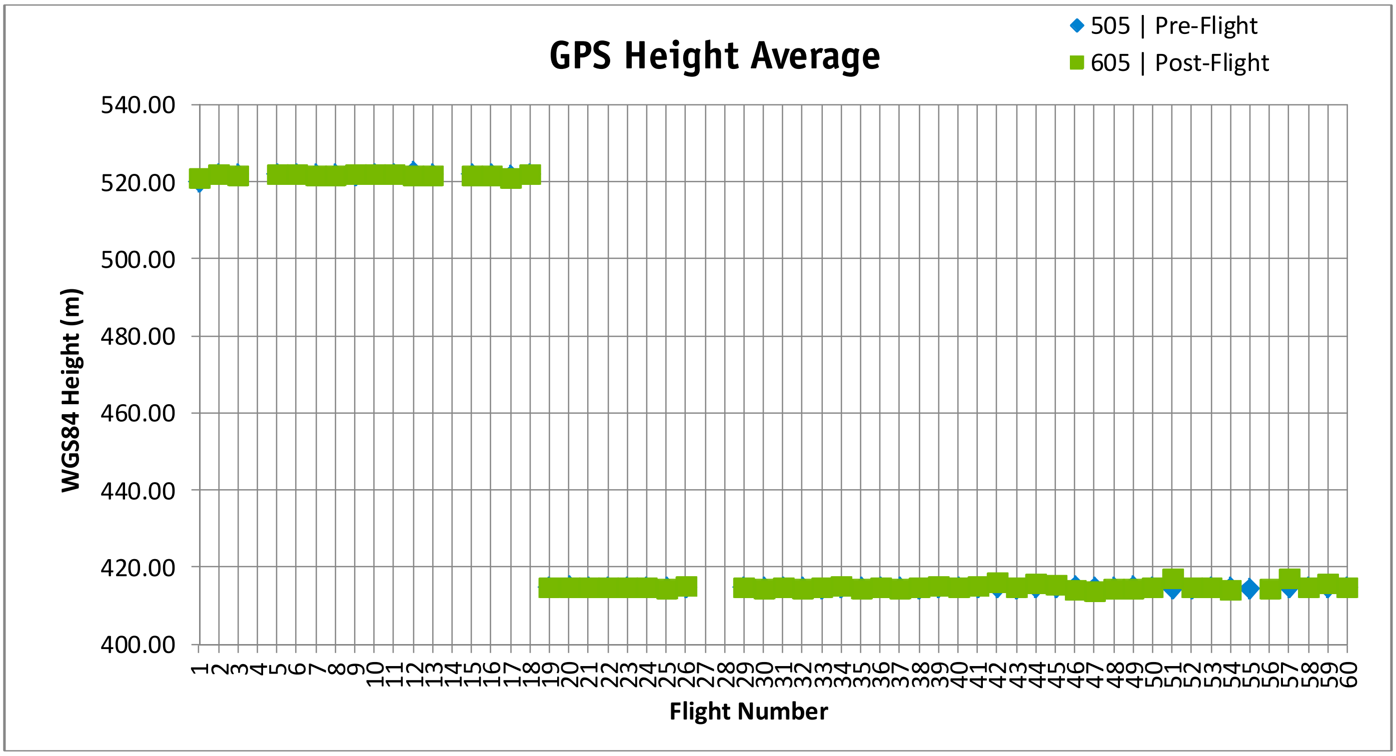
Average Repeat Point 'Easting' location relative to flight



Average Repeat Point 'Northing' location relative to flight



Average Repeat Point 'Height' relative to flight



6 DATA PROCESSING

6.1 Field Data Processing

6.1.1 Quality Control Specifications

6.1.1.1 Navigation Tolerance

The re-flight specifications applied for the duration of the survey were:

Electronic Navigation: absence of electronic navigation data (e.g. GPS base station fails).

Flight Path: where the flight path deviates from the flight plan by more than 40 metres for more than 1.5km or more unless the deviation is required by civil aviation requirements.

Altitude: the average terrain clearance for any one flight line shall be within ±5 metres of the nominal aircraft terrain clearance (120m). Portions of survey lines that are unable to be flown at the nominal survey height due to Australian Civil Aviation Safety Authority regulations of safety considerations shall be excluded from the average. Where the terrain clearance varies from that nominated by more than 20 metres over a continuous distance of two kilometres or more, a fill-in line will be flown at the Contractor's expense unless it can be reasonably demonstrated that such flying would put pilot and crew at risk.

6.1.1.2 Magnetic Noise and Diurnal Tolerance

The re-flight specifications applied for the duration of the survey were:

Magnetic Diurnal: where the magnetometer base station data exceeds a 10nT change in 10 minutes.

6.1.1.3 Electromagnetic Data

The quality control checks on the electromagnetic data were:

Sferics: where sferic activity renders a potential anomaly un-interpretable.

Repeat lines: these were flown regularly to check system repeatability. Section *2.3* lists the co-ordinates for the repeat lines used throughout the survey. The repeat lines were flown once every day for the first four successful production days, and once every three production days after that.

Noise: For any flight, if the standard deviation of the processed high altitude data for a window exceeds the corresponding Additive Noise specified in the Noise Characteristics table below, then that window will be deemed to be 'noisy'. If more than 25% of the windows are deemed to be noisy in either component, then that flight must be re-flown at the Contractor's expense.

Bias: For any flight, if the absolute value of the mean of the processed high altitude data for a window exceeds the corresponding Bias specified in the Noise Characteristics table below, then that window will be deemed to be 'biased'. If more than 25% of the windows are deemed to be biased in either component, then that flight must be re-flown at the Contractor's expense.

The following table lists a full record of zero-line noise additive and bias statistics.

Window	Additive Noise (standard deviation of high altitude data) (fT)		Bias (absolute value of mean of high altitude data) (fT)	
	X component	Z component	X component	Z component
1	0.0362	0.0267	0.0151	0.0145
2	0.0348	0.0160	0.0336	0.0248
3	0.0315	0.0140	0.0266	0.0195
4	0.0260	0.0134	0.0114	0.0081
5	0.0238	0.0122	0.0172	0.0132
6	0.0206	0.0123	0.0126	0.0096
7	0.0190	0.0117	0.0112	0.0093
8	0.0182	0.0118	0.0110	0.0090
9	0.0176	0.0110	0.0106	0.0087
10	0.0174	0.0102	0.0102	0.0087
11	0.0170	0.0099	0.0104	0.0081
12	0.0163	0.0084	0.0108	0.0078
13	0.0146	0.0075	0.0090	0.0066
14	0.0126	0.0070	0.0066	0.0054
15	0.0134	0.0087	0.0056	0.0051

Table 14: Record of zero-line noise additive and bias statistics

6.1.2 In-field Data Processing

Following acquisition, multiple copies of the EM data are made onto Blu-Ray Disks and Hard Disk Drives (HDD's). The EM, location, magnetic and ancillary data are then processed at the field base to the point that the quality of the data from each flight can be fully assessed. Copies of the raw and processed data are then transferred to Perth for final data processing. A more comprehensive statement of EM data processing is given in section 6.2.5.

6.2 Final Data Processing

6.2.1 Flight Path Recovery

The GPS position of the aircraft at every point along the survey line was post-processed (differentially corrected) by applying the same X, Y and Z positional changes (deviations from averaged position) as seen at the base GPS unit (see section 4.2 for a description of establishing the base GPS position).

The post-processed flight path (X and Y co-ordinates) and GPS height were then checked for spikes and level shifts, and if required, edited or improved by re-running the GPS post-processing. Section 5.1.1, describes the GPS repeat point test we conducted on every flight to confirm the repeatability of the GPS system. No other calibration procedures are performed for the GPS.

6.2.2 Magnetics

Magnetic data were compensated for aircraft manoeuvre noise using coefficients derived from the appropriate compensation flight, see section 5.3. Base station data was edited so that all significant spikes, level shifts and null data were eliminated. A diurnal base value of 53500nT was then added.

The International Geomagnetic Reference Field (IGRF) model (updated for secular variation 2010.5) was removed from the diurnally corrected total field magnetics. An IGRF base value of 54182nT, calculated on the 17th of October 2013 at a central point within the survey area, was then added to the data.

Following this, microlevelling was applied in order to subtly level the data. The algorithm is a CGG proprietary operation used to remove the small across-line corrugations that may appear in any gridded data. The process attempts to de-corrugate the data without destroying the data's integrity. This is achieved by confining the changes to small values and applying them as a correction to the along-line data.

6.2.3 Altimeters

Radar altimeter data are recorded by the data acquisition system as a value in millivolts. This value is converted to metres using the relationships determined during the altimeter calibration flights. This data has a parallax applied followed by a short smoothing filter to eliminate short-wavelength system noise.

The laser altimeter (LIDAR) data are recorded directly as a height in metres. Local maxima and minima were used to remove small sharp steps & spikes, resulting from vegetation and other cultural features.

6.2.4 Derived Ground Elevation

Aircraft navigation whilst in survey mode is via real time differential GPS, obtained by combining broadcast differential corrections with on-board GPS measurements. Terrain clearance is measured with a laser altimeter.

The ground elevation, relative to the WGS84 spheroid used by GPS receiver units, is obtained by finding the difference between the terrain clearance (from the final processed and edited laser altimeter) and the aircraft GPS antenna altitude above the ellipsoid (GPS height derived from post-processing of the DGPS data using the field base station data), and taking into account that the laser altimeter is mounted 2.275 metres below the GPS antenna.

The digital elevation model derived from this survey can be expected to have an absolute accuracy of +/- several metres in areas of low to moderate topographic relief. Sources of error include uncertainty in the height of the GPS base station, variations in the laser altimeter characteristics over ground of varying surface characteristics (i.e. false and non-returns are more prevalent over dense vegetation and water, respectively), and the finite footprint of the laser altimeter.

Following this, where appropriate, micro-levelling was applied in order to more subtly level the data. The algorithms are CGG proprietary operations used to remove the small across-line corrugations that may appear in the gridded data. The micro-levelling process attempts to de-corrugate the data without destroying the data's integrity. This is achieved by confining the changes to very small values and applying them as a correction to the along-line data.

An N-Value is then subtracted to correct the final data to the Australian Height Datum (AHD).

The final digital elevation model was then compared to the GEODATA 9 second DEM (DEM-9S) Version 3, which is a grid of ground elevation points covering the whole of Australia, with a grid spacing of 9 seconds in longitude and latitude (approximately 250m) in the GDA94 coordinate system. The DEM-9s grid is freely available through the Geophysical Archive Data Delivery System (GADDS).

Note:

The accuracy of the elevation calculation is directly dependent on the accuracy of the two input parameters, laser altitude and GPS altitude. The GPS altitude value is dependent on the number of available satellites, plus the accuracy of the averaged GPS base position. Although post-processing of GPS data will yield X and Y accuracies in the order of 0.5 metres, the accuracy of the altitude value is usually much less, but generally still within 1-2 metres. Further inaccuracies may be introduced during the interpolation and gridding process as only 1 out of every 5 points across-line is real data. Furthermore, along line obstructions may cause the pilot to veer laterally and so data interpolated between lines may vary significantly from real topography, and do not show artificial vertical obstructions.

Because of the inherent inaccuracies of this method, no guarantee is made or implied that the information displayed is a true representation of the height above sea level. Although this product may be of some use as a general reference, THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.

6.2.5 Electromagnetic Data Processing

Details of the pre-processing applied to TEMPEST data can be found in Lane et al. (2000).

6.2.5.1 Standard EM Processing

6.2.5.1.1 Calibration

High altitude pre and post flight zero line data (Section 5.1.4) are used to characterise the system response in the absence of any ground response. These calibration lines were acquired pre and post flight and were linearly interpolated during processing for use at individual transients during the flight.

6.2.5.1.2 Cleaning and Stacking

Routines to suppress sferic noise, powerline noise, VLF noise and coil motion noise (collectively termed “cleaning”) and to stack the data are applied to the survey line data. Output from the stacking filter is drawn at 0.2 second intervals. A cosine shaped filter making use of 152 transients (approximately 3 sec) is used in the stacking process.

6.2.5.1.3 Deconvolution

The survey height stacked data are deconvolved in the frequency domain using the interpolated high altitude reference waveform, to yield a quantity that is independent of system characteristics. This procedure accounts for slow variations in the transmitted current waveform’s amplitude and shape during the flight. It also accounts for the effect of eddy currents induced in the transmitter loop and airframe. The output of the deconvolved data is the summed effect of the direct coupling between the transmitter loop and receiver coils (primary field) and the coupling between currents induced in the ground and the receiver (secondary field).

6.2.5.1.4 Primary Field Estimation

Since the receiver’s orientation and position (relative to the transmitter) is not precisely known, the primary field cannot simply be theoretically computed and subtracted from the deconvolved data to yield the desired pure ground response. The primary field is instead estimated using knowledge of the asymptotic behaviour at the low frequency in-phase component of the deconvolved spectrum. The estimation of the primary field requires some assumptions to be made regarding the conductivity structure of the ground at depth. Once estimated the primary field is subtracted from the deconvolved data to yield the estimated pure ground response.

6.2.5.1.5 Transmitter-Receiver Separation Estimation

Once the primary field and coupling terms are estimated it is then possible to estimate the position of the receiver coils relative to the transmitter loop via basic dipole theory. Equations (1) and (2) define the coupling terms for an infinitesimal vertical magnetic dipole transmitter and an ideal receiver located at co-ordinates (*x, z*) with respect to the transmitter. The horizontal (or X) component coupling is defined by,

$$g_x = \frac{3xz}{\left(x^2 + z^2\right)^{5/2}}, \qquad (1)$$

As for the vertical (or Z) component data;

$$g_z = \frac{2z^2 - x^2}{\left(x^2 + z^2\right)^{5/2}}. \qquad (2)$$

The above equations are inverted to solve for the coil set position defined by the co-ordinates (x, z) as follows. From equations (1) and (2),

$$\frac{g_z}{g_x} = r = \frac{(2z^2 - x^2)}{3xz} \qquad (3)$$

Therefore,

$$x^2 + 3rxz - 2z^2 = 0 \tag{4}$$

Therefore,

$$x = -(3rz \pm \sqrt{9r^2 z^2 + 8z^2})/2 = z(-3r \pm \sqrt{9r^2 + 8})/2 = zr_1 \tag{5}$$

Substituting back into the expression for g_x, we get

$$g_x = \frac{3r_1}{z^3 (r_1^{\ 2} + 1)^{5/2}} \tag{6}$$

And

$$z = \left\{ \frac{3r_1}{g_x (r_1^{\ 2} + 1)^{5/2}} \right\}^{1/3}, \quad and \quad x = r_1 \left\{ \frac{3r_1}{g_x (r_1^{\ 2} + 1)^{5/2}} \right\}^{1/3} \tag{7}$$

Where

$$r_1 = \left\{ -3(g_z / g_x) + \sqrt{9(g_z / g_x)^2 + 8} \right\} / 2 \tag{8}$$

The (+/-) solutions collapse to a single solution due to a basic knowledge that the bird is always going to be below and behind the transmitter; Therefore equations (7) and (8) provide the necessary calculation to convert g_x and g_z values to x and z values which define the position of the receiver with respect to the transmitter.

When calculating the horizontal and vertical separations from the primary field it is assumed that the transmitter pitch and roll are both zero. Later in the processing stream the horizontal and vertical separation values are altered (rotated) such that they are consistent with the transmitter loop pitch (gyroscope measured pitch plus 0.9 degrees) and transmitter loop roll (gyroscope measured roll plus 0.1 degrees).

An estimate of transmitter-receiver separation is made for every 0.2 second sample drawn from the stacking filter. Along with other system geometry variables (either measured or assumed) the survey wide averages of the system geometry is shown in the table below.

Geometry Variable		
Transmitter loop pitch	Assumed	0.90°
	Measured	2.90°
Transmitter loop roll	Assumed	0.10°
	Measured	0.30°
Transmitter loop yaw	Assumed	0.00°
Transmitter loop terrain clearance	Estimated	120 m
Transmitter-receiver in-line horizontal separation (primary-field derived)	Estimated	-117.5m
Transmitter-receiver vertical separation (primary-field derived)	Estimated	-36.6m
Transmitter-receiver transverse horizontal separation (primary-field derived)	Assumed	0.0m
Transmitter-receiver horizontal separation (Bird GPS derived)	Measured	-117.0m
Transmitter-receiver vertical separation (Bird GPS derived)	Measured	-41.5m
Receiver pitch	Assumed	0.00°
Receiver roll	Assumed	0.00°
Receiver yaw	Assumed	0.00°

Table 15: TEMPEST Geometry variables for the CASA aircraft

With an aim to rely less on the estimated primary field and bird position, and to accurately measure the position of the bird/receiver coils. The TEMPEST system currently utilises a "Bird GPS" system located within the receiver apparatus, this facilitates a more accurate geometry value to be used for the processing stream.

Due to an intermittent hardware issue during the project, the transverse receiver bird separation for portions of lines 1008603, 1008703, 1009001 and 1009402 were not logged accurately. Consequently, in the final located data values deemed erroneous were substituted with null values, in accordance with the standard ASEG-GDF II format. Please substitute the null values with 0 when using the [TSEP_GPS] channel.

6.2.5.1.6 Transformation to B-field Response

The pure ground response data are transformed from dB/dt to B-field responses equivalent to that which would be observed for a perfect 100% duty cycle square wave waveform with a 1A peak to peak step.

6.2.5.1.7 Windowing

Finally, the evenly spaced samples are binned into a number of windows.

Window #	Start sample	End sample	No of samples	start time (s)	End time (s)	centre time (s)	centre time (ms)
1	1	2	2	0.000007	0.000020	0.000013	0.013
2	3	4	2	0.000033	0.000047	0.000040	0.040
3	5	6	2	0.000060	0.000073	0.000067	0.067
4	7	10	4	0.000087	0.000127	0.000107	0.107
5	11	16	6	0.000140	0.000207	0.000173	0.173
6	17	26	10	0.000220	0.000340	0.000280	0.280
7	27	42	16	0.000353	0.000553	0.000453	0.453
8	43	66	24	0.000567	0.000873	0.000720	0.720
9	67	102	36	0.000887	0.001353	0.001120	1.120
10	103	158	56	0.001367	0.002100	0.001733	1.733
11	159	246	88	0.002113	0.003273	0.002693	2.693
12	247	384	138	0.003287	0.005113	0.004200	4.200
13	385	600	216	0.005127	0.007993	0.006560	6.560
14	601	930	330	0.008007	0.012393	0.010200	10.200
15	931	1500	570	0.012407	0.019993	0.016200	16.200

Table 16: TEMPEST window information for 25Hz base frequency

The data are reviewed after windowing. Any decisions involving re-flights due to AEM factors are made at this point.

6.2.5.1.8 Geometry correction of EM Data

The "raw" or "uncorrected" EM amplitudes reflect, not only the variations in ground conductivity, but the variations in geometry of the various parts of the EM measurements (i.e. transmitter loop pitch, transmitter loop roll, transmitter loop terrain clearance, transmitter loop to receiver coil horizontal longitudinal separation, transmitter loop to receiver coil horizontal transverse separation, and transmitter loop to receiver coil vertical separation) during the survey. For example, the largest influence on the early time EM amplitude is the terrain clearance of the transmitter loop. The larger the terrain clearance is, the smaller the amplitude. Later window times (larger window number) show diminished variations due to terrain clearance.

"Final" or "geometry-corrected" located data are produced for optimum presentation of the EM amplitude data in image format (e.g. window amplitude images, principal component analysis images derived from the window amplitudes (Green, 1998b)). Between "raw" and "final" states, the ground response data undergo an approximate correction to produce data from a nominated standard geometry. A dipole-image method (Green, 1998a) is used to adjust the data to the response that would be expected at a standard terrain clearance, standard transmitter loop pitch and roll (zero degrees), and a standard transmitter loop to receiver coil geometry. These variables have been set to their respective standard values in the "final" located data (whereas the "raw" located data file contains the variable field data). Zero parallax is applied to transmitter loop pitch, roll, and terrain clearance, X component EM and Z component EM data prior to geometry correction. Over extremely conductive ground (e.g. > 100 S conductance), the estimates for transmitter loop to receiver coil separation determined from the primary field coupling factors may be in error at the metre scale due to uncertainty in the estimation of the primary field. This will influence the accuracy of very early time window amplitude information in the "geometry-corrected" located data. Receiver coil pitch has a significant effect on early time Z component response and late time X component response (Green and Lin, 1996). Receiver coil roll impacts early time Z component response.

