Arnhem Land, NT

TEMPEST
Geophysical Survey

for

Cameco Australia Pty Ltd

Acquisition and Processing Report

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Authorised for release by : ……………………………..

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Survey flown: November 2003

by

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FAS JOB# 1622

1 Introduction

This report summarises the acquisition and processing of data from the TEMPEST survey flown by Fugro Airborne Surveys (FAS) for the Arnhem Land projects during November of 2003, for Cameco Australia Pty Ltd.

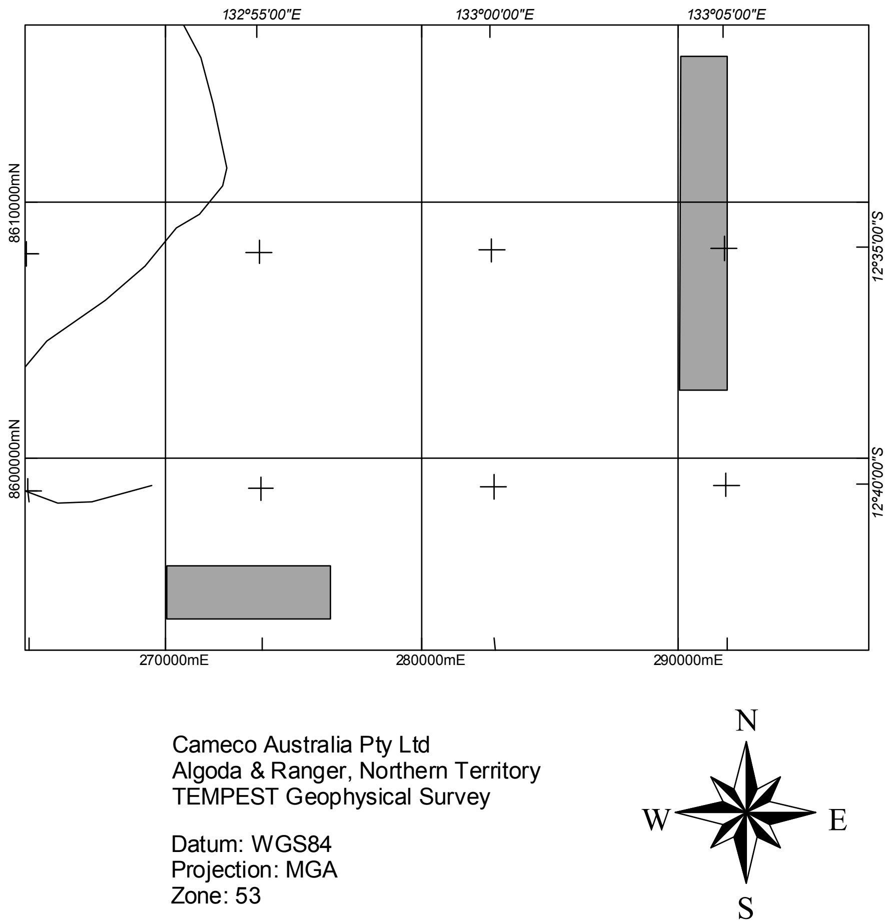
Electromagnetic and elevation data were acquired over the areas shown below. Coordinates are in WGS84.

Algoda survey area 1

	Eastings	Northings
1	290072	8615682
2	291906	8615682
3	291906	8602684
4	290056	8602684