Geometry Variable	Standard Value
Transmitter loop pitch	0.0°
Transmitter loop roll	0.0°
Transmitter loop yaw	0.0°
Transmitter loop terrain clearance	120.0 m
Transmitter-receiver in-line horizontal separation	-117.0 m
Transmitter-receiver vertical separation	-41.5 m
Transmitter-receiver transverse horizontal separation	0.0 m
Receiver pitch	0.0°
Receiver roll	0.0°
Receiver yaw	0.0°

Table 17: Values used to standardise transmitter height, pitch and roll and transmitter-receiver geometry

6.2.5.1.9 Levelling

Once the full dataset had been corrected to the same standard geometry, the following levelling procedure was applied:

- Small amplitude DC shifts to the window data to remove base-level shifts related to slight imperfections in the deconvolution stage of the EM data processing. This type of levelling is designed to improve the presentation and remove the small amplitude 'block' shifts in the later EM windows that may occur from flight to flight.

- Limited range micro-levelling was applied to all windows for presentation purposes and to ensure the input data for CDI processing was free of striping.

6.2.5.2 Factors and Corrections

6.2.5.2.1 Geometric Factor

The geometric factor gives the ratio of the strength of the primary field coupling between the transmitter loop and the receiver coil at each observation relative to the coupling observed at high altitude during acquisition of reference waveform data. Variations in this factor indicate a change in the attitude and/or relative separation of the transmitter loop and the receiver coil.

6.2.5.2.2 Transmitter-Receiver Geometry

Transmitter to receiver geometry values for each observation is derived from the high altitude reference waveforms and knowledge of the system characteristics. These data are available in the located data (see *Table 17* for "standardised" values)

6.2.5.2.3 GPS Antenna, Laser Altimeter and Transmitter Loop Offset Corrections

The transmitter loop was mounted about 0.125m above the GPS antenna on the aircraft. The GPS antenna is 2.275m above the belly of the aircraft. The laser altimeter sensor is mounted in the belly of the aircraft. Therefore a total of 2.40m (0.125m + 2.275m) was added to the laser altimeter data to determine the transmitter loop height above the ground.

6.2.5.2.4 Transmitter Loop Pitch and Roll Correction

Measured vertical gyro aircraft pitch and roll attitude measurements are converted to transmitter loop pitch and roll by adding 0.90 degrees for pitch and 0.1 degrees for roll. Nose up is positive for pitch, and left wing up is positive for roll.

6.2.5.2.5 Primary Field Calculation

The primary field data provided for both the X and Z components are calculated values. The geometric coupling factor (g/ga) and the primary field coupling strength at high altitude (ga) are used to solve for a (g) value. Multiplication of the (g) value by the permeability of free space factor ($4\pi \times 10^{-7}$ $H.m^{-1}$), lastly derives the primary field channels in femto Tesla (fT = 10^{-15} Tesla). The primary field amplitude is affected by the receiver bird geometry, mostly during the pitching motion of the bird. A lag has been applied to the primary field data channels consistent with the lag applied on the EM data (-6 seconds).

Note that there will not be an exact correspondence between the primary-field-estimated horizontal and vertical transmitter-receiver separations and the primary field data supplied in the data files. This is because the primary field data in the supplied data file have been derived from a filtered version of the primary field geometric factor.

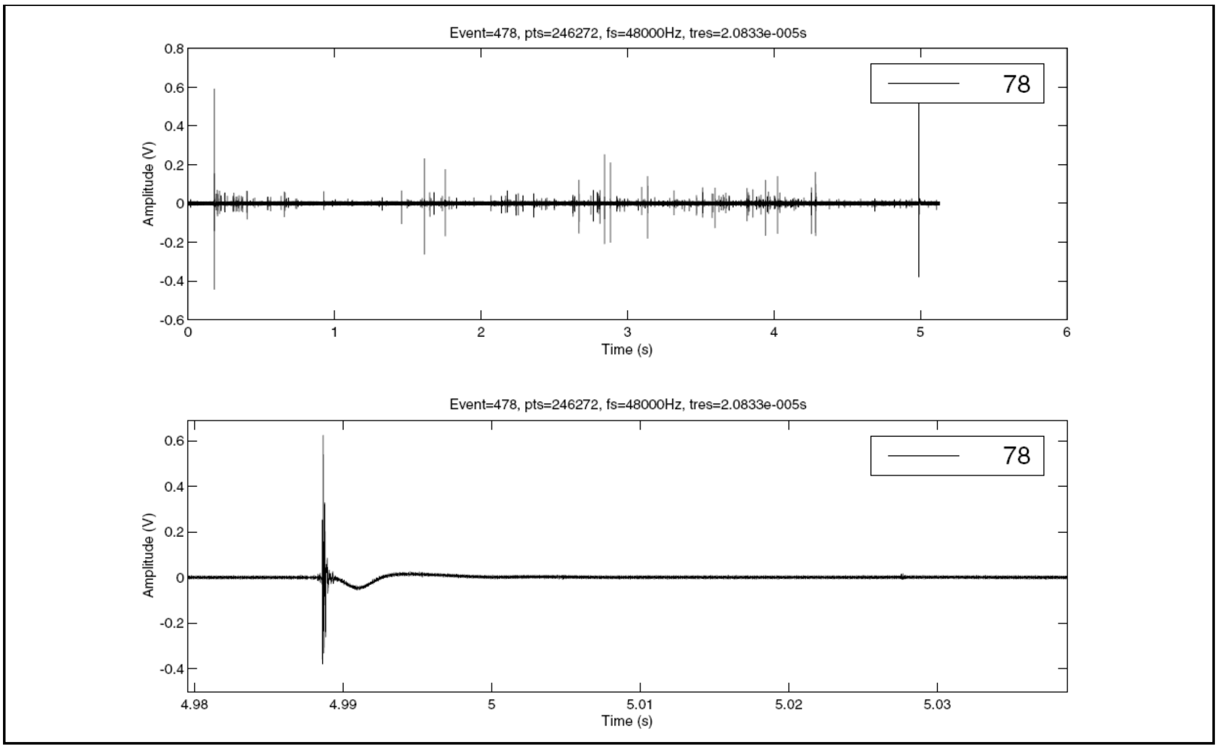
6.2.5.3 Primary Sources of EM Noise

A number of "monitor" values are calculated during processing to assist with interpretation. They generally represent quantities that have been removed as far as is practical from the data, but may still be present in trace amounts. These are more significant for interpretation of discrete conductors than for general mapping applications.

6.2.5.3.1 Sferic Monitor

Sferics are the electromagnetic signals associated with lightning activity. These signals travel large distances around the earth. Background levels of sferics are recorded at all times from lightning activity in tropical areas of the world (e.g. tropical parts of Asia, South America and Africa). Additional higher amplitude signals are produced by "local" lightning activity (i.e. at distances of kilometres to hundreds of kilometres).

The sferic monitor is the sum of the absolute differences brought about by the sferic filter operations, summed over 0.2 second intervals, normalised by the receiver effective area. It is given in units of uV/sq.m/0.2s. Many sferics have a characteristic form that is well illustrated by figure 2 in Garner and Thiel (2000), shown below. The high frequency, initial part of a sferic event can be detected and filtered more easily than the later, low frequency portion. The sferic monitor indicates where at least the high frequency portion of a sferic has been successfully removed, but it is quite possible that lower frequency elements of the sferic event may have eluded detection, passing through to the window amplitude data. Thus, discrete anomalies coincident with sferic activity as indicated by the sferic monitor should be down-weighted relative to features clear of any sign of sferic activity.



An electric field time-series sampled at 48 kilo samples per second using MIMDAS. The top panel exhibits the entire event, while the lower panel depicts a close up view of an individual sferic from that event. The sample rate and resolution in time are denoted by fs and tres, respectively; (Garner & Thiel, 2000.).

6.2.5.3.2 Low Frequency Monitor

The Low Frequency Monitor (LFM) makes use of amplitudes at frequencies below the base frequency which are present in the streamed data to estimate the amplitude of coil motion (Earth magnetic field) noise at the base frequency in log10(pV/sqrt(Hz)/sq.m). The coil motion noise below the base frequency is rejected through the use of tapered stacking, but the coil motion noise at the base frequency itself is not easily removed. A sharp spike in the LFM can be an indicator of a coil motion event (e.g. the bird passing through extremely turbulent air). Note that the LFM will also respond to sferic events with an appreciable low frequency (sub-base frequency) component. This situation can be inferred when both the LFM and sferic monitors show a discrete kick.

6.2.5.3.3 Powerline Monitor

The powerline monitor gives the amplitude of the received signal at the powerline frequency (50 Hz) in log10 (pV/sqrt (Hz)/sq.m). Careful selection of the base frequency (such that the powerline frequency is an even harmonic of the base frequency) and tapered stacking combine to strongly attenuate powerline signals. When passing directly over a powerline, the rapid lateral variations in the strength and direction of the magnetic fields associated with the powerline can result in imperfect cancellation of the powerline response during stacking. Some powerline-related interference can manifest itself in a form that is similar to the response of a discrete conductor. The exact form of the monitor profile over a powerline depends on the line direction, powerline direction, powerline current, and receiver component, but the monitor will show a general increase in amplitude approaching the powerline.

Grids of the powerline monitor reveal the location of the transmission lines. Note that the X component (horizontal receiver coil axis parallel with the flight line direction) does not register any response from powerlines parallel to the flight line direction since the magnetic fields associated with powerlines only vary in a direction perpendicular to the powerline. Note also that the Z component (vertical receiver coil axis) shows a narrow low directly over the powerline where the magnetic fields are purely horizontal.

6.2.5.3.4 Very Low Frequency Monitors

Wide area VLF communication signals in the 15 to 25 kHz frequency band are monitored by the TEMPEST system. In the Australian region, signals at 18.2 kHz, 19.8 kHz, 21.4 kHz and 22.2 kHz are monitored as the amplitude of the received signal at these frequencies in log10(pV/sqrt(Hz)/sq.m). The strongest signal comes from North West Cape (19.8 kHz). The signal at 18.2 kHz is often observed to pulse in a regular sequence. These strong narrow band signals have some impact on the high frequency response of the system, but they are strongly attenuated by selection of the base frequency and tapered stacking. The VLF transmissions are strongest in amplitude, in the horizontal direction at right angles to the direction to the VLF transmitter. This directional dependence enables the VLF monitors to be used to indicate the receiver coil attitude.

6.2.5.4 Other Sources of EM Noise

6.2.5.4.1 Man-made periodic discharges

If an image of the Z component sferic monitor shows the presence of spatially coherent events, then pulsed cultural interference would be strongly suspected. Since sferic signals are much stronger in the horizontal plane than in the vertical plane, few sferics of significant amplitude are recorded in Z component data. In contrast, evidence of cultural interference is generally swamped by true sferics in X component sferic monitor images.

Electric fences are the most common source of pulsed cultural interference. Periodic discharges (e.g. every second or so) into a large wire loop (fence) produce very large spikes in raw data. These are attenuated to a large degree by the sferic filter, but a residual artefact can still be present in the processed data.

6.2.5.4.2 Coil motion / Earth field noise

A change in coupling between the receiver coil and the ambient magnetic field will induce a voltage in the receiver coil. This noise is referred to as coil motion or Earth field noise. Receiver coils in the towed bird are suspended in a fashion that attempts to keep this noise below the noise floor at frequencies equal to and above the base frequency of the system. Severe turbulence, however, can result in 'coil knock events' that introduce noise into the processed data.

6.2.5.4.3 Grounded metal objects

Grounded extensive metal objects such as pipelines and rail lines can qualify as conductors and may produce a response that is visible in processed data. Grounded metal objects produce a response similar to shallow, highly conductive, steeply dipping conductors. These objects can sometimes be identified from good quality topographic maps, from aerial photographs, by viewing the tracking video, from their unusual spatial distribution (i.e. often a series of linear segments) and in some circumstances from their effect on the powerline monitor. A powerline running close to a long metal object will induce a 50 Hz response in the object.

6.2.6 Conductivity Depth Images (CDI)

CDI conductivity sections for TEMPEST data were calculated using EMFlow and then modified to reflect the finite depth of investigation using an in-house routine, *Sigtime*.

The *Sigtime* routine removes many of the spurious conductive features that appear at depth as a result of fitting long time constant exponential decays to very small amplitude features in the late times. For each observation, the time when the response falls below a signal threshold amplitude is determined. This time is transformed into a diffusion depth with reference to the conductivity values determined for that observation. Anomalous conductivity values below this depth are replaced by background values or set to undefined, reflecting the uncertainty in their origin. The settings and options applied are indicated in the appropriate header files for *Sigtime* output. This procedure is different to that which would be obtained by filtering conductivity values using either a constant time or constant depth across the entire line.

The "final" Z component EM data were input into version 5.10 of EMFlow to calculate Conductivity Depth Images (CDI). Conductivity values were calculated at each point then run through *Sigtime.*

EMFlow was developed within the CRC-AMET through AMIRA research projects (Macnae et al, 1998, Macnae and Zonghou, 1998, Stolz and Macnae, 1998). The software has been commercialised by Encom Technology Pty Ltd. Examples of TEMPEST conductivity data can be seen in Lane et al. (2000), Lane et al. (1999), and Lane and Pracillio (2000).

Conductivity values were calculated to a depth of 500 m below surface at each point, using a depth increment of 5 m and a conductivity range of 0.01 to 500mS/m.

6.2.7 System Specifications for Modelling TEMPEST Data

Differences between the specifications for the acquisition system, and those of the virtual system for which processed results are given, must be kept in mind when forward modelling, transforming or inverting TEMPEST data.

Acquisition is carried out with a 50% duty cycle square transmitter current waveform and dB/dt sensors.

During processing, TEMPEST EM data are transformed to the response that would be obtained with a B-field sensor for a 100% duty cycle square waveform at the base frequency, involving a 1A change in current (from -0.5A to +0.5A to -0.5A) in a 1sq.m transmitter. Data are given in units of femto Tesla (fT = 10^{-15} Tesla). It is this configuration, rather than the actual acquisition configuration, which must be specified when modelling TEMPEST data. Window timing information is given above (see section 6.2.5.1.7).

6.2.7.1 Standard Height and Geometry

The "final" EM data have been standardized through an approximate transformation to a standard transmitter loop terrain clearance, transmitter loop pitch and roll of zero degrees, and a fixed transmitter loop to receiver coil geometry (roughly equal to the average "raw" geometry values). Transmitter loop pitch, transmitter loop roll and transmitter loop terrain clearance values for each observation have been modified to reflect the standard values. Hence, the "final" (fixed) geometry values should be used if modelling with the final X- and Z-component amplitude data – Table 17 summarizes the values used to correct the transmitter height/pitch/roll/geometry to.

6.2.7.2 Parallax

The located data files utilize the following parallax values:

- Radar altimeter = 0 fiducials (0 observations from the zero parallax position)
- EM X-component = -6.0 fiducials (30 observations from the zero parallax position)
- EM Z-component = -6.0 fiducials (30 observations from the zero parallax position)

For the TEMPEST Airborne EM system, due to the asymmetry in the transmitter loop-receiver coil geometry with respect to flight direction, there is no single EM parallax value which will align the peak response for all conductivity distributions for lines flown in opposite directions.

The choice of EM parallax value depends on the intended usage. With the client's desire to model the data accurately, only a system parallax has been applied. The data therefore are not optimized for gridding.

Negative parallax values are defined in this case as shifting the indicated quantity forward along line to larger fiducial values. Location information remains in the zero parallax state.

6.2.8 CDI Depth Slices

Following calculation of the CDI data as described in section (6.2.6), conductivity depth slices (or interval conductivities) were derived for the top 200 meters by averaging conductivity data over the following depth intervals:

Interval	CDI Depth (m)	
	Start	**End**
1	0	5
2	5	10
3	10	15
4	15	20
5	20	30
6	30	40
7	40	60
8	60	100
9	100	150
10	150	200

Table 18: CDI depth slice intervals

The conductivity depth slice data was gridded for the survey area using a grid cell size of 1/5th of the line spacing. The gridding method used is a minimum curvature algorithm.

Finally, a 5-cell median filter and a 5-cell mean filter were applied to the conductivity depth slice grids to improve their appearance and smooth the blocky nature of the raw grids, which is a result of using 20 discretely defined conductivities in the CDI calculation.

6.2.9 Delivered Products

Appendix V contains a complete list of all data supplied:

- Digital ASCII located data and a Geosoft GDB format were produced, containing the raw and final, X and Z EM data, conductivity sections data, total magnetic intensity as well as digital terrain.
- Stacked CDI sections and CDI-multiplots in PDF format.
- Grids (in ER Mapper format) of the conductivity depth slices, total magnetic intensity and digital elevation were produced.
- A flight path map was delivered in a “PNG” image format.
- Acquisition and processing report as a hardcover copy and as a digital format copy.

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8 APPENDIX I – Weekly Acquisition Reports

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
14-October-2013														1.00	MO	TM and MA mobilise to Newman	19794.3	19931.6
Julian Day 287																	19794.3	19931.6
																	19794.3	19931.6
Monday																	19794.3	19931.6
									137.3								19794.3	19931.6
Date 15-Oct														1.00	SETUP	Base Setup in Newman	19794.3	19931.6
Julian Day 288																	19794.3	19931.6
																	19794.3	19931.6
Tuesday																	19794.3	19931.6
									137.3								19794.3	19931.6
Date 16-Oct														0.50	SETUP	Base Setup in Newman	19794.3	19931.6
Julian Day 289		MH				13:50:00	17:35:00	3.8						0.50	MO	Aircraft mobilises to site, recce carried out	19798.1	19931.6
		GH															19798.1	19931.6
Wednesday																	19798.1	19931.6
									133.5	3.8							19798.1	19931.6
Date 17-Oct	1	MH				7:38:00	10:03:00	2.4						1.00	SAF	Comp box carried out and reference line flown	19800.5	19931.6
Julian Day 290		GH															19800.5	19931.6
																	19800.5	19931.6
Thursday																	19800.5	19931.6
									131.1	6.2							19800.5	19931.6
Date 18-Oct														0.50	E	Engine run carried out in order to adjust transmitter power level	19801.0	19931.6
Julian Day 291														0.50	SETUP	Base stations re positioned at request of airport manager	19801.0	19931.6
															Comment :	PTW issued	19801.0	19931.6
Friday																	19801.0	19931.6
									130.6	6.7							19801.0	19931.6
Date 19-Oct	2	MH	TM	406.900		5:07:00	8:07:00	3.0						0.50	P	Began production, flew lines 10076 and 10077	19804.0	19931.6
Julian Day 292		GH											0.50	0.50	W	No second flight due to heat and turbulance	19804.0	19931.6
																	19804.0	19931.6
Saturday																	19804.0	19931.6
									127.6	9.7	406.900						19804.0	19931.6
Date 20-Oct	3	MH	TM	643.800		5:08:00	8:57:00	3.8						0.50	P	Continued production, flew lines 10114 and 10115	19807.8	19931.6
Julian Day 293		GH											0.50	0.50	W	No second flight due to heat and turbulance	19807.8	19931.6
															Comment :	James Kenny arrived on site	19807.8	19931.6
Sunday																	19807.8	19931.6
									123.8	13.5	1050.700						19807.8	19931.6
		Totals This Week: ▶		**1050.700**			Week Hours:▶	**13.0**	▲: A/C Hrs to Next Service				**1.00**	**7.00**				
		Total Accepted Line Kms This week: ▶		**1050.700**									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
21-October-2013	4	MH	TM			5:01:00	6:31:00	1.5						0.50	TF	Due to uncertainty regarding the accuracy / safety of the altimeter system, we flew a 30 km section of the reference line, four times at two separate heights.This confirmed that there was a systemic	19809.3	19931.6
Julian Day 294		GH												0.50	W	No second flight due to heat and turbulance	19809.3	19931.6
															Comment :	PDO tomorrow	19809.3	19931.6
Monday																	19809.3	19931.6
									122.3	15.0	1050.700						19809.3	19931.6
Date 22-Oct														1.00	PDO	PDO	19809.3	19931.6
Julian Day 295																	19809.3	19931.6
																	19809.3	19931.6
Tuesday																	19809.3	19931.6
									122.3	15.0	1050.700						19809.3	19931.6
Date 23-Oct	5	MH	TM	267.800	216.000	5:05:00	8:05:00	3.0						0.50	P & S	Carried out Rad Alt tests, then continued production, flew lines 10079 and 10078	19812.3	19931.6
Julian Day 296		GH											0.50	0.50	W	No second flight due to heat and turbulance	19812.3	19931.6
															Comment :	Danial Green, Richard Butterfield, Troy Wilhemi, Dave Little and Tim Masefield arrived on site.	19812.3	19931.6
Wednesday															Comment :	135 km scrubbed due to turbulance on first line only, second line was acceptable	19812.3	19931.6
									119.3	18.0	1318.500	216.000					19812.3	19931.6
Date 24-Oct	6	MH	TM			5:50:00	7:52:00	2.0						0.20	P & S	Attempted production, but turned back due to the number of coil knocks on every line we attempted. All scrubbed	19814.3	19931.6
Julian Day 297		TW												0.30	E	Danial worked on correcting the system polarity issue	19814.3	19931.6
															Comment :	Mark Harradence, Dave Little and Tim Masefield left site today.	19814.3	19931.6
Thursday													0.50	0.50	W	No second flight due to heat and turbulance	19814.3	19931.6
									117.3	20.0	1318.500	216.000					19814.3	19931.6
Date 25-Oct	7	GH	TM	741.100		5:14:00	9:32:00	4.3						0.30	P & S	Continued production, flew lines 10083, 10081, 10087 and part of 10085	19818.6	19931.6
Julian Day 298		TW												0.50	W	No second flight due to heat and turbulance	19818.6	19931.6
															Comment :	Winch found to be leaking oil, oil cleaned up, winch topped up, will monitor oil level.	19818.6	19931.6
Friday															Comment :	Some sections of the lines flown today may be scrubbed at a later date due to the height being outside contract specs.	19818.6	19931.6
									113.0	24.3	2059.600	216.000		0.20	E	Radalt items resolved	19818.6	19931.6
Date 26-Oct	8	GH	TM	470.600	198.200	5:11:00	9:27:00	4.3						0.50	P & S	Continued production, flew lines, 10089, 10091 and part of 10095, 10085 and 10093	19822.9	19931.6
Julian Day 299		TW												0.50	W	No second flight due to heat and turbulance	19822.9	19931.6
															Comment :	Danial Green and Richard Butterfield left site today	19822.9	19931.6
Saturday															Comment :	The Lidar to Xtrack link seemed to work, processor saw major improvement in average height flown.	19822.9	19931.6
									108.7	28.6	2530.200	414.200			Comment :	I failed to recognise the seriousness of the sferics activity, the result is all lines flown today will likely be scrubbed	19822.9	19931.6
Date 27-Oct														1.00	PDO	PDO taken as the weather was unsuitable for flying anyway.	19822.9	19931.6
Julian Day 300																	19822.9	19931.6
																	19822.9	19931.6
Sunday																	19822.9	19931.6
									108.7	28.6	2530.200	414.200					19822.9	19931.6
			Totals This Week: ▶	**1479.500**	**414.200**	Week Hours: ▶		**15.1**	▲: A/C Hrs to Next Service				**1.00**	**7.00**				
			Total Accepted Line Kms This week: ▶	**1479.500**									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
28-October-2013	9	GH	TM	628.700		5:09:00	8:45:00	3.6						0.50	P	Continued production, flew lines, 10099 (complete length of the repeat line flown), 10097 and the rest of 10095 and 10093	19826.5	19931.6
Julian Day 301		TW											0.50	0.50	W	No production due to poor weather	19826.5	19931.6
																	19826.5	19931.6
Monday																	19826.5	19931.6
									105.1	32.2	3158.900	414.200					19826.5	19931.6
Date 29-Oct	10	GH	TM	221.000	149.000	4:58:00	7:27:00	2.5						0.50	P & S	Continued production, flew lines 10103, 10105 and 5 km of the repeat line 10099 (135 KM was scrubbed from todays flight due to coil knocks)	19829.0	19931.6
Julian Day 302		TW											0.50	0.50	W	No production due to poor weather	19829.0	19931.6
																	19829.0	19931.6
Tuesday																	19829.0	19931.6
									102.6	34.7	3379.900	563.200					19829.0	19931.6
Date 30-Oct	11	GH	TM	40.000	300.000	5:00:00	7:18:00	2.3						0.50	P & S	Some data scrubbed due to turbulence. Continued production, flew part of lines, 10103, 10105, 10106 and 10107. Reapeat line 10099 not flown today	19831.3	19931.6
Julian Day 303		TW											0.50	0.50	W	No production due to poor weather	19831.3	19931.6
																	19831.3	19931.6
Wednesday																	19831.3	19931.6
									100.3	37.0	3419.900	863.200					19831.3	19931.6
Date 31-Oct														1.00	E	Apparent coil tilt discovered due to increased coil knocks, day spent investigating and rectifying	19831.3	19931.6
Julian Day 304																	19831.3	19931.6
																	19831.3	19931.6
Thursday																	19831.3	19931.6
									100.3	37.0	3419.900	863.200					19831.3	19931.6
Date 1-Nov	12	GH	TM	878.800		4:54:00	9:31:00	4.6						0.50	P	Continued production, flew lines 10106, 10104, 10102, 10096, 10098, 10101 and 5 km of the repeat line 10099	19835.9	19931.6
Julian Day 305		TW												0.50	W	No second flight due to heat and turbulance	19835.9	19931.6
															Comment :	Good data collected but some tilt still evident, opened the bird and took pictues of coil set tilt after todays flight, closed the bird.	19835.9	19931.6
Friday																	19835.9	19931.6
									95.7	41.6	4298.700	863.200					19835.9	19931.6
Date 2-Nov	13	GH	TM	788.500		5:05:00	9:36:00	4.5						0.50	P	Continued production, flew lines 10108, 10088, 10090, 10092, 10094, 10107 (all but the last 40 km of 10107) and 5 km of the repeat line 10099	19840.4	19931.6
Julian Day 306		TW											0.50	0.50	W	No second flight due to heat and turbulance	19840.4	19931.6
															Comment :	Bird GPS was intermittent during the penultimate line and it dropped out completely during the last line. During ground running Danial and I were able to duplicated the fault (possibly temperature	19840.4	19931.6
Saturday																	19840.4	19931.6
									91.2	46.1	5087.200	863.200					19840.4	19931.6
Date 3-Nov														1.00	PDO	PDO taken	19840.4	19931.6
Julian Day 307															Comment :	No production today due to bird GPS problem	19840.4	19931.6
															Comment :	Ongoing Bird GPS problem. Ran bird GPS several times on ground until it failed, sent data collected to Danial for analysis.	19840.4	19931.6
Sunday																	19840.4	19931.6
									91.2	46.1	5087.200	863.200					19840.4	19931.6
			Totals This Week: ►	**2557.000**	**449.000**		Week Hours: ►	**17.5**	▲: A/C Hrs to Next Service				**2.00**	**7.00**				
			Total Accepted Line Kms This week: ►	**2557.000**									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodic Inspection	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contribution	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspection Actually Due
04-November-2013														1.00	E	Ongoing Bird GPS problem prevented any production today	19840.4	19931.6
Julian Day 308															Comment:	Benn Riggs arrived on site	19840.4	19931.6
																	19840.4	19931.6
Monday																	19840.4	19931.6
									91.2	46.1	5087.200	863.200					19840.4	19931.6
Date 5-Nov														1.00	E	Ongoing Bird GPS problem prevented any production today	19840.4	19931.6
Julian Day 309															Comment:	Ben found the bird GPS fault, however we'll need to run the system for several hours tomorrow in order to confirm fix.	19840.4	19931.6
															Comment:	Mohamed and Troy left site today.	19840.4	19931.6
Tuesday																	19840.4	19931.6
									91.2	46.1	5087.200	863.200					19840.4	19931.6
Date 6-Nov														1.00	E	Ongoing Bird GPS problem prevented any production today, ran system for 5.5 hours without failure	19840.4	19931.6
Julian Day 310															Comment:	Some tow cable spot tie/looming was falling apart, so it was removed and re-done	19840.4	19931.6
															Comment:	An attempt was made by BR to balance the coil set in the field	19840.4	19931.6
Wednesday																	19840.4	19931.6
									91.2	46.1	5087.200	863.200					19840.4	19931.6
Date 7-Nov														1.00	LOG	Pilot won't arrive in time to fly today (temperature will be too high to take off)	19840.4	19931.6
Julian Day 311															Comment:	BR left site today, MH and MWC arrived on site today	19840.4	19931.6
																	19840.4	19931.6
Thursday																	19840.4	19931.6
									91.2	46.1	5087.200	863.200					19840.4	19931.6
Date 8-Nov	14	GH	TM			5:02:00	5:57:00	0.9						0.50	P	Returned after the repeat line due to high winds	19841.3	19931.6
Julian Day 312		MH											1.00	0.50	W	No second flight due to heat, wind and turbulence	19841.3	19931.6
															Comment:	System locked in flight, after re-start, no bird data was displayed (lost all reference data)	19841.3	19931.6
Friday															Comment:	Bird cradle lock on port side closes by itself in flight, James is working on a fix.	19841.3	19931.6
									90.3	47.0	5087.200	863.200					19841.3	19931.6
Date 9-Nov	15	GH	TM	689.800	45.900	5:07:00	9:42:00	4.6						0.50	P & S	Continued production, flew lines 10110, 10084, 10086, 10109, and 5 km of the repeat line 10099 Line 10086 scrubbed	19845.9	19931.6
Julian Day 313		MH												0.50	W	No second flight due to heat, wind and turbulence	19845.9	19931.6
																	19845.9	19931.6
Saturday																	19845.9	19931.6
									85.7	51.6	5777.000	909.100					19845.9	19931.6
Date 10-Nov	16	GH	TM	781.300		4:55:00	9:34:00	4.7						0.50	P & R	Continued production, flew lines 10111, 10112, 10080, 10082, and re-flew line 10086 that was scrubbed yesterday	19850.6	19931.6
Julian Day 314		MH												0.50	W	No second flight due to heat, wind and turbulence	19850.6	19931.6
															Comment:	Mag data now has a 20 nT ripple, Matt will begin an investigation Monday, we're still clear to fly tomorrow.	19850.6	19931.6
Sunday																	19850.6	19931.6
									81.0	56.3	6558.300	909.100					19850.6	19931.6
			Totals This Week: ▶	**1471.100**	**45.900**		Week Hours: ▶	**10.2**	▲: A/C Hrs to Next Service				**1.00**	**7.00**				
			Total Accepted Line Kms This week: ▶	**1471.100**									▲					

Date		Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
11-November-2013		17	GH	TM	319.900		5:08:00	8:35:00	3.5						0.50	P & R	Continued production, flew line 10113 and re-flew a section of 10103,	19854.1	19931.6
Julian Day	315		MH											0.50	0.50	W	No second flight due to heat, wind and turbulence	19854.1	19931.6
																Comment:	Mag data ripple issue fixed, it was an import problem.	19854.1	19931.6
Monday																Comment:	Almost completed the Newman section of the block, we only have one partial section of line 10079 that needs to be re-flown, Milgun Station gave us permission to fly this line tomorrow morning.	19854.1	19931.6
										77.5	59.8	6878.200	909.100					19854.1	19931.6
Date	12-Nov	18	GH	TM	333.200		4:55:00	7:44:00	2.8						0.50	R	Reflew 10079 and 10089, and flew 5 km of repeat line 10099	19856.9	19931.6
Julian Day	316		MH												0.50	A	Hydraulic pump failed in flight. James investigated and fixed the fault.	19856.9	19931.6
																Comment:	Completed the Newman part of the block, packing up for demob to Paraburdoo tomorrow	19856.9	19931.6
Tuesday																		19856.9	19931.6
										74.7	62.6	7211.400	909.100					19856.9	19931.6
Date	13-Nov		GH				10:52:00	11:45:00	0.9						1.00	MO	Ferry flight from Newman to Paraburdoo with MH. GH and JK onboard	19857.8	19931.6
Julian Day	317		MH													Comment:	Matt and Terry drove the 4WD from Newman to Paraburdoo	19857.8	19931.6
																Comment:	No production tomorrow, PDO	19857.8	19931.6
Wednesday																Comment:	Will set up and run base stations	19857.8	19931.6
										73.8	63.5	7211.400	909.100					19857.8	19931.6
Date	14-Nov														0.50	SETUP	Base stations set up and collecting data for operational testing	19857.8	19931.6
Julian Day	318															Comment:	PTW issued	19857.8	19931.6
															0.50	PDO	PDO	19857.8	19931.6
Thursday																		19857.8	19931.6
										73.8	63.5	7211.400	909.100					19857.8	19931.6
Date	15-Nov														0.50	E	Failed to receive Omni GPS data on startup with several attempts, system ran up OK a few hours later.	19857.8	19931.6
Julian Day	319													0.50	0.50	W	No second flight due to heat, wind and turbulence	19857.8	19931.6
																Comment:	Will monitor Omni GPS tomorrow, been given the OK to fly anyway if it doesn't run up.	19857.8	19931.6
Friday																Comment:	Base mags are collecting more data.	19857.8	19931.6
										73.8	63.5	7211.400	909.100			Comment:	Deep scratch found in bird teflon axle, we've been given the OK to fly with it in its present condition.	19857.8	19931.6
Date	16-Nov	19	GH	TM	834.900		5:23:00	9:35:00	4.2						0.50	P	Continued production, flew line 10053, 10052 and part of 10051 and 10050,	19862.0	19931.6
Julian Day	320		MH												0.50	W	No second flight due to heat, wind and turbulence	19862.0	19931.6
																Comment:	Bird winch topped up with oil, it took very little to fill it	19862.0	19931.6
Saturday																Comment:	Again the Omni GPS failed to run up at startup, but came good when aircraft was taxied	19862.0	19931.6
										69.6	67.7	8046.300	909.100					19862.0	19931.6
Date	17-Nov	20	GH	TM	835.300	54.000	5:27:00	10:10:00	4.7						0.50	P & S	Continued production, flew line 10049, 10048 and remainder of 10051 and 10050, and 5 km of repeat line 10053	19866.7	19931.6
Julian Day	321		MH												0.50	W	No second flight due to heat, wind and turbulence and sferics	19866.7	19931.6
																Comment:	The last 54 km of the last line was scrubbed due to sferics	19866.7	19931.6
Sunday																Comment:	Matt has chosen a new repeat line as the one we were using isn't suitable	19866.7	19931.6
										64.9	72.4	8881.600	963.100					19866.7	19931.6
			Totals This Week: ►		2323.300	54.000	Week Hours: ►		16.1	▲: A/C Hrs to Next Service				1.00	7.00				
	Total Accepted Line Kms This week: ►				2323.300									▲					

Date		Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
18-November-2013		21	GH	TM	884.900		5:17:00	10:00:00	4.7						1.00	P	Continued production, flew line 10047, 10046 and part of 10044 and 10045, and 5 km of repeat line 10053	19871.4	19931.6
Julian Day	322		MH													Comment :	No second flight due to heat, wind and turbulance	19871.4	19931.6
																Comment :	Bird winch topped up with oil, it took very little to fill it	19871.4	19931.6
Monday																		19871.4	19931.6
										60.2	77.1	9766.500	963.100					19871.4	19931.6
Date	19-Nov	22	GH	TM	833.700		5:25:00	10:04:00	4.7						0.50	P	Continued production, flew line 10043, part of line 10042 and the remainder of 10044 and 10045, and 5 km of repeat line 10053 (911)	19876.1	19931.6
Julian Day	323		MH												0.50	W	No second flight due to heat, wind and turbulance	19876.1	19931.6
																Comment :	Repeat line is now numbered 911	19876.1	19931.6
Tuesday																Comment :	We couldn't complete line 10042 as we didn't have enough fuel	19876.1	19931.6
										55.5	81.8	10600.200	963.100					19876.1	19931.6
Date	20-Nov	23	GH	TM	708.100		5:30:00	9:35:00	4.1						0.50	P	Continued production, flew line 10041, 10040, the remainder of line 10042 and 5 km of repeat line 911	19880.2	19931.6
Julian Day	324		MH												0.50	W	No second flight due to heat, wind and turbulance	19880.2	19931.6
																Comment :	Transmitter ran up 180 degrees out of phase, cold re-start was the only way to fix it	19880.2	19931.6
Wednesday																Comment :	Comms problem in flight, Operator could barely hear Pilot and visa versa (however side tone was OK, as was Operator - Co-Pilot and Pilot - Co-Pilot comms), replacement parts will be requested	19880.2	19931.6
										51.4	85.9	11308.300	963.100			Comment :	PDO tomorrow	19880.2	19931.6
Date	21-Nov														1.00	PDO	PDO	19880.2	19931.6
Julian Day	325															Comment :	Ray arrived on site	19880.2	19931.6
																		19880.2	19931.6
Thursday																		19880.2	19931.6
										51.4	85.9	11308.300	963.100					19880.2	19931.6
Date	22-Nov	24	GH	TM	626.000		5:27:00	9:07:00	3.7						0.50	P	Continued production, flew lines 10038, and 10039	19883.9	19931.6
Julian Day	326		MH												0.50	W	No second flight due to heat, wind and turbulance	19883.9	19931.6
																Comment :	Danial and Pete arrived on site	19883.9	19931.6
Friday																		19883.9	19931.6
										47.7	89.6	11934.300	963.100					19883.9	19931.6
Date	23-Nov	25	MH	TM	650.700		5:38:00	9:42:00	4.1						0.50	P	Continued production, flew lines 10036, and 10037	19888.0	19931.6
Julian Day	327		PH												0.40	W	No second flight due to heat, wind and turbulance	19888.0	19931.6
																Comment :	Andrew arrived on site	19888.0	19931.6
Saturday							10:18:00	11:00:00	0.7						0.10	TR	2nd sortie was a Pilot check flight Harro - Peter	19888.7	19931.6
										42.9	94.4	12585.000	963.100					19888.7	19931.6
Date	24-Nov	26	GH	TM	370.000		5:55:00	9:08:00	3.2						0.50	P	Continued production, flew lines 10164, 10163, 10162, 10161, 10160, 10159 and 10158	19891.9	19931.6
Julian Day	328		PH												0.50	R&D	UWA bird ground testing and fittment to aircraft in preparation for tomorrows test flights	19891.9	19931.6
																Comment :	A fuel spill occurred on the tarmac this morning during the pre-flight checks, incident report raised.	19891.9	19931.6
Sunday																Comment :	Ben arrived on site	19891.9	19931.6
										39.7	97.6	12955.000	963.100					19891.9	19931.6
				Totals This Week: ►	**4073.400**			Week Hours:►	**25.1**	▲: A/C Hrs to Next Service					**7.00**				
				Total Accepted Line Kms This week: ►	**4073.400**									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
25-November-2013	27	GH, PH	TM			5:40:00	6:28:00	0.8						0.50	R&D	test flight R&D bird 1	19892.7	19931.6
Julian Day 329	28	GH,PH	TM, BR			7:22:00	8:21:00	1.0						0.50	R&D	test flight R&D bird 2	19893.7	19931.6
																	19893.7	19931.6
Monday																	19893.7	19931.6
									37.9	99.4	12955.000	963.100					19893.7	19931.6
Date 26-Nov	29	GH,PH	BR	680.100		5:33:00	9:51:00	4.3						1.00	P		19898.0	19931.6
Julian Day 330																	19898.0	19931.6
																	19898.0	19931.6
Tuesday																	19898.0	19931.6
									33.6	103.7	13635.100	963.100					19898.0	19931.6
Date 27-Nov														0.50	PDO	PDO	19898.0	19931.6
Julian Day 331														0.50	SAF	Discussed the safe flying height and height indicators in the aircraft.	19898.0	19931.6
																	19898.0	19931.6
Wednesday																	19898.0	19931.6
									33.6	103.7	13635.100	963.100					19898.0	19931.6
Date 28-Nov	30	PH,GH	BR	884.800		5:55:00	10:33:00	4.6						1.00	P		19902.6	19931.6
Julian Day 332																	19902.6	19931.6
																	19902.6	19931.6
Thursday																	19902.6	19931.6
									29.0	108.3	14519.900	963.100					19902.6	19931.6
Date 29-Nov	31	GH,PH	BR	519.900		5:33:00	9:24:00	3.9						1.00	P		19906.5	19931.6
Julian Day 333															Comment :	EM computer locked up twice today.	19906.5	19931.6
																	19906.5	19931.6
Friday																	19906.5	19931.6
									25.1	112.2	15039.800	963.100					19906.5	19931.6
Date 30-Nov	32	PH, GH	BR	673.000		5:33:00	9:24:00	3.9						1.00	P		19910.4	19931.6
Julian Day 334															Comment :	TW Arrives, JK departs	19910.4	19931.6
																	19910.4	19931.6
Saturday																	19910.4	19931.6
									21.2	116.1	15712.800	963.100					19910.4	19931.6
Date 1-Dec	33	TW, PH	BR	689.900		5:45:00	10:05:00	4.3						1.00	P	Turbulent today, VLF is becoming a factor as we approach exmouth.	19914.7	19931.6
Julian Day 335															Comment :	GS Arrives, GH Departs	19914.7	19931.6
															Comment :	Weekly safety Meeting	19914.7	19931.6
Sunday																	19914.7	19931.6
									16.9	120.4	16402.700	963.100					19914.7	19931.6