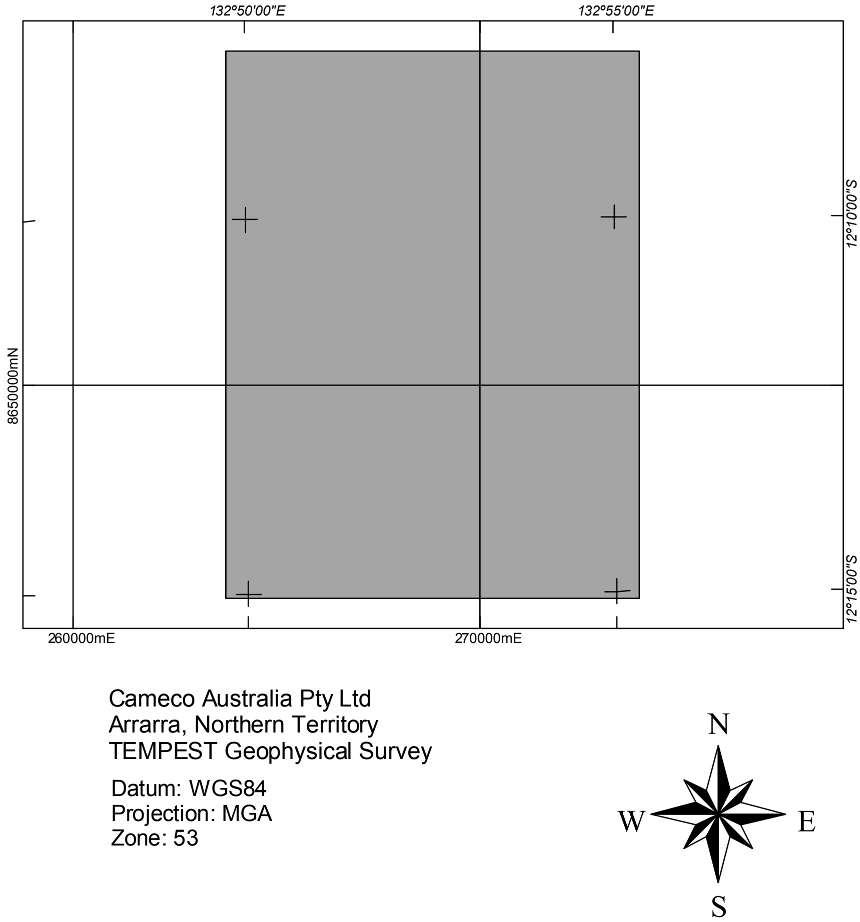
Ranger survey area 7

	Eastings	Northings
1	276446	8595831
2	276446	8593739
3	270047	8593739
4	270047	8595831



Arrarra survey area 2

	Eastings	Northings
1	273940	8658240
2	273940	8644755
3	263765	8644755
4	263765	8658240



Caramal survey area 3

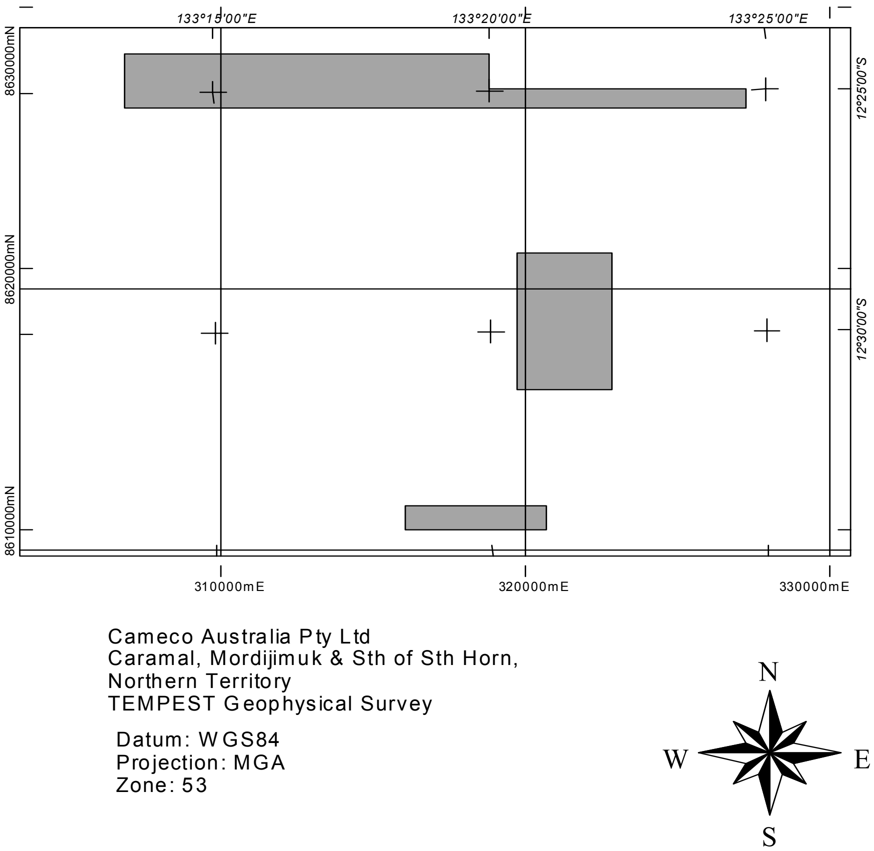
	Eastings	Northings
1	323324	8620717
2	323342	8615088
3	319966	8615088
4	319948	8620737