Totals This Week: ► **3447.700** Week Hours:► **22.8** ▲: A/C Hrs to Next Service **7.00**

Total Accepted Line Kms This week: ► **3447.700** ▲

Date		Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time		Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
							Start	End											
02-December-2013		34	TW, PH	BR	697.200		5:37:00	9:59:00	4.4						1.00	P	Mild Turbulence.	19919.1	19931.6
Julian Day	336																	19919.1	19931.6
																		19919.1	19931.6
Monday																		19919.1	19931.6
										12.5	124.8	17099.900	963.100					19919.1	19931.6
Date	3-Dec	35	TW, PH	BR	697.100		4:47:00	9:10:00	4.4						1.00	P		19923.5	19931.6
Julian Day	337																	19923.5	19931.6
																		19923.5	19931.6
Tuesday																		19923.5	19931.6
										8.1	129.2	17797.000	963.100					19923.5	19931.6
Date	4-Dec	36	TW, PH	BR	697.000		4:50:00	9:34:00	4.7						1.00	P		19928.2	19931.6
Julian Day	338																	19928.2	19931.6
																		19928.2	19931.6
Wednesday																		19928.2	19931.6
										3.4	133.9	18494.000	963.100					19928.2	19931.6
Date	5-Dec	37	TW, PH	BR	159.000	155.000	4:55:00	7:53:00	3.0						1.00	P & S	Turbulence	19931.2	19931.6
Julian Day	339															Comment :	PH, TW, MVC return to Perth	19931.2	19931.6
																Comment :	BH, JRG arrive for aircraft mainteance	19931.2	19931.6
Thursday																		19931.2	19931.6
										0.4	136.9	18653.000	1118.100					19931.2	19931.6
Date	6-Dec														1.00	MA	TEM goes into maintenance	19931.2	19931.6
Julian Day	340																	19931.2	19931.6
																		19931.2	19931.6
Friday																		19931.2	19931.6
										0.4	136.9	18653.000	1118.100					19931.2	19931.6
Date	7-Dec														1.00	MA	TEM Maintenance	19931.2	19931.6
Julian Day	341															Comment :	BR returns to Perth	19931.2	19931.6
																		19931.2	19931.6
Saturday																		19931.2	19931.6
										0.4	136.9	18653.000	1118.100					19931.2	19931.6
Date	8-Dec														1.00	MA	TEM Maintenance	19931.2	19931.6
Julian Day	342																	19931.2	19931.6
																		19931.2	19931.6
Sunday																		19931.2	19931.6
										0.4	136.9	18653.000	1118.100					19931.2	19931.6
		Totals This Week: ▶			**2250.300**	**155.000**	Week Hours: ▶		**16.5**	▲: A/C Hrs to Next Service					**7.00**				
		Total Accepted Line Kms This week: ▶			**2250.300**									▲					

Date		Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS <u>Weather</u>, <u>Data delivery</u> <u>Aircraft movement</u>, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
09-December-2013															1.00	MA	TEM Maintenance	19931.2	19931.6
Julian Day	343																	19931.2	19931.6
																		19931.2	19931.6
Monday																		19931.2	19931.6
										0.4	136.9	18653.000	1118.100					19931.2	19931.6
Date	10-Dec														1.00	MA	TEM Maintenance	19931.2	19931.6
Julian Day	344															Comment :	BH, JRG return to Perth	19931.2	19931.6
																Comment :	BR, PH, TW, WS arrive	19931.2	19931.6
Tuesday					-63.200		12:42:00	12:42:00								Comment :	Adjustment for rounding errors - weekly now matches the MR	19931.2	19931.6
										0.4	136.9	18589.800	1118.100			Comment :	Adjustment for production figures - weekly now matches Lines flown	19931.2	19931.6
Date	11-Dec	38	TW, PH	BR	696.900		4:58:00	9:52:00	4.9						1.00	P		19936.1	20080.9
Julian Day	345															Comment :	MA arrives	19936.1	20080.9
																		19936.1	20080.9
Wednesday																		19936.1	20080.9
										144.8	141.8	19286.700	1118.100					19936.1	20080.9
Date	12-Dec	39	PH, WS	BR	696.700		5:13:00	9:45:00	4.5						1.00	P		19940.6	20080.9
Julian Day	346																	19940.6	20080.9
																		19940.6	20080.9
Thursday																		19940.6	20080.9
										140.3	146.3	19983.400	1118.100					19940.6	20080.9
Date	13-Dec	40	TW, WS	BR	600.000	60.000	4:56:00	9:14:00	4.3						0.75	P & S	Turbulence	19944.9	20080.9
Julian Day	347														0.25	TF	Comp Box	19944.9	20080.9
																		19944.9	20080.9
Friday																		19944.9	20080.9
										136.0	150.6	20583.400	1178.100					19944.9	20080.9
Date	14-Dec	41	PH, TW	BR	530.000	35.000	4:53:00	8:59:00	4.1						1.00	P & S	Last 35km of last line flown, effected by coil knocks	19949.0	20080.9
Julian Day	348															Comment :	Coil tilt evident. One of the bungies had jumped a tab.	19949.0	20080.9
																		19949.0	20080.9
Saturday																		19949.0	20080.9
										131.9	154.7	21113.400	1213.100					19949.0	20080.9
Date	15-Dec	42	PH, WS	BR	450.000		4:57:00	8:44:00	3.8						0.75	P & R	reflight from FLT0037	19952.8	20080.9
Julian Day	349															Comment :	Bird tilt resolved	19952.8	20080.9
															0.25	SAF	Weekly Safety Meeting	19952.8	20080.9
Sunday																		19952.8	20080.9
										128.1	158.5	21563.400	1213.100					19952.8	20080.9
		Totals This Week: ►			**2910.400**	**95.000**	Week Hours: ►		**21.6**	▲: A/C Hrs to Next Service					**7.00**				
		Total Accepted Line Kms This week: ►			**2910.400**									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
16-December-2013	43	TW, WS	BR	667.700		5:00:00	9:37:00	4.6						1.00	P		19957.4	20080.9
Julian Day 350																	19957.4	20080.9
																	19957.4	20080.9
Monday																	19957.4	20080.9
									123.5	163.1	22231.100	1213.100					19957.4	20080.9
Date 17-Dec	44	PH, TW	BR	606.100		5:01:00	9:20:00	4.3						1.00	P		19961.7	20080.9
Julian Day 351																	19961.7	20080.9
																	19961.7	20080.9
Tuesday																	19961.7	20080.9
									119.2	167.4	22837.200	1213.100					19961.7	20080.9
Date 18-Dec	45	PH, WS	BR	625.000		5:00:00	9:44:00	4.7						1.00	P		19966.4	20080.9
Julian Day 352																	19966.4	20080.9
																	19966.4	20080.9
Wednesday																	19966.4	20080.9
									114.5	172.1	23462.200	1213.100					19966.4	20080.9
Date 19-Dec	46	TW, WS	BR	251.700		4:55:00	8:15:00	3.3						1.00	P	Flight cut short due to an observed issue with the laser altimeter that could not be resolved during the flight. Post flight analysis indicated it was a false alarm.	19969.7	20080.9
Julian Day 353																	19969.7	20080.9
																	19969.7	20080.9
Thursday																	19969.7	20080.9
									111.2	175.4	23713.900	1213.100					19969.7	20080.9
Date 20-Dec	47	PH, WS	BR	512.000		4:58:00	9:39:00	4.7						1.00	P		19974.4	20080.9
Julian Day 354																	19974.4	20080.9
																	19974.4	20080.9
Friday																	19974.4	20080.9
									106.5	180.1	24225.900	1213.100					19974.4	20080.9
Date 21-Dec	48	PH, WS	BR	606.600		4:52:00	9:30:00	4.6						1.00	P	Sferics	19979.0	20080.9
Julian Day 355																	19979.0	20080.9
																	19979.0	20080.9
Saturday																	19979.0	20080.9
									101.9	184.7	24832.500	1213.100					19979.0	20080.9
Date 22-Dec	49	TW, WS	BR	510.600	105.800	4:55:00	9:05:00	4.2						1.00	P & S	Sferics. Aircraft system does not have a VLF filter, Impossible to see the effect of the spherics in the aircraft due to the proximity of the survey to Exmouth.	19983.2	20080.9
Julian Day 356															Comment:	Site Packup	19983.2	20080.9
															Comment:	TW Departs	19983.2	20080.9
Sunday																	19983.2	20080.9
									97.7	188.9	25343.100	1318.900					19983.2	20080.9
Totals This Week: ▶				**3779.700**	**105.800**	Week Hours: ▶		**30.5**	▲: A/C Hrs to Next Service					**7.00**				
Total Accepted Line Kms This week: ▶				**3779.700**									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
23-December-2013														1.00	Comment :	BR, PH, WS, GS, MA depart.	19983.2	20080.9
Julian Day 357																	19983.2	20080.9
																	19983.2	20080.9
Monday																	19983.2	20080.9
									97.7	188.9	25343.100	1318.900					19983.2	20080.9
Date 24-Dec																	19983.2	20080.9
Julian Day 358																	19983.2	20080.9
																	19983.2	20080.9
Tuesday																	19983.2	20080.9
									97.7	188.9	25343.100	1318.900					19983.2	20080.9
Date 25-Dec																	19983.2	20080.9
Julian Day 359																	19983.2	20080.9
																	19983.2	20080.9
Wednesday																	19983.2	20080.9
									97.7	188.9	25343.100	1318.900					19983.2	20080.9
Date 26-Dec																	19983.2	20080.9
Julian Day 360																	19983.2	20080.9
																	19983.2	20080.9
Thursday																	19983.2	20080.9
									97.7	188.9	25343.100	1318.900					19983.2	20080.9
Date 27-Dec														1.00	Comment :	TM, GH, MA and WS arrived on site	19983.2	20080.9
Julian Day 361																	19983.2	20080.9
																	19983.2	20080.9
Friday																	19983.2	20080.9
									97.7	188.9	25343.100	1318.900					19983.2	20080.9
Date 28-Dec	50	GH	TM		708.800	5:05:00	10:01:00	4.9						1.00	S	All data scrubbed due to spherics	19988.1	20080.9
Julian Day 362		WS													Comment :	Began discussions about the possible impact on operations from the cyclone currently forming off the coast	19988.1	20080.9
															Comment :	Will fly N-S lines tomorrow in an attempt to minimise the effect of spherics on our operations	19988.1	20080.9
Saturday																	19988.1	20080.9
									92.8	193.8	25343.100	2027.700					19988.1	20080.9
Date 29-Dec	51	GH	TM	608.800		5:02:00	9:53:00	4.9						1.00	P & R	All data from today's flight was good, L10075, L10074, L10073, L10072, L10071, L10069, L10068 flown, no repeat line today	19993.0	20080.9
Julian Day 363		WS													Comment :	GH and WS will fly TEM to Geralton tomorrow to avoid the cyclone.	19993.0	20080.9
															Comment :	TM and MA will stay in Paraburdoo until TEM returns.	19993.0	20080.9
Sunday															Comment :	I'll dismantle the base stations tomorrow and stow all of our equipment away from the coming storm	19993.0	20080.9
									87.9	198.7	25951.900	2027.700			Comment :	I managed to contact Milgun Station last night and was given the OK to fly over their property.	19993.0	20080.9
Totals This Week: ▶				**608.800**	**708.800**	Week Hours: ▶		**9.8**	▲: A/C Hrs to Next Service					**4.00**				
Total Accepted Line Kms This week: ▶				**608.800**									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
30-December-2013		GH				8:18:00	10:40:00	2.4						1.00	W	VH-TEM flew to Geralton this morning to avoid the cyclone's path	19995.4	20080.9
Julian Day 364		WS													Comment :	All CGG equipment in Paraburdoo has now been packed up and secured	19995.4	20080.9
																	19995.4	20080.9
Monday																	19995.4	20080.9
									85.5	201.1	25951.900	2027.700					19995.4	20080.9
Date 31-Dec														1.00	W	Cyclone Christine prevented any flying today	19995.4	20080.9
Julian Day 365															Comment :	GH, WS and VH-TEM still safe in Geralton	19995.4	20080.9
															Comment :	TM and MA still safe in Paraburdoo	19995.4	20080.9
Tuesday															Comment :	Kms remaining figure for this document may not be correct, MA and TM are working to correct this error.	19995.4	20080.9
									85.5	201.1	25951.900	2027.700					19995.4	20080.9
Date 1-Jan		GH				11:10:00	13:30:00	2.3						1.00	W	VH-TEM flew back to Paraburdoo from Geralton this afternoon	19997.7	20080.9
Julian Day 1		WS													Comment :	Base stations set up	19997.7	20080.9
															Comment :	Kms remaining figure for this document may not be correct, MA and TM are still working to correct this error	19997.7	20080.9
Wednesday															Comment :	No production today as TEM was being flown back to Paraburdoo.	19997.7	20080.9
									83.2	203.4	25951.900	2027.700					19997.7	20080.9
Date 2-Jan	52	GH	TM	512.800		4:57:00	9:00:00	4.1						1.00	P	All data from today's flight was good, L10067, L10066, L10065, L10166, L10064, L10063, L10062 flown, no repeat line today	20001.8	20080.9
Julian Day 2		WS													Comment :	MA fixed the kms remaining figures, weekly report and production log figures are now correct and match	20001.8	20080.9
																	20001.8	20080.9
Thursday																	20001.8	20080.9
									79.1	207.5	26464.700	2027.700					20001.8	20080.9
Date 3-Jan	53	GH	TM	618.000	17.800	4:54:00	9:49:00	4.9						1.00	P & R & S	Re-flew , 10139, 10140, 10141, 10142, 10143, 10148, 10048 and repeat line.911	20006.7	20080.9
Julian Day 3		WS													Comment :	MA will take a closer look at line 10148 and may scub a section tomorrow due to spherics	20006.7	20080.9
															Comment :	Shorter production day tomorrow, we need to get back to the airport by 9 am, as re-fueller wont be around after 9 am	20006.7	20080.9
Friday																	20006.7	20080.9
									74.2	212.4	27082.700	2045.500					20006.7	20080.9
Date 4-Jan	54	GH	TM	326.400		5:02:00	8:04:00	3.0						1.00	P & S	All data from today's flight was good, L10061, L10060, L10059, L10158 flown, no repeat line today 17.8 kms of line 10148 from yesterday's flight was scrubbed	20009.7	20080.9
Julian Day 4		WS													Comment :	We'll be re-fuelling in Onslow tomorrow due to the long ferry back to Paraburdoo	20009.7	20080.9
															Comment :	Shorter production day today due to there being no re-fueller available after 9 am	20009.7	20080.9
Saturday																	20009.7	20080.9
									71.2	215.4	27409.100	2045.500					20009.7	20080.9
Date 5-Jan	55	GH	TM	706.700		5:00:00	9:55:00	4.9						0.70	P & R	All data from today's flight was accepted, L10131, L10133, L10134, L10135, L10036, L10037, L10038, L10148 flown, no repeat line today	20014.6	20080.9
Julian Day 5	56	WS		117.000		11:55:00	13:31:00	1.6						0.30	P	L10132 flown as we were returning to Paraburdoo from Onslow, many coil knocks, MA will take a closer look at line 10132 and may scub this line or a section of the line tomorrow due to coil knocks	20016.2	20080.9
															Comment :	We'll be re-fuelling in Onslow again tomorrow due to the long ferry back to Paraburdoo, but wont fly another line on the ferry back as high temperatures and turbulence are an issue as shown today.	20016.2	20080.9
Sunday																	20016.2	20080.9
									64.7	221.9	28232.800	2045.500					20016.2	20080.9
			Totals This Week: ▶	2280.900	17.800	Week Hours:▶		23.2	▲: A/C Hrs to Next Service					7.00				
			Total Accepted Line Kms This week: ▶	2280.900									▲					

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	CGG Scrub	Time Start	Time End	Engin Hours on M/R	Hours Periodi Inspecti	Job Hrs to Date	Prod. to Date	CGG Scrubs to Date	Stdby Days	Activity Contributi	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc	M/R TTIS Prog.	Periodic Inspecti Actually Due
06-January-2014	57	GH	TM	753.700		5:00:00	10:10:00	5.2						0.70	P	All data from today's flight was good, L10116, L10117, L10118, L10119, L10120, L10121, L10122, L10123, L10124, L10125 flown, and repeat line 911	20021.4	20080.9
Julian Day 6		WS				10:52:00	12:09:00	1.3						0.30	Comment :	Second sortie was the ferry from Onslow to Paraburdoo following re-fuel.	20022.7	20080.9
																	20022.7	20080.9
Monday																	20022.7	20080.9
									58.2	228.4	28986.500	2045.500					20022.7	20080.9
Date 7-Jan	58	GH	TM	590.500		5:03:00	9:57:00	4.9						1.00	P	L10126, L10127, L10128, L10129, L10130, L10132 flown, no repeat line today	20027.6	20080.9
Julian Day 7		WS													Comment :	Today's sortie was flown with a large coil tilt the data from todays flight has not been processed or accepted as yet (Mohamed was assisting us in the repair of the bird).	20027.6	20080.9
															Comment :	There is an error in the daily report "remaining kms" and "percentage complete"sections. Remaining kms reads -36km, but should read 130 kms, we haven't had time to investigate.	20027.6	20080.9
Tuesday															Comment :	Coil tilt was discovered in initial processing, investigation showed it was caused by a coil set string failure, this has been repaired and we hope to complete data collection for this job tomorrow	20027.6	20080.9
									53.3	233.3	29577.000	2045.500					20027.6	20080.9
Date 8-Jan	59	GH	TM	120.000		5:03:00	7:22:00	2.3						1.00	P	Re-flew a section of L10105 data was accepted.	20029.9	20080.9
Julian Day 8		WS													Comment :	All lines of J2446 have now been flown and accepted	20029.9	20080.9
															Comment :	However, we need to fly the repeat line once more tomorrow morning due to the fact that the bird was altered..	20029.9	20080.9
Wednesday															Comment :	There's still a "remaining kms" error on this document.	20029.9	20080.9
									51.0	235.6	29697.000	2045.500					20029.9	20080.9
Date 9-Jan	60	GH	TM			5:01:00	5:50:00	0.8						0.50	P	Flew the repeat line (911)	20030.7	20080.9
Julian Day 9		WS												0.50	MO	VH-TEM demob to Perth with GH and WS onboard, Packed up Base stations and office, packed truck for drive to Port Hedland tomorrow	20030.7	20080.9
															Comment :	"Kms remaining" error fixed	20030.7	20080.9
Thursday															Comment :	Data collection for J2446 is now complete	20030.7	20080.9
									50.2	236.4	29697.000	2045.500			Comment :	MA will fly out tomorrow morning, TM will drive the truck to Port Hedland tomorrow morning, freight our equipment back to Jandakot, return truck then fly back to Perth in the afternoon.	20030.7	20080.9
Date 10-Jan																	20030.7	20080.9
Julian Day 10																	20030.7	20080.9
																	20030.7	20080.9
Friday																	20030.7	20080.9
									50.2	236.4	29697.000	2045.500					20030.7	20080.9
Date 11-Jan																	20030.7	20080.9
Julian Day 11																	20030.7	20080.9
																	20030.7	20080.9
Saturday																	20030.7	20080.9
									50.2	236.4	29697.000	2045.500					20030.7	20080.9
Date 12-Jan																	20030.7	20080.9
Julian Day 12																	20030.7	20080.9
																	20030.7	20080.9
Sunday																	20030.7	20080.9
									50.2	236.4	29697.000	2045.500					20030.7	20080.9
			Totals This Week: ►	**1464.200**			Week Hours:►	**14.5**	▲: A/C Hrs to Next Service					**4.00**				
			Total Accepted Line Kms This week: ►	**1464.200**									▲					

9 APPENDIX II – Located Data Format

9.1 Final Located Data Headers

9.1.1 Capricorn Regional Survey – Final Time Domain EM Data (Survey Lines)

```
COMM CGG PROJECT NUMBER                                        2446
COMM AREA NUMBER:                                                 1
COMM SURVEY COMPANY:                          CGG Aviation Australia
COMM CLIENT:                                                     GA
COMM SURVEY TYPE:                               25Hz TEMPEST Survey
COMM AREA NAME:                                           Capricorn
COMM STATE:                                                      WA
COMM COUNTRY:                                             Australia
COMM SURVEY FLOWN:                    October 2013 to January 2014
COMM LOCATED DATA CREATED:                               April 2014
COMM
COMM DATUM:                                                   GDA94
COMM PROJECTION:                                                MGA
COMM ZONE:                                                       50
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM LINE SPACING:                                           5000 m
COMM LINE DIRECTION:                                        Various
COMM NOMINAL TERRAIN CLEARANCE:                               120 m
COMM FINAL LINE KILOMETRES:                                30119 km
COMM
COMM LINE NUMBERING
COMM
COMM SURVEY LINE NUMBERS:                           L10001 - L10102
COMM                                                L10116 - L10157
COMM                                                L10166 - L10167
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                     CASA 212, VH-TEM
COMM
COMM MAGNETOMETER:                        Scintrex Cs-2 Cesium Vapour
COMM INSTALLATION:                                 Stinger mounted
COMM RESOLUTION:                                           0.001 nT
COMM RECORDING INTERVAL:                                      0.2 s
COMM
COMM ELECTROMAGNETIC SYSTEM:                            25Hz TEMPEST
```

```
COMM INSTALLATION:                  Transmitter loop mounted on the aircraft
COMM                                          Receiver coils in a towed bird
COMM COIL ORIENTATION:                                                  X,Z
COMM RECORDING INTERVAL:                                              0.2 s
COMM SYSTEM GEOMETRY:
COMM HPRG CORRECTED RECEIVER DISTANCE BEHIND THE TRANSMITTER:         117 m
COMM HPRG CORRECTED RECEIVER DISTANCE BELOW THE TRANSMITTER:         41.5 m
COMM
COMM RADAR ALTIMETER:                                          Sperry RT200
COMM RECORDING INTERVAL:                                              0.1 s
COMM
COMM LASER ALTIMETER:                                       Riegl LD90-3300
COMM RECORDING INTERVAL:                                              0.1 s
COMM
COMM NAVIGATION:                                Real-time differential GPS
COMM RECORDING INTERVAL:                                              1.0 s
COMM
COMM ACQUISITION SYSTEM:                                             FASDAS
COMM
COMM DATA PROCESSING
COMM
COMM MAGNETIC DATA
COMM DIURNAL CORRECTION APPLIED                       base value 53500 nT
COMM PARALLAX CORRECTION APPLIED                                      0 s
COMM IGRF CORRECTION APPLIED                          base value 54182 nT
COMM IGRF MODEL EXTRAPOLATED TO                                2013/10/17
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM TERRAIN CLEARANCE DATA
COMM LASER ALTIMETER: PARALLAX CORRECTION APPLIED                    0 s
COMM RADAR ALTIMETER: PARALLAX CORRECTION APPLIED                    0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM
COMM DIGITAL TERRAIN DATA
COMM DTM CALCULATED [DTM = GPS ALTITUDE - (LASER ALT + SENSOR SEPARATION)]
COMM DATA CORRECTED TO AUSTRALIAN HEIGHT DATUM
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM ELECTROMAGNETIC DATA
COMM SYSTEM PARALLAX REMOVED, AS FOLLOWS:
COMM    X-COMPONENT EM DATA                                         6 s
COMM    Z-COMPONENT EM DATA                                         6 s
COMM DATA CORRECTED FOR TRANSMITTER HEIGHT, PITCH AND ROLL
```

```
COMM DATA CORRECTED FOR TRANSMITTER-RECEIVER GEOMETRY VARIATIONS
COMM DATA HAVE BEEN MICROLEVELLED
COMM CONDUCTIVITY DEPTH INVERSION CALCULATED                 EMFlow V5.10
COMM CONDUCTIVITY DEPTH RANGE                                 000 - 500 m
COMM CONDUCTIVITY DEPTH INTERVAL                                      5 m
COMM CONDUCTIVITIES CALCULATED USING HPRG CORRECTED EM X and Z DATA
COMM
COMM ----------------------------------------------------------------------
COMM DISCLAIMER
COMM ----------------------------------------------------------------------
COMM It is CGG Aviation’s understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without CGG Aviation's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by CGG Aviation exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and CGG Aviation
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved CGG Aviation's use of any
COMM information provided by the Client or third parties, upon which
COMM CGG Aviation was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information.
COMM CGG Aviation is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and CGG Aviation.
COMM
COMM With regard to DIGITAL TERRAIN DATA, the accuracy of the elevation
COMM calculation is directly dependent on the accuracy of the two input
COMM parameters laser altitude and GPS altitude. The laser and radar altitude
COMM value may be erroneous in areas of heavy tree cover, where the altimeters
COMM reflect the distance to the tree canopy rather than the ground. The GPS
COMM altitude value is primarily dependent on the number of available satellites.
COMM Although post-processing of GPS data will yield X and Y accuracies in the
COMM order of 1-2 metres, the accuracy of the altitude value is usually
COMM much less, sometimes in the ±5 metre range.  Further inaccuracies
COMM may be introduced during the interpolation and gridding process.
COMM Because of the inherent inaccuracies of this method, no guarantee is
COMM made or implied that the information displayed is a true
```

```
COMM representation of the height above sea level.  Although this product
COMM may be of some use as a general reference,
COMM THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.
COMM ----------------------------------------------------------------------
COMM
COMM ELECTROMAGNETIC SYSTEM
COMM
COMM TEMPEST IS A TIME-DOMAIN SQUARE-WAVE SYSTEM,
COMM TRANSMITTING AT A BASE FREQUENCY OF 25Hz,
COMM WITH 2 ORTHOGONAL-AXIS RECEIVER COILS IN A TOWED BIRD.
COMM FINAL EM OUTPUT IS RECORDED 5 TIMES PER SECOND.
COMM THE TIMES (IN MILLISECONDS) FOR THE 15 WINDOWS ARE:
COMM
COMM WINDOW      START       END      CENTRE
COMM    1        0.007      0.020      0.013
COMM    2        0.033      0.047      0.040
COMM    3        0.060      0.073      0.067
COMM    4        0.087      0.127      0.107
COMM    5        0.140      0.207      0.173
COMM    6        0.220      0.340      0.280
COMM    7        0.353      0.553      0.453
COMM    8        0.567      0.873      0.720
COMM    9        0.887      1.353      1.120
COMM   10        1.367      2.100      1.733
COMM   11        2.113      3.273      2.693
COMM   12        3.287      5.113      4.200
COMM   13        5.127      7.993      6.560
COMM   14        8.007     12.393     10.200
COMM   15       12.407     19.993     16.200
COMM
COMM PULSE WIDTH: 10 ms
COMM
COMM TEMPEST EM data are transformed to the response that would be
COMM obtained with a B-field sensor for a 100% duty cycle square
COMM waveform at the base frequency, involving a 1A change in
COMM current (from -0.5A to +0.5A to -0.5A) in a 1sq.m transmitter.
COMM It is this configuration, rather than the actual acquisition
COMM configuration, which must be specified when modelling TEMPEST data.
COMM
COMM
COMM LOCATED DATA FORMAT
COMM
COMM Output field format: ASCII ASEG-GDF
COMM
COMM
```

COMM FIELD		CHANNEL	Description	UNITS	NULL	FORMAT
COMM	0	Line	Line Number		-99999999	I10
COMM	1	Flight	Flight Number		-99	I4
COMM	2	Fiducial	Fiducial Number		-999999.9	F8.1
COMM	3	Project_CGG	CGG Project Number		-9999	I6
COMM	4	Project_GA	GA Project Number		-9999	I6
COMM	5	Aircraft	Aircraft System Number		-9	I3
COMM	6	Date	Date (yyyymmdd)		-9999999	I9
COMM	7	Time	Time - Local Midnight	s	-9999.9	F8.1
COMM	8	Time_Secs_Week	GPS Seconds Of Week	s	-9999.9	F10.1
COMM	9	Bearing	Line Bearing	deg	-99	I4
COMM	10	Latitude	Latitude, Datum: GDA94	deg	-99.9999999	F12.7
COMM	11	Longitude	Longitude, Datum: GDA94	deg	-999.9999999	F13.7
COMM	12	Easting	Easting, Projection: GDA94/MGA50	m	-99999.99	F10.2
COMM	13	Northing	Northing, Projection: GDA94/MGA50	m	-999999.99	F11.2
COMM	14	Pressure	Barometric Pressure	hPa	-9999.99	F9.2
COMM	15	Temperature	Temperature	degC	-999.99	F8.2
COMM	16	Lidar_Raw	Raw Laser Altimeter	m	-999.99	F8.2
COMM	17	Lidar	Final Laser Altimeter	m	-999.99	F8.2
COMM	18	Radalt	Final Radar Altimeter	m	-999.99	F8.2
COMM	19	Tx_Elevation	Final Tx Elevation, Datum: GDA94 Ellipsoid	m	-999.99	F8.2
COMM	20	GPSalt	GPS Altitude	m	-99999.99	F10.2
COMM	21	GPSalt_AHD	GPS Altitude (AHD)	m	-99999.99	F10.2
COMM	22	DTM_AHD	Digital Terrain Model (AHD)	m	-999.99	F8.2
COMM	23	DTM	Final Ground Elevation (AHD)	m	-999.99	F8.2
COMM	24	FluxgateX	Fluxgate X Component	nT	-9999999.99	F12.2
COMM	25	FluxgateY	Fluxgate Y Component	nT	-9999999.99	F12.2
COMM	26	FluxgateZ	Fluxgate Z Component	nT	-9999999.99	F12.2
COMM	27	Diurnal	Diurnal	nT	-99999.999	F11.3
COMM	28	UnCompMag	Uncompensated TMI	nT	-99999.999	F11.3
COMM	29	CompMag	Compensated TMI	nT	-99999.999	F11.3
COMM	30	Mag	Final TMI	nT	-99999.999	F11.3
COMM	31	Tx_Roll	Tx Loop Roll	deg	-999.99	F8.2
COMM	32	Tx_Pitch	Tx Loop Pitch	deg	-999.99	F8.2
COMM	33	Tx_Clearance	Transmitter Terrain Clearance	m	-999.99	F8.2
COMM	34	HSep_Raw	Tx-Rx Horizontal Separation	m	-999.99	F8.2
COMM	35	VSep_Raw	Tx-Rx Vertical Separation	m	-999.99	F8.2
COMM	36	HSep_gps	Tx-Rx Horizontal GPS Separation	m	-999.99	F8.2
COMM	37	VSep_gps	Tx-Rx Vertical GPS Separation	m	-999.99	F8.2
COMM	38	TSep_gps	Tx-Rx Transverse GPS Separation	m	-999.99	F8.2
COMM	39	HSep_std	Tx-Rx HPRG Horizontal Separation	m	-999.99	F8.2
COMM	40	VSep_std	Tx-Rx HPRG Vertical Separation	m	-999.99	F8.2
COMM	41	Tx_Clearance_std	Tx HPRG Terrain Clearance	m	-999.99	F8.2
COMM	42	Flag_Birdgps	Flag Channel For Missing Bird GPS Data		-99	I2
COMM	43	EMX_nonhprg[1:15]	Raw (non-HPRG) EMX Windows	fT	-999.999999	15 F12.6

COMM	44	EMZ_nonhprg[1:15]	Raw (non-HPRG) EMZ Windows	fT	-999.999999	15 F12.6
COMM	45	EMX_hprg[1:15]	Final HPRG EMX Windows	fT	-999.999999	15 F12.6
COMM	46	EMZ_hprg[1:15]	Final HPRG EMZ Windows	fT	-999.999999	15 F12.6
COMM	47	EMX_final[1:15]	Final HPRG With Levelling EMX Windows	fT	-999.999999	15 F12.6
COMM	48	EMZ_final[1:15]	Final HPRG With Levelling EMZ Windows	fT	-999.999999	15 F12.6
COMM	49	X_Geofact	Geometry factor - X component		-9999.999	F10.3
COMM	50	Z_Geofact	Geometry factor - Z component		-9999.999	F10.3
COMM	51	X_LowFreq	Low Frequency monitor - X component		-9999.999	F10.3
COMM	52	Z_LowFreq	Low Frequency monitor - Z component		-9999.999	F10.3
COMM	53	X_PrimaryField	Primary Field - X Component	fT	-99.9999999	F12.7
COMM	54	Z_PrimaryField	Primary Field - Z Component	fT	-99.9999999	F12.7
COMM	55	X_Powerline	Powerline - X component		-9999.999	F10.3
COMM	56	Z_Powerline	Powerline - Z component		-9999.999	F10.3
COMM	57	X_Sferics	Sferics - X component		-9999.999	F10.3
COMM	58	Z_Sferics	Sferics - Z component		-9999.999	F10.3
COMM	59	X_VLF1	18.2kHz monitor - X component		-9999.999	F10.3
COMM	60	Z_VLF1	18.2kHz monitor - Z component		-9999.999	F10.3
COMM	61	X_VLF2	19.8kHz monitor - X component		-9999.999	F10.3
COMM	62	Z_VLF2	19.8kHz monitor - Z component		-9999.999	F10.3
COMM	63	X_VLF3	21.4kHz monitor - X component		-9999.999	F10.3
COMM	64	Z_VLF3	21.4kHz monitor - Z component		-9999.999	F10.3
COMM	65	X_VLF4	22.2kHz monitor - X component		-9999.999	F10.3
COMM	66	Z_VLF4	22.2kHz monitor - Z component		-9999.999	F10.3

9.1.2 Capricorn Regional Survey – Final Time Domain EM Data (Repeat Lines)

COMM CGG PROJECT NUMBER	2446
COMM AREA NUMBER:	1
COMM SURVEY COMPANY:	CGG Aviation Australia
COMM CLIENT:	GA
COMM SURVEY TYPE:	25Hz TEMPEST Survey
COMM AREA NAME:	Capricorn
COMM STATE:	WA
COMM COUNTRY:	Australia
COMM SURVEY FLOWN:	October 2013 to January 2014
COMM LOCATED DATA CREATED:	April 2014
COMM	
COMM DATUM:	GDA94
COMM PROJECTION:	MGA
COMM ZONE:	50
COMM	
COMM REPEAT LINES SPECIFICATIONS	
COMM	

```
COMM LINE DIRECTION:                                      000 - 180 deg
COMM NOMINAL TERRAIN CLEARANCE:                                   120 m
COMM FINAL LINE KILOMETRES:                                      167 km
COMM
COMM REPEAT LINE NUMBERS:                           L9100201 - L9116001
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                          CASA 212, VH-TEM
COMM
COMM MAGNETOMETER:                             Scintrex Cs-2 Cesium Vapour
COMM INSTALLATION:                                       Stinger mounted
COMM RESOLUTION:                                               0.001 nT
COMM RECORDING INTERVAL:                                          0.2 s
COMM
COMM ELECTROMAGNETIC SYSTEM:                                25Hz TEMPEST
COMM INSTALLATION:                  Transmitter loop mounted on the aircraft
COMM                                        Receiver coils in a towed bird
COMM COIL ORIENTATION:                                              X,Z
COMM RECORDING INTERVAL:                                          0.2 s
COMM SYSTEM GEOMETRY:
COMM HPRG CORRECTED RECEIVER DISTANCE BEHIND THE TRANSMITTER:      117 m
COMM HPRG CORRECTED RECEIVER DISTANCE BELOW THE TRANSMITTER:      41.5 m
COMM
COMM RADAR ALTIMETER:                                       Sperry RT200
COMM RECORDING INTERVAL:                                          0.1 s
COMM
COMM LASER ALTIMETER:                                    Riegl LD90-3300
COMM RECORDING INTERVAL:                                          0.1 s
COMM
COMM NAVIGATION:                                Real-time differential GPS
COMM RECORDING INTERVAL:                                          1.0 s
COMM
COMM ACQUISITION SYSTEM:                                          FASDAS
COMM
COMM DATA PROCESSING
COMM
COMM MAGNETIC DATA
COMM DIURNAL CORRECTION APPLIED                     base value 53500 nT
COMM PARALLAX CORRECTION APPLIED                                    0 s
COMM IGRF CORRECTION APPLIED                        base value 54182 nT
COMM IGRF MODEL EXTRAPOLATED TO                              2013/10/17
COMM DATA HAVE NOT BEEN MICROLEVELLED
COMM
COMM TERRAIN CLEARANCE DATA
```

```
COMM LASER ALTIMETER: PARALLAX CORRECTION APPLIED                     0 s
COMM RADAR ALTIMETER: PARALLAX CORRECTION APPLIED                     0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                      0 s
COMM
COMM DIGITAL TERRAIN DATA
COMM DTM CALCULATED [DTM = GPS ALTITUDE - (LASER ALT + SENSOR SEPARATION)]
COMM DATA CORRECTED TO AUSTRALIAN HEIGHT DATUM
COMM DATA HAVE NOT BEEN MICROLEVELLED
COMM
COMM ELECTROMAGNETIC DATA
COMM SYSTEM PARALLAX REMOVED, AS FOLLOWS:
COMM    X-COMPONENT EM DATA                                          6 s
COMM    Z-COMPONENT EM DATA                                          6 s
COMM DATA CORRECTED FOR TRANSMITTER HEIGHT, PITCH AND ROLL
COMM DATA CORRECTED FOR TRANSMITTER-RECEIVER GEOMETRY VARIATIONS
COMM DATA HAVE BEEN NOT MICROLEVELLED
COMM CONDUCTIVITY DEPTH INVERSION CALCULATED               EMFlow V5.10
COMM CONDUCTIVITY DEPTH RANGE                               000 - 500 m
COMM CONDUCTIVITY DEPTH INTERVAL                                     5 m
COMM CONDUCTIVITIES CALCULATED USING HPRG CORRECTED EM X and Z DATA
COMM
COMM ----------------------------------------------------------------------
COMM DISCLAIMER
COMM ----------------------------------------------------------------------
COMM It is CGG Aviation's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without CGG Aviation's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by CGG Aviation exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and CGG Aviation
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved CGG Aviation's use of any
COMM information provided by the Client or third parties, upon which
COMM CGG Aviation was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information.
```

```
COMM CGG Aviation is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and CGG Aviation.
COMM
COMM With regard to DIGITAL TERRAIN DATA, the accuracy of the elevation
COMM calculation is directly dependent on the accuracy of the two input
COMM parameters laser altitude and GPS altitude. The laser and radar altitude
COMM value may be erroneous in areas of heavy tree cover, where the altimeters
COMM reflect the distance to the tree canopy rather than the ground. The GPS
COMM altitude value is primarily dependent on the number of available satellites.
COMM Although post-processing of GPS data will yield X and Y accuracies in the
COMM order of 1-2 metres, the accuracy of the altitude value is usually
COMM much less, sometimes in the ±5 metre range.  Further inaccuracies
COMM may be introduced during the interpolation and gridding process.
COMM Because of the inherent inaccuracies of this method, no guarantee is
COMM made or implied that the information displayed is a true
COMM representation of the height above sea level.  Although this product
COMM may be of some use as a general reference,
COMM THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.
COMM -----------------------------------------------------------------------
COMM
COMM ELECTROMAGNETIC SYSTEM
COMM
COMM TEMPEST IS A TIME-DOMAIN SQUARE-WAVE SYSTEM,
COMM TRANSMITTING AT A BASE FREQUENCY OF 25Hz,
COMM WITH 2 ORTHOGONAL-AXIS RECEIVER COILS IN A TOWED BIRD.
COMM FINAL EM OUTPUT IS RECORDED 5 TIMES PER SECOND.
COMM THE TIMES (IN MILLISECONDS) FOR THE 15 WINDOWS ARE:
COMM
COMM WINDOW      START       END      CENTRE
COMM    1        0.007      0.020      0.013
COMM    2        0.033      0.047      0.040
COMM    3        0.060      0.073      0.067
COMM    4        0.087      0.127      0.107
COMM    5        0.140      0.207      0.173
COMM    6        0.220      0.340      0.280
COMM    7        0.353      0.553      0.453
COMM    8        0.567      0.873      0.720
COMM    9        0.887      1.353      1.120
COMM   10        1.367      2.100      1.733
COMM   11        2.113      3.273      2.693
COMM   12        3.287      5.113      4.200
COMM   13        5.127      7.993      6.560
COMM   14        8.007     12.393     10.200
COMM   15       12.407     19.993     16.200
```

```
COMM
COMM PULSE WIDTH: 10 ms
COMM
COMM TEMPEST EM data are transformed to the response that would be
COMM obtained with a B-field sensor for a 100% duty cycle square
COMM waveform at the base frequency, involving a 1A change in
COMM current (from -0.5A to +0.5A to -0.5A) in a 1sq.m transmitter.
COMM It is this configuration, rather than the actual acquisition
COMM configuration, which must be specified when modelling TEMPEST data.
COMM
COMM
COMM LOCATED DATA FORMAT
COMM
COMM Output field format: ASCII ASEG-GDF
COMM
COMM
COMM FIELD     CHANNEL          Description                                  UNITS    NULL           FORMAT
COMM     0     Line             Line Number                                           -99999999      I10
COMM     1     Flight           Flight Number                                         -99            I4
COMM     2     Fiducial         Fiducial Number                                       -999999.9      F8.1
COMM     3     Project_CGG      CGG Project Number                                    -9999          I6
COMM     4     Project_GA       GA Project Number                                     -9999          I6
COMM     5     Aircraft         Aircraft System Number                                -9             I3
COMM     6     Date             Date (yyyymmdd)                                       -9999999       I9
COMM     7     Time             Time - Local Midnight                        s        -9999.9        F8.1
COMM     8     Time_Secs_Week   GPS Seconds Of Week                          s        -9999.9        F10.1
COMM     9     Bearing          Line Bearing                                 deg      -99            I4
COMM    10     Latitude         Latitude, Datum: GDA94                       deg      -99.9999999    F12.7
COMM    11     Longitude        Longitude, Datum: GDA94                      deg      -999.9999999   F13.7
COMM    12     Easting          Easting, Projection: GDA94/MGA50             m        -99999.99      F10.2
COMM    13     Northing         Northing, Projection: GDA94/MGA50            m        -999999.99     F11.2
COMM    14     Pressure         Barometric Pressure                          hPa      -9999.99       F9.2
COMM    15     Temperature      Temperature                                  degC     -999.99        F8.2
COMM    16     Lidar_Raw        Raw Laser Altimeter                          m        -999.99        F8.2
COMM    17     Lidar            Final Laser Altimeter                        m        -999.99        F8.2
COMM    18     Radalt           Final Radar Altimeter                        m        -999.99        F8.2
COMM    19     Tx_Elevation     Final Tx Elevation, Datum: GDA94 Ellipsoid   m        -999.99        F8.2
COMM    20     GPSalt           GPS Altitude                                 m        -99999.99      F10.2
COMM    21     GPSalt_AHD       GPS Altitude (AHD)                           m        -99999.99      F10.2
COMM    22     DTM_AHD          Digital Terrain Model (AHD)                  m        -999.99        F8.2
COMM    23     DTM              Final Ground Elevation (AHD)                 m        -999.99        F8.2
COMM    24     FluxgateX        Fluxgate X Component                         nT       -9999999.99    F12.2
COMM    25     FluxgateY        Fluxgate Y Component                         nT       -9999999.99    F12.2
COMM    26     FluxgateZ        Fluxgate Z Component                         nT       -9999999.99    F12.2
COMM    27     Diurnal          Diurnal                                      nT       -99999.999     F11.3
```