Mordijimuk survey area 6

	Eastings	Northings
1	306073	8626680
2	306059	8628924
3	319002	8628913
4	319005	8627505
5	328067	8627497
6	328067	8626712
7	318770	8626712

New Area survey area 8

	Eastings	Northings
1	316000	8610300
2	321000	8610300
3	321000	8609300
4	316000	8609300

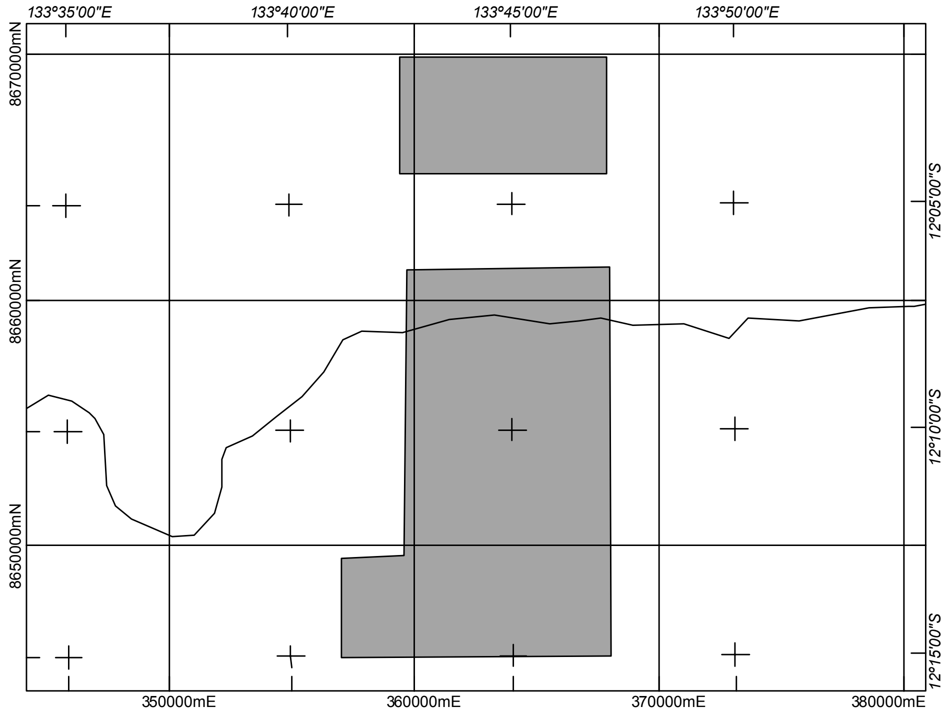


Goomadeer North survey area 4

	Eastings	Northings
1	367832	8669926
2	367832	8665144
3	359397	8665144
4	359397	8669926

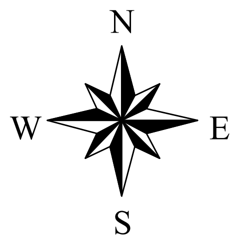
Goomadeer South survey area 5

	Eastings	Northings
1	357037	8645423
2	357037	8649483
3	359589	8649560
4	359674	8661235
5	367966	8661359
6	367997	8645460



Cameco Australia Pty Ltd
Goomadeer N & Goomadeer S, Northern Territory
TEMPEST Geophysical Survey

Datum: WGS84
Projection: MGA
Zone: 53



2 Project Crew

The following personnel were employed for this project:

Field Operations

Processors	Matthew Hope / Daniel Sattel
Airborne Operators & Techs	Scott Miller
Crew Leader	Dave Chappell
Pilots	Tim Haldane / Dave Chappell

Base Operations

Project Manager	Davin Allen
Processing Manager	Andrea Tovey
Data Processing	Matthew Owers

3 Summary of Survey Parameters

3.1 Survey Area Parameters

Fugro Job Number	1622
Survey Company	Fugro Airborne Surveys
Date Flown	2nd November 2003 to 12th November 2003
Client	Cameco Australia Pty Ltd
EM System	25Hz TEMPEST
Aircraft	CASA C212-200 Turbo Prop survey aircraft (VH-TEM)
Navigation	Real-time differential GPS
Datum	AGD66 (AMG, Zone 53)

Area (Name)	Line Spacing	Line Direction	Terrain Clearance	Line kilometres
Area 1 (Algoda)	200 metres	000 – 180	110 metres	133 kilometres
Area 2 (Arrarra)	200 metres	000 – 180	110 metres	702 kilometres
Area 3 (Caramal)	200 metres	000 – 180	110 metres	101 kilometres
Area 4 (Goomadeer North)	200 metres	090 – 270	120 metres	209 kilometres
Area 5 (Goomadeer South)	200 metres	090 – 270	120 metres	733 kilometres
Area 6 (Mordijimuk)	200 metres	090 – 270	120 metres	190 kilometres
Area 7 (Ranger)	200 metres	090 – 270	110 metres	73 kilometres
Area 8 (South of South Horn)	200 metres	090 – 270	110 metres	32 kilometres
Total Line Kilometres				**2173 kilometres**

3.2 Flight Plans

The flight plans are given in Appendix I.

3.3 Standby Days

A total of 2 standby days were accrued.

DATE	REASON
10th November, 2003	Bad weather conditions and sferics
11th November, 2003	Bad weather conditions and sferics

3.4 Job Safety Plan

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

4 Data Acquisition equipment and Specifications

The airborne data acquisition system utilised on this project consists of the following sub-systems:

4.1 Survey Aircraft

A CASA C212-200 Turbo Prop, registration VH-TEM, was used for this survey.

4.2 TEMPEST System Specifications

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

- Base frequency - 25Hz
- Transmitter area - 244m^2
- Transmitter turns - 1
- Waveform - Square
- Duty cycle - 50%
- Transmitter pulse width - 10 ms
- Transmitter off-time - 10 ms
- Peak current - 300 A
- Peak moment - 73,200 Am^2
- Average moment - 36,600 Am^2
- Sample rate - 75 kHz
- Sample interval - 13.33 microseconds
- Samples per half-cycle - 1500
- 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 - 120 m (nominal)
- Tx-Rx vertical separation - 35 m (nominal)
- Stacked data output interval - 200 ms (~12 m)
- Number of output windows - 15
- Window centre times - 13.3 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 - 0.2 nT
- GPS cycle rate - 1 second

4.2.1 EM Receiver and Logging Computer

The EM receiver computer is a Picodas PDAS-1000 data acquisition system. 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 DSP signal processing boards by the timing card, which ensures that all waveform generation and sampling is accomplished with high accuracy. The timing card is synchronised to GPS through the use of the PPS output from the system GPS card.

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.

4.2.2 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.

4.2.3 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.

4.3 PDAS 1000 Survey Computer

The survey computer is a Picodas PDAS-1000 data acquisition system. The survey computer executes a proprietary program for acquisition and recording of location and ancillary data. Data are presented both numerically and graphically in real time on the VGA 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 QC display.