COMM	28	UnCompMag	Uncompensated TMI	nT	-99999.999	F11.3
COMM	29	CompMag	Compensated TMI	nT	-99999.999	F11.3
COMM	30	Mag	Final TMI	nT	-99999.999	F11.3
COMM	31	Tx_Roll	Tx Loop Roll	deg	-999.99	F8.2
COMM	32	Tx_Pitch	Tx Loop Pitch	deg	-999.99	F8.2
COMM	33	Tx_Clearance	Transmitter Terrain Clearance	m	-999.99	F8.2
COMM	34	HSep_Raw	Tx-Rx Horizontal Separation	m	-999.99	F8.2
COMM	35	VSep_Raw	Tx-Rx Vertical Separation	m	-999.99	F8.2
COMM	36	HSep_gps	Tx-Rx Horizontal GPS Separation	m	-999.99	F8.2
COMM	37	VSep_gps	Tx-Rx Vertical GPS Separation	m	-999.99	F8.2
COMM	38	TSep_gps	Tx-Rx Transverse GPS Separation	m	-999.99	F8.2
COMM	39	HSep_std	Tx-Rx HPRG Horizontal Separation	m	-999.99	F8.2
COMM	40	VSep_std	Tx-Rx HPRG Vertical Separation	m	-999.99	F8.2
COMM	41	Tx_Clearance_std	Tx HPRG Terrain Clearance	m	-999.99	F8.2
COMM	42	Flag_Birdgps	Flag Channel For Missing Bird GPS Data		-99	I2
COMM	43	EMX_nonhprg[1:15]	Raw (non-HPRG) EMX Windows	fT	-999.999999	15 F12.6
COMM	44	EMZ_nonhprg[1:15]	Raw (non-HPRG) EMZ Windows	fT	-999.999999	15 F12.6
COMM	45	EMX_hprg[1:15]	Final HPRG EMX Windows	fT	-999.999999	15 F12.6
COMM	46	EMZ_hprg[1:15]	Final HPRG EMZ Windows	fT	-999.999999	15 F12.6
COMM	47	EMX_final[1:15]	Final HPRG EMX Windows	fT	-999.999999	15 F12.6
COMM	48	EMZ_final[1:15]	Final HPRG EMZ Windows	fT	-999.999999	15 F12.6
COMM	49	X_Geofact	Geometry factor - X component		-9999.999	F10.3
COMM	50	Z_Geofact	Geometry factor - Z component		-9999.999	F10.3
COMM	51	X_LowFreq	Low Frequency monitor - X component		-9999.999	F10.3
COMM	52	Z_LowFreq	Low Frequency monitor - Z component		-9999.999	F10.3
COMM	53	X_PrimaryField	Primary Field - X Component	fT	-99.9999999	F12.7
COMM	54	Z_PrimaryField	Primary Field - Z Component	fT	-99.9999999	F12.7
COMM	55	X_Powerline	Powerline - X component		-9999.999	F10.3
COMM	56	Z_Powerline	Powerline - Z component		-9999.999	F10.3
COMM	57	X_Sferics	Sferics - X component		-9999.999	F10.3
COMM	58	Z_Sferics	Sferics - Z component		-9999.999	F10.3
COMM	59	X_VLF1	18.2kHz monitor - X component		-9999.999	F10.3
COMM	60	Z_VLF1	18.2kHz monitor - Z component		-9999.999	F10.3
COMM	61	X_VLF2	19.8kHz monitor - X component		-9999.999	F10.3
COMM	62	Z_VLF2	19.8kHz monitor - Z component		-9999.999	F10.3
COMM	63	X_VLF3	21.4kHz monitor - X component		-9999.999	F10.3
COMM	64	Z_VLF3	21.4kHz monitor - Z component		-9999.999	F10.3
COMM	65	X_VLF4	22.2kHz monitor - X component		-9999.999	F10.3
COMM	66	Z_VLF4	22.2kHz monitor - Z component		-9999.999	F10.3

9.1.3 Capricorn Regional Survey – Final Time Domain EM Data (Zero Lines)

COMM CGG PROJECT NUMBER 2446

```
COMM AREA NUMBER:                                                         1
COMM SURVEY COMPANY:                                CGG Aviation Australia
COMM CLIENT:                                                             GA
COMM SURVEY TYPE:                                     25Hz TEMPEST Survey
COMM AREA NAME:                                                   Capricorn
COMM STATE:                                                              WA
COMM COUNTRY:                                                     Australia
COMM SURVEY FLOWN:                           October 2013 to January 2014
COMM LOCATED DATA CREATED:                                       April 2014
COMM
COMM DATUM:                                                           GDA94
COMM PROJECTION:                                                        MGA
COMM ZONE:                                                               50
COMM
COMM ZERO SURVEY SPECIFICATIONS
COMM
COMM LINE DIRECTION:                                                Various
COMM
COMM PRE ZERO LINE NUMBERS:                           L9020002 - L9020059
COMM POST ZERO LINE NUMBERS:                          L9050002 - L9050059
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                           CASA 212, VH-TEM
COMM
COMM MAGNETOMETER:                              Scintrex Cs-2 Cesium Vapour
COMM INSTALLATION:                                         Stinger mounted
COMM RESOLUTION:                                                   0.001 nT
COMM RECORDING INTERVAL:                                              0.2 s
COMM
COMM ELECTROMAGNETIC SYSTEM:                                   25Hz TEMPEST
COMM INSTALLATION:                 Transmitter loop mounted on the aircraft
COMM                                           Receiver coils in a towed bird
COMM COIL ORIENTATION:                                                  X,Z
COMM RECORDING INTERVAL:                                              0.2 s
COMM SYSTEM GEOMETRY:
COMM HPRG CORRECTED RECEIVER DISTANCE BEHIND THE TRANSMITTER:         117 m
COMM HPRG CORRECTED RECEIVER DISTANCE BELOW THE TRANSMITTER:         41.5 m
COMM
COMM RADAR ALTIMETER:                                          Sperry RT200
COMM RECORDING INTERVAL:                                              0.1 s
COMM
COMM LASER ALTIMETER:                                        Riegl LD90-3300
COMM RECORDING INTERVAL:                                              0.1 s
COMM
```

```
COMM NAVIGATION:                                Real-time differential GPS
COMM RECORDING INTERVAL:                                             1.0 s
COMM
COMM ACQUISITION SYSTEM:                                            FASDAS
COMM
COMM DATA PROCESSING
COMM
COMM MAGNETIC DATA
COMM DIURNAL CORRECTION APPLIED                       base value 53500 nT
COMM PARALLAX CORRECTION APPLIED                                      0 s
COMM IGRF CORRECTION APPLIED                          base value 54182 nT
COMM IGRF MODEL EXTRAPOLATED TO                                2013/10/17
COMM DATA HAVE NOT BEEN MICROLEVELLED
COMM
COMM TERRAIN CLEARANCE DATA
COMM LASER ALTIMETER: PARALLAX CORRECTION APPLIED                    0 s
COMM RADAR ALTIMETER: PARALLAX CORRECTION APPLIED                    0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM
COMM DIGITAL TERRAIN DATA
COMM DTM CALCULATED [DTM = GPS ALTITUDE - (LASER ALT + SENSOR SEPARATION)]
COMM DATA CORRECTED TO AUSTRALIAN HEIGHT DATUM
COMM DATA HAVE NOT BEEN MICROLEVELLED
COMM
COMM ELECTROMAGNETIC DATA
COMM SYSTEM PARALLAX REMOVED, AS FOLLOWS:
COMM    X-COMPONENT EM DATA                                         6 s
COMM    Z-COMPONENT EM DATA                                         6 s
COMM DATA CORRECTED FOR TRANSMITTER HEIGHT, PITCH AND ROLL
COMM DATA CORRECTED FOR TRANSMITTER-RECEIVER GEOMETRY VARIATIONS
COMM DATA HAVE NOT BEEN MICROLEVELLED
COMM CONDUCTIVITY DEPTH INVERSION CALCULATED                EMFlow V5.10
COMM CONDUCTIVITY DEPTH RANGE                                000 - 500 m
COMM CONDUCTIVITY DEPTH INTERVAL                                    5 m
COMM CONDUCTIVITIES CALCULATED USING HPRG CORRECTED EM X and Z DATA
COMM
COMM ----------------------------------------------------------------------
COMM DISCLAIMER
COMM ----------------------------------------------------------------------
COMM It is CGG Aviation’s understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
```

```
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without CGG Aviation's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by CGG Aviation exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and CGG Aviation
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved CGG Aviation's use of any
COMM information provided by the Client or third parties, upon which
COMM CGG Aviation was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information.
COMM CGG Aviation is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and CGG Aviation.
COMM
COMM With regard to DIGITAL TERRAIN DATA, the accuracy of the elevation
COMM calculation is directly dependent on the accuracy of the two input
COMM parameters laser altitude and GPS altitude. The laser and radar altitude
COMM value may be erroneous in areas of heavy tree cover, where the altimeters
COMM reflect the distance to the tree canopy rather than the ground. The GPS
COMM altitude value is primarily dependent on the number of available satellites.
COMM Although post-processing of GPS data will yield X and Y accuracies in the
COMM order of 1-2 metres, the accuracy of the altitude value is usually
COMM much less, sometimes in the ±5 metre range.  Further inaccuracies
COMM may be introduced during the interpolation and gridding process.
COMM Because of the inherent inaccuracies of this method, no guarantee is
COMM made or implied that the information displayed is a true
COMM representation of the height above sea level.  Although this product
COMM may be of some use as a general reference,
COMM THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.
COMM -----------------------------------------------------------------------
COMM
COMM ELECTROMAGNETIC SYSTEM
COMM
COMM TEMPEST IS A TIME-DOMAIN SQUARE-WAVE SYSTEM,
COMM TRANSMITTING AT A BASE FREQUENCY OF 25Hz,
COMM WITH 2 ORTHOGONAL-AXIS RECEIVER COILS IN A TOWED BIRD.
COMM FINAL EM OUTPUT IS RECORDED 5 TIMES PER SECOND.
COMM THE TIMES (IN MILLISECONDS) FOR THE 15 WINDOWS ARE:
COMM
COMM WINDOW      START       END      CENTRE
```

```
COMM   1       0.007     0.020     0.013
COMM   2       0.033     0.047     0.040
COMM   3       0.060     0.073     0.067
COMM   4       0.087     0.127     0.107
COMM   5       0.140     0.207     0.173
COMM   6       0.220     0.340     0.280
COMM   7       0.353     0.553     0.453
COMM   8       0.567     0.873     0.720
COMM   9       0.887     1.353     1.120
COMM  10       1.367     2.100     1.733
COMM  11       2.113     3.273     2.693
COMM  12       3.287     5.113     4.200
COMM  13       5.127     7.993     6.560
COMM  14       8.007    12.393    10.200
COMM  15      12.407    19.993    16.200
COMM
COMM PULSE WIDTH: 10 ms
COMM
COMM TEMPEST EM data are transformed to the response that would be
COMM obtained with a B-field sensor for a 100% duty cycle square
COMM waveform at the base frequency, involving a 1A change in
COMM current (from -0.5A to +0.5A to -0.5A) in a 1sq.m transmitter.
COMM It is this configuration, rather than the actual acquisition
COMM configuration, which must be specified when modelling TEMPEST data.
COMM
COMM
COMM LOCATED DATA FORMAT
COMM
COMM Output field format: ASCII ASEG-GDF
COMM
COMM
COMM FIELD      CHANNEL            Description                              UNITS     NULL            FORMAT
COMM        0    Line               Line Number                                        -99999999       I10
COMM        1    Flight             Flight Number                                      -99             I4
COMM        2    Fiducial           Fiducial Number                                    -999999.9       F8.1
COMM        3    Project_CGG        CGG Project Number                                 -9999           I6
COMM        4    Project_GA         GA Project Number                                  -9999           I6
COMM        5    Aircraft           Aircraft System Number                             -9              I3
COMM        6    Date               Date (yyyymmdd)                                    -9999999        I9
COMM        7    Time               Time - Local Midnight                     s        -9999.9         F8.1
COMM        8    Time_Secs_Week     GPS Seconds Of Week                       s        -9999.9         F10.1
COMM        9    Bearing            Line Bearing                              deg      -99             I4
COMM       10    Latitude           Latitude, Datum: GDA94                    deg      -99.9999999     F12.7
COMM       11    Longitude          Longitude, Datum: GDA94                   deg      -999.9999999    F13.7
COMM       12    Easting            Easting, Projection: GDA94/MGA50          m        -99999.99       F10.2
```

COMM	13	Northing	Northing, Projection: GDA94/MGA50	m	-999999.99	F11.2
COMM	14	Pressure	Barometric Pressure	hPa	-9999.99	F9.2
COMM	15	Temperature	Temperature	degC	-999.99	F8.2
COMM	16	Lidar_Raw	Raw Laser Altimeter	m	-999.99	F8.2
COMM	17	Lidar	Final Laser Altimeter	m	-999.99	F8.2
COMM	18	Radalt	Final Radar Altimeter	m	-999.99	F8.2
COMM	19	Tx_Elevation	Final Tx Elevation, Datum: GDA94 Ellipsoid	m	-999.99	F8.2
COMM	20	GPSalt	GPS Altitude	m	-99999.99	F10.2
COMM	21	GPSalt_AHD	GPS Altitude (AHD)	m	-99999.99	F10.2
COMM	22	DTM_AHD	Digital Terrain Model (AHD)	m	-999.99	F8.2
COMM	23	DTM	Final Ground Elevation (AHD)	m	-999.99	F8.2
COMM	24	FluxgateX	Fluxgate X Component	nT	-9999999.99	F12.2
COMM	25	FluxgateY	Fluxgate Y Component	nT	-9999999.99	F12.2
COMM	26	FluxgateZ	Fluxgate Z Component	nT	-9999999.99	F12.2
COMM	27	Diurnal	Diurnal	nT	-99999.999	F11.3
COMM	28	UnCompMag	Uncompensated TMI	nT	-99999.999	F11.3
COMM	29	CompMag	Compensated TMI	nT	-99999.999	F11.3
COMM	30	Mag	Final TMI	nT	-99999.999	F11.3
COMM	31	Tx_Roll	Tx Loop Roll	deg	-999.99	F8.2
COMM	32	Tx_Pitch	Tx Loop Pitch	deg	-999.99	F8.2
COMM	33	Tx_Clearance	Transmitter Terrain Clearance	m	-999.99	F8.2
COMM	34	HSep_Raw	Tx-Rx Horizontal Separation	m	-999.99	F8.2
COMM	35	VSep_Raw	Tx-Rx Vertical Separation	m	-999.99	F8.2
COMM	36	HSep_gps	Tx-Rx Horizontal GPS Separation	m	-999.99	F8.2
COMM	37	VSep_gps	Tx-Rx Vertical GPS Separation	m	-999.99	F8.2
COMM	38	TSep_gps	Tx-Rx Transverse GPS Separation	m	-999.99	F8.2
COMM	39	HSep_std	Tx-Rx HPRG Horizontal Separation	m	-999.99	F8.2
COMM	40	VSep_std	Tx-Rx HPRG Vertical Separation	m	-999.99	F8.2
COMM	41	Tx_Clearance_std	Tx HPRG Terrain Clearance	m	-999.99	F8.2
COMM	42	Flag_Birdgps	Flag Channel For Missing Bird GPS Data		-99	I2
COMM	43	EMX_nonhprg[1:15]	Raw (non-HPRG) EMX Windows	fT	-999.999999	15 F12.6
COMM	44	EMZ_nonhprg[1:15]	Raw (non-HPRG) EMZ Windows	fT	-999.999999	15 F12.6
COMM	45	EMX_hprg[1:15]	Final HPRG EMX Windows	fT	-999.999999	15 F12.6
COMM	46	EMZ_hprg[1:15]	Final HPRG EMZ Windows	fT	-999.999999	15 F12.6
COMM	47	EMX_final[1:15]	Final HPRG EMX Windows	fT	-999.999999	15 F12.6
COMM	48	EMZ_final[1:15]	Final HPRG EMZ Windows	fT	-999.999999	15 F12.6
COMM	49	X_Geofact	Geometry factor - X component		-9999.999	F10.3
COMM	50	Z_Geofact	Geometry factor - Z component		-9999.999	F10.3
COMM	51	X_LowFreq	Low Frequency monitor - X component		-9999.999	F10.3
COMM	52	Z_LowFreq	Low Frequency monitor - Z component		-9999.999	F10.3
COMM	53	X_PrimaryField	Primary Field - X Component	fT	-99.9999999	F12.7
COMM	54	Z_PrimaryField	Primary Field - Z Component	fT	-99.9999999	F12.7
COMM	55	X_Powerline	Powerline - X component		-9999.999	F10.3
COMM	56	Z_Powerline	Powerline - Z component		-9999.999	F10.3
COMM	57	X_Sferics	Sferics - X component		-9999.999	F10.3