4.3.1 GPS Receiver

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

4.3.2 Differential GPS Demodulator

The OMNISTAR differential GPS service provides real time differential corrections.

4.4 Navigation System

A Picodas PNAV 2001 Navigation Computer is used for real-time navigation. The PNAV computer loads 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 WGS-84 latitude and longitude positional data received from the Novatel GPScard 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 analog HSI indicator. 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 PNAV is interfaced to the SURVEY computer for auto selection and verification of the line to be flown. The GPS information passed to the PNAV 2001 navigation computer is corrected using the received real time differential data, enabling the aircraft to fly as close to the intended track as possible.

4.5 Altimeter System

4.5.1 Radar Altimeter

Model:	Sperry Stars AA-200 radio altimeter system
Sample interval:	1.0 second
Accuracy:	+/- 1.5 % of indicated altitude.

The Sperry radio 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.

4.5.2 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.

4.6 Video Tracking System

The video tape recorded by a PAL VHS colour video system is synchronised with the geophysical record by a digital fiducial display, which is recorded along with GPS latitude and longitude information and survey line number.

4.7 Data Recorded by the Airborne Acquisition Equipment

Raw EM data including fiducial, local time, X, Y, Z axis sensor response, current monitor and bird auxiliary sensor output are recorded on the EM receiver computer as “**G**” EM files.

The Survey computer records all other survey data including GPS data using as “**S**” Survey files, and “**R**” Rover files containing GPS raw range data for post processing.

5 Ground Data Acquisition Equipment

5.1 GPS Base Station System

The GPS base station consists of a Novatel GPS PC card mounted in a portable IBM computer. The computer is connected to a mains UPS backup, with a reserve capacity of approximately 100 minutes, to ensure continuous data logging in the event of mains power interruptions. For this survey, the antenna for the GPS base station was located on the roof of room 2 at the Jabiru Lodge at Jabiru.

The GPS base station was positioned by collecting 36 hours of data at the aircraft and this was used to post correct the base GPS position using GrafNav software.

The calculated GPS base position was (in WGS 84):

Lat: 12° 39′ 52.84775″ S
Long: 132° 50′ 09.70004″ E
Height: 109.270 m

6 EM and other Calibrations and Monitoring

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.

These checks include:-

6.1 Pre-Flight Barometer Calibration: Line C1511

A recording of the barometer output at a known elevation is carried out before take-off to assist with calibration and determination of drift during the flight. The barometer is used as a back-up to the GPS for aircraft altitude.

6.2 Pre-Flight Zero: Line C9001

This manoeuvre is performed once the aircraft is established en route to the survey area. Background EM levels are recorded and assessed by the airborne operator to determine if:-

a. the system noise level is acceptable,
b. the response had not varied significantly from previous flights, and
c. the sferic level is acceptable.

These data are recorded for approximately 90 seconds.

6.3 Pre-Flight Swoops: Line C9002

This manoeuvre is conducted immediately after the pre sortie zero. During this manoeuvre the relative position of the towed sensor is deliberately made to vary relative to the aircraft. The EM data are monitored by the airborne operator to confirm correct operation of the system during the manoeuvre.

6.4 Post-Flight Zero: Line C9003

This calibration is performed immediately following the completion of the survey sorties. Background EM levels are recorded to characterise any changes occurred in the system over the duration of the flight. These data are recorded for approximately 90 seconds.

6.5 Post-Flight Barometer Calibration: Line C1611

A recording of the barometer output is repeated following landing at the end of the flight to assist with calibration and determination of drift during the flight.

6.6 Additive EM Measurements: Lines C9004, C9005, and C9007

A recording of the background signal through the X, Y and Z receiver coil inputs is carried out before and/or after acquisition of data for survey lines on each flight. These measurements may be made with the transmitter on (C9004, C9005) or with the transmitter off (C9007). The signal from the receiver coils is removed from the signal pathway by disconnecting the power to the bird at the winch inside the aircraft.