COMM	58	Z_Sferics	Sferics - Z component	-9999.999	F10.3
COMM	59	X_VLF1	18.2kHz monitor - X component	-9999.999	F10.3
COMM	60	Z_VLF1	18.2kHz monitor - Z component	-9999.999	F10.3
COMM	61	X_VLF2	19.8kHz monitor - X component	-9999.999	F10.3
COMM	62	Z_VLF2	19.8kHz monitor - Z component	-9999.999	F10.3
COMM	63	X_VLF3	21.4kHz monitor - X component	-9999.999	F10.3
COMM	64	Z_VLF3	21.4kHz monitor - Z component	-9999.999	F10.3
COMM	65	X_VLF4	22.2kHz monitor - X component	-9999.999	F10.3
COMM	66	Z_VLF4	22.2kHz monitor - Z component	-9999.999	F10.3

9.1.4 Capricorn Regional Survey – Final Conductivity Data

COMM CGG PROJECT NUMBER	2446
COMM AREA NUMBER:	1
COMM SURVEY COMPANY:	CGG Aviation Australia
COMM CLIENT:	GA
COMM SURVEY TYPE:	25Hz TEMPEST Survey
COMM AREA NAME:	Capricorn
COMM STATE:	WA
COMM COUNTRY:	Australia
COMM SURVEY FLOWN:	October 2013 to January 2014
COMM LOCATED DATA CREATED:	April 2014
COMM	
COMM DATUM:	GDA94
COMM PROJECTION:	MGA
COMM ZONE:	50
COMM	
COMM SURVEY SPECIFICATIONS	
COMM	
COMM LINE SPACING:	5000 m
COMM LINE DIRECTION:	Various
COMM NOMINAL TERRAIN CLEARANCE:	120 m
COMM FINAL LINE KILOMETRES:	30119 km
COMM	
COMM LINE NUMBERING	
COMM	
COMM SURVEY LINE NUMBERS:	L10001 - L10102
COMM	L10116 - L10157
COMM	L10166 - L10167
COMM	
COMM SURVEY EQUIPMENT	
COMM	
COMM AIRCRAFT:	CASA 212, VH-TEM

```
COMM
COMM MAGNETOMETER:                              Scintrex Cs-2 Cesium Vapour
COMM INSTALLATION:                                          Stinger mounted
COMM RESOLUTION:                                                   0.001 nT
COMM RECORDING INTERVAL:                                              0.2 s
COMM
COMM ELECTROMAGNETIC SYSTEM:                                   25Hz TEMPEST
COMM INSTALLATION:                   Transmitter loop mounted on the aircraft
COMM                                          Receiver coils in a towed bird
COMM COIL ORIENTATION:                                                  X,Z
COMM RECORDING INTERVAL:                                              0.2 s
COMM SYSTEM GEOMETRY:
COMM HPRG CORRECTED RECEIVER DISTANCE BEHIND THE TRANSMITTER:         117 m
COMM HPRG CORRECTED RECEIVER DISTANCE BELOW THE TRANSMITTER:         41.5 m
COMM
COMM RADAR ALTIMETER:                                          Sperry RT200
COMM RECORDING INTERVAL:                                              0.1 s
COMM
COMM LASER ALTIMETER:                                        Riegl LD90-3300
COMM RECORDING INTERVAL:                                              0.1 s
COMM
COMM NAVIGATION:                                  Real-time differential GPS
COMM RECORDING INTERVAL:                                              1.0 s
COMM
COMM ACQUISITION SYSTEM:                                             FASDAS
COMM
COMM DATA PROCESSING
COMM
COMM MAGNETIC DATA
COMM DIURNAL CORRECTION APPLIED                        base value 53500 nT
COMM PARALLAX CORRECTION APPLIED                                       0 s
COMM IGRF CORRECTION APPLIED                           base value 54182 nT
COMM IGRF MODEL EXTRAPOLATED TO                                 2013/10/17
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM TERRAIN CLEARANCE DATA
COMM LASER ALTIMETER: PARALLAX CORRECTION APPLIED                     0 s
COMM RADAR ALTIMETER: PARALLAX CORRECTION APPLIED                     0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                      0 s
COMM
COMM DIGITAL TERRAIN DATA
COMM DTM CALCULATED [DTM = GPS ALTITUDE - (LASER ALT + SENSOR SEPARATION)]
COMM DATA CORRECTED TO AUSTRALIAN HEIGHT DATUM
```

```
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM ELECTROMAGNETIC DATA
COMM SYSTEM PARALLAX REMOVED, AS FOLLOWS:
COMM    X-COMPONENT EM DATA                                       6 s
COMM    Z-COMPONENT EM DATA                                       6 s
COMM DATA CORRECTED FOR TRANSMITTER HEIGHT, PITCH AND ROLL
COMM DATA CORRECTED FOR TRANSMITTER-RECEIVER GEOMETRY VARIATIONS
COMM DATA HAVE BEEN MICROLEVELLED
COMM CONDUCTIVITY DEPTH INVERSION CALCULATED                EMFlow V5.10
COMM CONDUCTIVITY DEPTH RANGE                                000 - 500 m
COMM CONDUCTIVITY DEPTH INTERVAL                                    5 m
COMM CONDUCTIVITIES CALCULATED USING HPRG CORRECTED EM X and Z DATA
COMM
COMM ---------------------------------------------------------------------
COMM DISCLAIMER
COMM ---------------------------------------------------------------------
COMM It is CGG Aviation's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without CGG Aviation's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by CGG Aviation exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and CGG Aviation
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved CGG Aviation's use of any
COMM information provided by the Client or third parties, upon which
COMM CGG Aviation was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information.
COMM CGG Aviation is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and CGG Aviation.
COMM
COMM With regard to DIGITAL TERRAIN DATA, the accuracy of the elevation
COMM calculation is directly dependent on the accuracy of the two input
COMM parameters laser altitude and GPS altitude. The laser and radar altitude
COMM value may be erroneous in areas of heavy tree cover, where the altimeters
COMM reflect the distance to the tree canopy rather than the ground. The GPS
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```
COMM altitude value is primarily dependent on the number of available satellites.
COMM Although post-processing of GPS data will yield X and Y accuracies in the
COMM order of 1-2 metres, the accuracy of the altitude value is usually
COMM much less, sometimes in the ±5 metre range.  Further inaccuracies
COMM may be introduced during the interpolation and gridding process.
COMM Because of the inherent inaccuracies of this method, no guarantee is
COMM made or implied that the information displayed is a true
COMM representation of the height above sea level.  Although this product
COMM may be of some use as a general reference,
COMM THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.
COMM -----------------------------------------------------------------------
COMM
COMM ELECTROMAGNETIC SYSTEM
COMM
COMM TEMPEST IS A TIME-DOMAIN SQUARE-WAVE SYSTEM,
COMM TRANSMITTING AT A BASE FREQUENCY OF 25Hz,
COMM WITH 2 ORTHOGONAL-AXIS RECEIVER COILS IN A TOWED BIRD.
COMM FINAL EM OUTPUT IS RECORDED 5 TIMES PER SECOND.
COMM THE TIMES (IN MILLISECONDS) FOR THE 15 WINDOWS ARE:
COMM
COMM WINDOW      START       END       CENTRE
COMM    1        0.007      0.020      0.013
COMM    2        0.033      0.047      0.040
COMM    3        0.060      0.073      0.067
COMM    4        0.087      0.127      0.107
COMM    5        0.140      0.207      0.173
COMM    6        0.220      0.340      0.280
COMM    7        0.353      0.553      0.453
COMM    8        0.567      0.873      0.720
COMM    9        0.887      1.353      1.120
COMM   10        1.367      2.100      1.733
COMM   11        2.113      3.273      2.693
COMM   12        3.287      5.113      4.200
COMM   13        5.127      7.993      6.560
COMM   14        8.007     12.393     10.200
COMM   15       12.407     19.993     16.200
COMM
COMM PULSE WIDTH: 10 ms
COMM
COMM TEMPEST EM data are transformed to the response that would be
COMM obtained with a B-field sensor for a 100% duty cycle square
COMM waveform at the base frequency, involving a 1A change in
COMM current (from -0.5A to +0.5A to -0.5A) in a 1sq.m transmitter.
COMM It is this configuration, rather than the actual acquisition
COMM configuration, which must be specified when modelling TEMPEST data.
```

```
COMM
COMM
COMM LOCATED DATA FORMAT
COMM
COMM  Output field format : ASCII ASEG-GDF
COMM
COMM   FIELD     CHANNEL               DESCRIPTION                                   UNITS    NULL              FORMAT
COMM       0     Line                  Line Number                                            -99999999         I10
COMM       1     Flight                Flight Number                                          -99               I4
COMM       2     Fiducial              Fiducial Number                                        -999999.9         F8.1
COMM       3     Project_CGG           CGG Project Number                                     -9999             I6
COMM       4     Project_GA            GA Project Number                                      -9999             I6
COMM       5     Aircraft              Aircraft System Number                                 -9                I3
COMM       6     Date                  Date (yyyymmdd)                                        -9999999          I9
COMM       7     Time                  Time - Local Midnight                         s        -9999.9           F8.1
COMM       8     Bearing               Line Bearing                                  deg      -99               I4
COMM       9     Latitude              Latitude, Datum: GDA94                        deg      -99.9999999       F12.7
COMM      10     Longitude             Longitude, Datum: GDA94                       deg      -999.9999999      F13.7
COMM      11     Easting               Easting, Projection: GDA94/MGA50              m        -99999.99         F10.2
COMM      12     Northing              Northing, Projection: GDA94/MGA50             m        -999999.99        F11.2
COMM      13     Lidar                 Final Laser Altimeter                         m        -999.99           F8.2
COMM      14     Radalt                Final Radar Altimeter                         m        -999.99           F8.2
COMM      15     Tx_Elevation          Final Tx Elevation, Datum: GDA94 Ellipsoid    m        -999.99           F8.2
COMM      16     DTM                   Final Ground Elevation (AHD)                  m        -999.99           F8.2
COMM      17     Mag                   Final TMI                                     nT       -99999.999        F11.3
COMM      18     CDI_depth_slice_01    Conductivity depth slice 000-005m             mS/m     -9999.999         F10.3
COMM      19     CDI_depth_slice_02    Conductivity depth slice 005-010m             mS/m     -9999.999         F10.3
COMM      20     CDI_depth_slice_03    Conductivity depth slice 010-015m             mS/m     -9999.999         F10.3
COMM      21     CDI_depth_slice_04    Conductivity depth slice 015-020m             mS/m     -9999.999         F10.3
COMM      22     CDI_depth_slice_05    Conductivity depth slice 020-030m             mS/m     -9999.999         F10.3
COMM      23     CDI_depth_slice_06    Conductivity depth slice 030-040m             mS/m     -9999.999         F10.3
COMM      24     CDI_depth_slice_07    Conductivity depth slice 040-060m             mS/m     -9999.999         F10.3
COMM      25     CDI_depth_slice_08    Conductivity depth slice 060-100m             mS/m     -9999.999         F10.3
COMM      26     CDI_depth_slice_09    Conductivity depth slice 100-150m             mS/m     -9999.999         F10.3
COMM      27     CDI_depth_slice_10    Conductivity depth slice 150-200m             mS/m     -9999.999         F10.3
COMM      28     CND_001               Conductivity 000-005m                         mS/m     -9999.999         F10.3
COMM      29     CND_002               Conductivity 005-010m                         mS/m     -9999.999         F10.3
COMM      30     CND_003               Conductivity 010-015m                         mS/m     -9999.999         F10.3
COMM      31     CND_004               Conductivity 015-020m                         mS/m     -9999.999         F10.3
COMM      32     CND_005               Conductivity 020-025m                         mS/m     -9999.999         F10.3
COMM      33     CND_006               Conductivity 025-030m                         mS/m     -9999.999         F10.3
COMM      34     CND_007               Conductivity 030-035m                         mS/m     -9999.999         F10.3
COMM      35     CND_008               Conductivity 035-040m                         mS/m     -9999.999         F10.3
COMM      36     CND_009               Conductivity 040-045m                         mS/m     -9999.999         F10.3
COMM      37     CND_010               Conductivity 045-050m                         mS/m     -9999.999         F10.3
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COMM	38	CND_011	Conductivity 050-055m	mS/m	-9999.999	F10.3
COMM	39	CND_012	Conductivity 055-060m	mS/m	-9999.999	F10.3
COMM	40	CND_013	Conductivity 060-065m	mS/m	-9999.999	F10.3
COMM	41	CND_014	Conductivity 065-070m	mS/m	-9999.999	F10.3
COMM	42	CND_015	Conductivity 070-075m	mS/m	-9999.999	F10.3
COMM	43	CND_016	Conductivity 075-080m	mS/m	-9999.999	F10.3
COMM	44	CND_017	Conductivity 080-085m	mS/m	-9999.999	F10.3
COMM	45	CND_018	Conductivity 085-090m	mS/m	-9999.999	F10.3
COMM	46	CND_019	Conductivity 090-095m	mS/m	-9999.999	F10.3
COMM	47	CND_020	Conductivity 095-100m	mS/m	-9999.999	F10.3
COMM	48	CND_021	Conductivity 100-105m	mS/m	-9999.999	F10.3
COMM	49	CND_022	Conductivity 105-110m	mS/m	-9999.999	F10.3
COMM	50	CND_023	Conductivity 110-115m	mS/m	-9999.999	F10.3
COMM	51	CND_024	Conductivity 115-120m	mS/m	-9999.999	F10.3
COMM	52	CND_025	Conductivity 120-125m	mS/m	-9999.999	F10.3
COMM	53	CND_026	Conductivity 125-130m	mS/m	-9999.999	F10.3
COMM	54	CND_027	Conductivity 130-135m	mS/m	-9999.999	F10.3
COMM	55	CND_028	Conductivity 135-140m	mS/m	-9999.999	F10.3
COMM	56	CND_029	Conductivity 140-145m	mS/m	-9999.999	F10.3
COMM	57	CND_030	Conductivity 145-150m	mS/m	-9999.999	F10.3
COMM	58	CND_031	Conductivity 150-155m	mS/m	-9999.999	F10.3
COMM	59	CND_032	Conductivity 155-160m	mS/m	-9999.999	F10.3
COMM	60	CND_033	Conductivity 160-165m	mS/m	-9999.999	F10.3
COMM	61	CND_034	Conductivity 165-170m	mS/m	-9999.999	F10.3
COMM	62	CND_035	Conductivity 170-175m	mS/m	-9999.999	F10.3
COMM	63	CND_036	Conductivity 175-180m	mS/m	-9999.999	F10.3
COMM	64	CND_037	Conductivity 180-185m	mS/m	-9999.999	F10.3
COMM	65	CND_038	Conductivity 185-190m	mS/m	-9999.999	F10.3
COMM	66	CND_039	Conductivity 190-195m	mS/m	-9999.999	F10.3
COMM	67	CND_040	Conductivity 195-200m	mS/m	-9999.999	F10.3
COMM	68	CND_041	Conductivity 200-205m	mS/m	-9999.999	F10.3
COMM	69	CND_042	Conductivity 205-210m	mS/m	-9999.999	F10.3
COMM	70	CND_043	Conductivity 210-215m	mS/m	-9999.999	F10.3
COMM	71	CND_044	Conductivity 215-220m	mS/m	-9999.999	F10.3
COMM	72	CND_045	Conductivity 220-225m	mS/m	-9999.999	F10.3
COMM	73	CND_046	Conductivity 225-230m	mS/m	-9999.999	F10.3
COMM	74	CND_047	Conductivity 230-235m	mS/m	-9999.999	F10.3
COMM	75	CND_048	Conductivity 235-240m	mS/m	-9999.999	F10.3
COMM	76	CND_049	Conductivity 240-245m	mS/m	-9999.999	F10.3
COMM	77	CND_050	Conductivity 245-250m	mS/m	-9999.999	F10.3
COMM	78	CND_051	Conductivity 250-255m	mS/m	-9999.999	F10.3
COMM	79	CND_052	Conductivity 255-260m	mS/m	-9999.999	F10.3
COMM	80	CND_053	Conductivity 260-265m	mS/m	-9999.999	F10.3
COMM	81	CND_054	Conductivity 265-270m	mS/m	-9999.999	F10.3
COMM	82	CND_055	Conductivity 270-275m	mS/m	-9999.999	F10.3

COMM	83	CND_056	Conductivity 275-280m	mS/m	-9999.999	F10.3
COMM	84	CND_057	Conductivity 280-285m	mS/m	-9999.999	F10.3
COMM	85	CND_058	Conductivity 285-290m	mS/m	-9999.999	F10.3
COMM	86	CND_059	Conductivity 290-295m	mS/m	-9999.999	F10.3
COMM	87	CND_060	Conductivity 295-300m	mS/m	-9999.999	F10.3
COMM	88	CND_061	Conductivity 300-305m	mS/m	-9999.999	F10.3
COMM	89	CND_062	Conductivity 305-310m	mS/m	-9999.999	F10.3
COMM	90	CND_063	Conductivity 310-315m	mS/m	-9999.999	F10.3
COMM	91	CND_064	Conductivity 315-320m	mS/m	-9999.999	F10.3
COMM	92	CND_065	Conductivity 320-325m	mS/m	-9999.999	F10.3
COMM	93	CND_066	Conductivity 325-330m	mS/m	-9999.999	F10.3
COMM	94	CND_067	Conductivity 330-335m	mS/m	-9999.999	F10.3
COMM	95	CND_068	Conductivity 335-340m	mS/m	-9999.999	F10.3
COMM	96	CND_069	Conductivity 340-345m	mS/m	-9999.999	F10.3
COMM	97	CND_070	Conductivity 345-350m	mS/m	-9999.999	F10.3
COMM	98	CND_071	Conductivity 350-355m	mS/m	-9999.999	F10.3
COMM	99	CND_072	Conductivity 355-360m	mS/m	-9999.999	F10.3
COMM	100	CND_073	Conductivity 360-365m	mS/m	-9999.999	F10.3
COMM	101	CND_074	Conductivity 365-370m	mS/m	-9999.999	F10.3
COMM	102	CND_075	Conductivity 370-375m	mS/m	-9999.999	F10.3
COMM	103	CND_076	Conductivity 375-380m	mS/m	-9999.999	F10.3
COMM	104	CND_077	Conductivity 380-385m	mS/m	-9999.999	F10.3
COMM	105	CND_078	Conductivity 385-390m	mS/m	-9999.999	F10.3
COMM	106	CND_079	Conductivity 390-395m	mS/m	-9999.999	F10.3
COMM	107	CND_080	Conductivity 395-400m	mS/m	-9999.999	F10.3
COMM	108	CND_081	Conductivity 400-405m	mS/m	-9999.999	F10.3
COMM	109	CND_082	Conductivity 405-410m	mS/m	-9999.999	F10.3
COMM	110	CND_083	Conductivity 410-415m	mS/m	-9999.999	F10.3
COMM	111	CND_084	Conductivity 415-420m	mS/m	-9999.999	F10.3
COMM	112	CND_085	Conductivity 420-425m	mS/m	-9999.999	F10.3
COMM	113	CND_086	Conductivity 425-430m	mS/m	-9999.999	F10.3
COMM	114	CND_087	Conductivity 430-435m	mS/m	-9999.999	F10.3
COMM	115	CND_088	Conductivity 435-440m	mS/m	-9999.999	F10.3
COMM	116	CND_089	Conductivity 440-445m	mS/m	-9999.999	F10.3
COMM	117	CND_090	Conductivity 445-450m	mS/m	-9999.999	F10.3
COMM	118	CND_091	Conductivity 450-455m	mS/m	-9999.999	F10.3
COMM	119	CND_092	Conductivity 455-460m	mS/m	-9999.999	F10.3
COMM	120	CND_093	Conductivity 460-465m	mS/m	-9999.999	F10.3
COMM	121	CND_094	Conductivity 465-470m	mS/m	-9999.999	F10.3
COMM	122	CND_095	Conductivity 470-475m	mS/m	-9999.999	F10.3
COMM	123	CND_096	Conductivity 475-480m	mS/m	-9999.999	F10.3
COMM	124	CND_097	Conductivity 480-485m	mS/m	-9999.999	F10.3
COMM	125	CND_098	Conductivity 485-490m	mS/m	-9999.999	F10.3
COMM	126	CND_099	Conductivity 490-495m	mS/m	-9999.999	F10.3
COMM	127	CND_100	Conductivity 495-500m	mS/m	-9999.999	F10.3

10 APPENDIX III – Streamed Data Header Table

10.1 Streamed data header table

Streamed Data File Name	Line Number
HTEM_FLT02_04.raw	10077.0001
HTEM_FLT02_05.raw	10077.0001
HTEM_FLT02_06.raw	10077.0001
HTEM_FLT02_07.raw	10077.0001
HTEM_FLT02_07.raw	10076.0001
HTEM_FLT02_08.raw	10076.0001
HTEM_FLT02_09.raw	10076.0001
HTEM_FLT02_10.raw	10076.0001
HTEM_FLT03_04.raw	10101.0001
HTEM_FLT03_05.raw	10101.0001
HTEM_FLT03_06.raw	10101.0001
HTEM_FLT03_07.raw	10101.0001
HTEM_FLT03_08.raw	10101.0001
HTEM_FLT03_09.raw	10102.0001
HTEM_FLT03_10.raw	10102.0001
HTEM_FLT03_11.raw	10102.0001
HTEM_FLT03_12.raw	10102.0001
HTEM_FLT03_13.raw	10102.0001
HTEM_FLT04_02.raw	10089.0001
HTEM_FLT04_03.raw	10089.0001
HTEM_FLT04_03.raw	10089.0002
HTEM_FLT04_04.raw	10089.0003
HTEM_FLT04_04.raw	10089.0004
HTEM_FLT04_05.raw	10089.0004
HTEM_FLT05_04.raw	10079.0001
HTEM_FLT05_05.raw	10079.0001
HTEM_FLT05_06.raw	10079.0001
HTEM_FLT05_07.raw	10079.0001
HTEM_FLT05_07.raw	10078.0001
HTEM_FLT05_08.raw	10078.0001
HTEM_FLT05_09.raw	10078.0001
HTEM_FLT05_10.raw	10078.0001
HTEM_FLT06_04.raw	10081.0001
HTEM_FLT06_05.raw	10080.0001
HTEM_FLT06_06.raw	10080.0001
HTEM_FLT07_03.raw	10081.0002
HTEM_FLT07_04.raw	10081.0002
HTEM_FLT07_05.raw	10081.0002
HTEM_FLT07_06.raw	10081.0002

HTEM_FLT07_07.raw	10080.0002
HTEM_FLT07_08.raw	10080.0002
HTEM_FLT07_09.raw	10080.0002
HTEM_FLT07_10.raw	10083.0001
HTEM_FLT07_11.raw	10083.0001
HTEM_FLT07_12.raw	10083.0001
HTEM_FLT07_13.raw	10083.0001
HTEM_FLT07_13.raw	10082.0001
HTEM_FLT07_14.raw	10082.0001
HTEM_FLT07_15.raw	10082.0001
HTEM_FLT08_04.raw	10082.0002
HTEM_FLT08_05.raw	10082.0002
HTEM_FLT08_06.raw	10085.0001
HTEM_FLT08_07.raw	10085.0001
HTEM_FLT08_08.raw	10085.0001
HTEM_FLT08_09.raw	10085.0001
HTEM_FLT08_09.raw	10084.0001
HTEM_FLT08_10.raw	10084.0001
HTEM_FLT08_11.raw	10084.0001
HTEM_FLT08_12.raw	10087.0001
HTEM_FLT08_13.raw	10087.0001
HTEM_FLT08_13.raw	10086.0001
HTEM_FLT08_14.raw	10086.0001
HTEM_FLT08_15.raw	10086.0001
HTEM_FLT09_02.raw	10089.0005
HTEM_FLT09_03.raw	10089.0005
HTEM_FLT09_04.raw	10089.0005
HTEM_FLT09_05.raw	10089.0005
HTEM_FLT09_06.raw	10089.0005
HTEM_FLT09_06.raw	10086.0002
HTEM_FLT09_07.raw	10086.0002
HTEM_FLT09_08.raw	10086.0002
HTEM_FLT09_08.raw	10087.0002
HTEM_FLT09_09.raw	10087.0002
HTEM_FLT09_09.raw	10088.0001
HTEM_FLT09_10.raw	10088.0001
HTEM_FLT09_11.raw	10088.0001
HTEM_FLT09_12.raw	10088.0001
HTEM_FLT10_03.raw	10091.0001
HTEM_FLT10_04.raw	10091.0001
HTEM_FLT10_05.raw	10091.0001
HTEM_FLT10_06.raw	10091.0001
HTEM_FLT10_06.raw	10092.0001
HTEM_FLT10_07.raw	10092.0001
HTEM_FLT10_08.raw	10092.0001

HTEM_FLT11_02.raw	10091.0002
HTEM_FLT11_03.raw	10091.0002
HTEM_FLT11_04.raw	10091.0002
HTEM_FLT11_04.raw	10092.0002
HTEM_FLT11_05.raw	10092.0002
HTEM_FLT11_06.raw	10092.0002
HTEM_FLT11_06.raw	10093.0001
HTEM_FLT11_07.raw	10093.0001
HTEM_FLT11_07.raw	10094.0001
HTEM_FLT11_08.raw	10094.0001
HTEM_FLT12_03.raw	10093.0002
HTEM_FLT12_04.raw	10093.0002
HTEM_FLT12_05.raw	10093.0002
HTEM_FLT12_06.raw	10093.0002
HTEM_FLT12_07.raw	10093.0002
HTEM_FLT12_07.raw	10092.0003
HTEM_FLT12_08.raw	10092.0003
HTEM_FLT12_08.raw	10091.0003
HTEM_FLT12_09.raw	10091.0003
HTEM_FLT12_09.raw	10088.0002
HTEM_FLT12_10.raw	10088.0002
HTEM_FLT12_11.raw	10089.0006
HTEM_FLT12_11.raw	10090.0001
HTEM_FLT12_12.raw	10090.0001
HTEM_FLT12_13.raw	10090.0001
HTEM_FLT12_14.raw	10090.0001
HTEM_FLT12_15.raw	10090.0001
HTEM_FLT12_16.raw	10090.0001
HTEM_FLT13_03.raw	10095.0001
HTEM_FLT13_04.raw	10095.0001
HTEM_FLT13_05.raw	10095.0001
HTEM_FLT13_06.raw	10095.0001
HTEM_FLT13_07.raw	10095.0001
HTEM_FLT13_08.raw	10084.0002
HTEM_FLT13_09.raw	10084.0002
HTEM_FLT13_09.raw	10085.0002
HTEM_FLT13_10.raw	10085.0002
HTEM_FLT13_10.raw	10086.0003
HTEM_FLT13_10.raw	10087.0003
HTEM_FLT13_11.raw	10087.0003
HTEM_FLT13_12.raw	10094.0002
HTEM_FLT13_13.raw	10094.0002
HTEM_FLT13_14.raw	10094.0002
HTEM_FLT13_15.raw	10094.0002
HTEM_FLT13_16.raw	10094.0002

HTEM_FLT15_03.raw	10097.0001
HTEM_FLT15_04.raw	10097.0001
HTEM_FLT15_05.raw	10097.0001
HTEM_FLT15_06.raw	10097.0001
HTEM_FLT15_07.raw	10097.0001
HTEM_FLT15_08.raw	10097.0001
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HTEM_FLT52_05.raw	10067.0002
HTEM_FLT52_06.raw	10066.0002
HTEM_FLT52_07.raw	10066.0002
HTEM_FLT52_07.raw	10065.0003
HTEM_FLT52_08.raw	10065.0003
HTEM_FLT52_09.raw	10166.0001
HTEM_FLT52_09.raw	10166.0002
HTEM_FLT52_09.raw	10064.0002
HTEM_FLT52_10.raw	10064.0002
HTEM_FLT52_11.raw	10064.0002

HTEM_FLT52_11.raw	10063.0002
HTEM_FLT52_12.raw	10063.0002
HTEM_FLT52_12.raw	10062.0002
HTEM_FLT52_13.raw	10062.0002
HTEM_FLT52_14.raw	10062.0002
HTEM_FLT53_04.raw	10143.0002
HTEM_FLT53_05.raw	10143.0002
HTEM_FLT53_06.raw	10143.0002
HTEM_FLT53_06.raw	10148.0002
HTEM_FLT53_07.raw	10148.0002
HTEM_FLT53_08.raw	10148.0002
HTEM_FLT53_08.raw	10141.0002
HTEM_FLT53_09.raw	10141.0002
HTEM_FLT53_10.raw	10141.0002
HTEM_FLT53_10.raw	10142.0002
HTEM_FLT53_11.raw	10142.0002
HTEM_FLT53_11.raw	10139.0002
HTEM_FLT53_12.raw	10139.0002
HTEM_FLT53_13.raw	10139.0002
HTEM_FLT53_13.raw	10140.0002
HTEM_FLT53_14.raw	10140.0002
HTEM_FLT53_17.raw	10048.0002
HTEM_FLT53_18.raw	10048.0002
HTEM_FLT54_04.raw	10061.0002
HTEM_FLT54_05.raw	10061.0002
HTEM_FLT54_06.raw	10061.0002
HTEM_FLT54_06.raw	10060.0002
HTEM_FLT54_07.raw	10060.0002
HTEM_FLT54_08.raw	10060.0002
HTEM_FLT54_08.raw	10059.0002
HTEM_FLT54_09.raw	10059.0002
HTEM_FLT54_09.raw	10058.0002
HTEM_FLT54_10.raw	10058.0002
HTEM_FLT54_11.raw	10058.0002
HTEM_FLT55_05.raw	10148.0003
HTEM_FLT55_06.raw	10148.0003
HTEM_FLT55_07.raw	10137.0002
HTEM_FLT55_08.raw	10137.0002
HTEM_FLT55_08.raw	10138.0002
HTEM_FLT55_09.raw	10138.0002
HTEM_FLT55_09.raw	10135.0001
HTEM_FLT55_10.raw	10135.0001
HTEM_FLT55_11.raw	10135.0001
HTEM_FLT55_11.raw	10136.0002
HTEM_FLT55_12.raw	10136.0002

HTEM_FLT55_13.raw	10133.0001
HTEM_FLT55_14.raw	10133.0001
HTEM_FLT55_15.raw	10133.0001
HTEM_FLT55_15.raw	10134.0001
HTEM_FLT55_16.raw	10134.0001
HTEM_FLT55_17.raw	10131.0001
HTEM_FLT55_18.raw	10131.0001
HTEM_FLT56_02.raw	10132.0001
HTEM_FLT56_03.raw	10132.0001
HTEM_FLT56_04.raw	10132.0001
HTEM_FLT57_07.raw	10116.0001
HTEM_FLT57_08.raw	10116.0001
HTEM_FLT57_08.raw	10117.0001
HTEM_FLT57_09.raw	10117.0001
HTEM_FLT57_10.raw	10118.0001
HTEM_FLT57_11.raw	10118.0001
HTEM_FLT57_11.raw	10119.0001
HTEM_FLT57_12.raw	10119.0001
HTEM_FLT57_12.raw	10120.0001
HTEM_FLT57_13.raw	10120.0001
HTEM_FLT57_13.raw	10121.0001
HTEM_FLT57_14.raw	10121.0001
HTEM_FLT57_14.raw	10122.0001
HTEM_FLT57_15.raw	10122.0001
HTEM_FLT57_16.raw	10122.0001
HTEM_FLT57_16.raw	10123.0001
HTEM_FLT57_17.raw	10123.0001
HTEM_FLT57_17.raw	10124.0001
HTEM_FLT57_18.raw	10124.0001
HTEM_FLT57_18.raw	10125.0001
HTEM_FLT57_19.raw	10125.0001
HTEM_FLT58_06.raw	10126.0001
HTEM_FLT58_07.raw	10126.0001
HTEM_FLT58_08.raw	10126.0001
HTEM_FLT58_08.raw	10127.0001
HTEM_FLT58_09.raw	10127.0001
HTEM_FLT58_09.raw	10128.0001
HTEM_FLT58_10.raw	10128.0001
HTEM_FLT58_11.raw	10128.0001
HTEM_FLT58_11.raw	10129.0001
HTEM_FLT58_12.raw	10129.0001
HTEM_FLT58_12.raw	10130.0001
HTEM_FLT58_13.raw	10130.0001
HTEM_FLT58_14.raw	10130.0001
HTEM_FLT58_15.raw	10132.0002

HTEM_FLT58_16.raw	10132.0002
HTEM_FLT58_17.raw	10132.0002
HTEM_FLT59_06.raw	10092.0004
HTEM_FLT59_07.raw	10092.0004
HTEM_FLT59_08.raw	10092.0004

11 APPENDIX IV – CDI section file layout

11.1 CDI section file format

Data type	Scale	Description
Terrain clearance, Pitch and Roll		
Tx_roll	10 degrees/cm	Roll variation of transmitter loop
Tx_pitch	10 degrees/cm	Pitch variation of transmitter loop
Tx_terrain_clearance	20 meters/cm	Terrain clearance of transmitter
X EM Monitors		
22.2kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
21.4kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
19.8kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
18.2kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
powerline	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.3
low_freq	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.2
g\ga	1 unit/cm	Refer to item 6.2.5.2.1
sferics	2000 uV/sq.m.0.2s/cm	Refer to item 6.2.5.3.1
X Windows (asinh(fT))		
X01_0.013ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 1
X02_0.040ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 2
X03_0.067ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 3
X04_0.107ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 4
X05_0.173ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 5
X06_0.280ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 6
X07_0.453ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 7
X08_0.720ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 8
X09_1.120 ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 9
X10_1.733ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 10
X11_2.693ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 11

X12_4.200ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 12
X13_6.560ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 13
X14_10.200ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 14
X15_16.200ms	0.3 asinh(fT)/cm	Arcsinh values for EM X, with relative centre time of window 15
Z EM Monitors		
22.2kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
21.4kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
19.8kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
18.2kHz	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.4
powerline	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.3
low_freq	1 log10(pV/sqrt(Hz)/sq.m)/cm	Refer to item 6.2.5.3.2
g\ga	1 unit/cm	Refer to item 6.2.5.2.1
sferics	2000 uV/sq.m.0.2s/cm	Refer to item 6.2.5.3.1
Z Windows (asinh(fT))		
Z01_0.013ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 1
Z02_0.040ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 2
Z03_0.067ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 3
Z04_0.107ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 4
Z05_0.173ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 5
Z06_0.280ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 6
Z07_0.453ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 7
Z08_0.720ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 8
Z09_1.120 ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 9
Z10_1.733ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 10
Z11_2.693ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 11
Z12_4.200ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 12
Z13_6.560ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 13

Z14_10.200ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 14
Z15_16.200ms	0.3 asinh(fT)/cm	Arcsinh values for EM Z, with relative centre time of window 15
CDI Vertical Section		
Conductivity depth profile	mS/m	Terrain elevation draped CDI
Magnetics		
Vertical_derivative	0.335 nT/m/cm	First vertical derivative value of TMI
Total_magnetic_field	50 nT/cm	Magnetic Field Intensity value

12 APPENDIX V - List of all Supplied Data and Products

12.1 Standard Deliverables

- **Field (Raw) Products**
  - **Raw Located Data** (ASEG-GDF II Format)
    - **2446_1_Capricorn_Mag_data.dat**:
    A flat ASCII file containing the located TMI data for the compensation box flight (Flight 1).
    - **2446_EM_Lag_test_data.dat**:
    A flat ASCII file containing the located EM data for a system lag test flight (Pre job commencement).
    - **2446_1_Capricorn_field_data_repeat_line.dat**:
    A flat ASCII file containing located EM, TMI and digital terrain data for the repeat lines (Sent every flight for the first four production flights, then once every third production flight).
    - **2446_1_Capricorn_field_data_zero_lines_flt** *FFFF* **_flt** *FFFF*.**dat**:
    A flat ASCII file containing located data for the zero lines (Sent weekly during survey).
    Note: FFFF is the flight number.
  - **Raw Digital Products** (PNG Format)
    - CDI plots for all repeat lines (Sent every flight for the first four production flights, then once every third production flight).

- **Raw Products**
  - **Raw Grids** (ERMapper format) (GDA94 MGA50S)
    - Raw EM Channels (X and Z) for all 15 windows.
    - Raw Digital Terrain Model.
    - Raw Total Magnetic Intensity.
  - **Raw Located Data** (ASEG-GDF II Format)
    - **Capricorn_Regional_Raw_field_data_repeat_lines.dat**:
    A flat ASCII file containing located EM, TMI and digital terrain data for the repeat lines.
    - **Capricorn_Regional_Raw_field_data_survey_lines.dat**:
    A flat ASCII file containing located EM, TMI and digital terrain data for all survey lines.
    - **Capricorn_Regional_Raw_field_data_zero_lines.dat**:
    A flat ASCII file containing located EM, TMI and digital terrain data for the high altitude zero lines.
  - **Raw Digital Products**
    - Raw CDI Multiplots for all of the survey lines and repeat lines (PDF Format).

- **Final Products**
  - **Final Grids** (ERMapper format) (GDA94 MGA50S)
    - Digital Terrain Model.
    - Conductivity Depth Slices at set intervals (see section 6.2.8).
    - EM Time Constant for X-component.
    - EM Time Constant for Z-component.
    - Total Magnetic Intensity.
  - **Final Digital Products**
    - Flight Path map (PNG format).
    - Conductivity Depth Image (CDI) Multiplots & Stacked sections for all survey lines (PDF format).

- **Final Located Data** (ASEG-GDF II Format)
    - **EM Data**
        - **Capricorn_Final_EM_Survey_Lines.des**:
          A header file describing the contents of the located data.
        - **Capricorn_Final_EM_Survey_Lines.dat**:
          A flat ASCII file containing located EM, digital terrain data and TMI data.

        - **Capricorn_Final_Repeat_Lines.des**:
          A header file describing the contents of the located data for the repeat lines.
        - **Capricorn_Final_Repeat_Lines.dat**:
          A flat ASCII file containing located EM, TMI and DTM data for the repeat lines.

        - **Capricorn_Final_Zero_Lines.des**:
          A header file describing the contents of the located data for the zero lines.
        - **Capricorn_Final_Zero_Lines.dat**:
          A flat ASCII file containing located EM, TMI and DTM data for the zero lines.

    - **Conductivity Data**
        - **Capricorn_Final_CND_Survey_Lines.des**:
          A header file describing the contents of the located data.
        - **Capricorn_Final_CND_Survey_Lines.dat**:
          A flat ASCII file containing located conductivity and digital terrain data.

- **Acquisition and Processing Report**
    - Delivered both as a hardcover copy and digitally in PDF format.

- **Raw Streamed Data**
    - For each survey flight the raw continuous time series data was delivered as a series of binary (*.raw) files for each traverse and calibration line (each file being a maximum 1GB in size). An associated text file linking the traverse line to the file name accompanied the data.