6.7 Parallax Checks

Due to the relative positions of the EM towed bird 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, EM data and the altimeters are 'parallaxed' with respect to the position information. System parallax is checked occasionally or following any major changes in the aircraft system which are likely to affect the parallax values.

6.8 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 it's operating range.

Absolute radar and barometric altimeter calibration was carried out over water (15th October 2003, over Mandurah, WA) and was successful in calibrating the radar altimeter to information provided by the GPS and barometer instrument. Calibration factors were as expected. The calibration procedure also provides parallax information required for positional correction of the radar and GPS altimeters.

7 Data Processing

7.1 Field Data Processing

7.1.1 Quality Control Specifications

7.1.1.1 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).

Traverse Lines Separation - actual flight line path deviates more than 125% off course for a distance of 5 km or more, or if a flight line intersects an adjacent flight line. Where flight lines are more than 20 m off course over a continuous distance of 1500 m or more unless the deviation is required by civil aviation requirements.

Altitude - terrain clearance continuously exceeds the nominal terrain clearance by plus or minus 20 m over a distance of 2 km or more unless to do so would, in the sole opinion of the pilot, jeopardise the safety of the aircraft or the crew or the equipment or would be in contravention of the Civil Aviation Safety Authority regulation such as those pertaining to built up areas.

7.1.1.2 Electromagnetic Data

The quality control checks on the electromagnetic data were:

Noise - where RMS noise in the last channel of the EM data exceeds 0.1 fT over 3 km for B-field (assessed in a resistive region) or where FAS believes an important anomaly is rendered un-interpretable.

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

7.1.2 In-Field Data Processing

Following acquisition, multiple copies of the EM data are made onto Exabyte tapes. The EM, location 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 7.2.3.

7.2 Final Data Processing

7.2.1 Derived Topography

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 radar altimeter.

The ground elevation, relative to the WGS84 spheroid used by GPS receiver units, is obtained by subtracting the terrain clearance from the aircraft altitude, noting the vertical separation between the GPS antenna and the laser altimeter, and applying suitable corrections for the separation between the two instruments (see section 7.2.2.2).

Derived surface topography, or digital elevation model (DEM), values with respect to mean sea level (referenced to the geoid) are obtained by correcting the spheroid values with geoid-spheroid separation values supplied by AUSLIG.

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 location of the GPS base station, variations in the radar altimeter characteristics over ground of varying surface texture, and the finite footprint of the radar altimeter.

7.2.2 Electromagnetic Data Processing

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

7.2.2.1 Standard EM Processing

Calibration
High altitude calibration data are used to characterise the system response in the absence of any ground response.

Cleaning and Stacking
Routines to suppress sferic noise, powerline noise, VLF noise, 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. The stacked data are saved to file as an internal data management practice.

Deconvolution and Binning
The survey height stacked data are deconvolved using the high altitude reference waveform. The effect of currents in the transmitter loop and airframe (“primary”) are then removed, leaving a “pure” ground response. The deconvolved ground response data are then transformed to B-field response for a perfect 100% duty cycle square wave. Finally, the evenly spaced samples are binned into a number of windows.

Table of TEMPEST window information for 25Hz base frequency

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

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

Raw and Final 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, 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 (nominally 120m), standard transmitter loop pitch and roll (zero degrees), and a standard transmitter loop to receiver coil geometry (nominally 120 m behind and 35 m below the aircraft). 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, 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.

Levelling

Limited range micro-levelling has been be applied to the final window amplitudes for presentation purposes, principally for multi-flight surveys or when isolated re-flight lines are present.

7.2.2.2 Factors and Corrections

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.

Transmitter-Receiver Geometry
Transmitter to receiver geometry values for each observation are derived from the high altitude reference waveforms and knowledge of the system characteristics. These data are available in the located data (see section 7.2.4.1 for “standardised” values)

GPS Antenna and Transmitter Loop Corrections
The transmitter loop was mounted 0.1m above the GPS antenna on the aircraft. The GPS antenna is 2.3m above the belly of the aircraft. The laser altimeter sensor is mounted in the belly of the aircraft. Therefore a total of 2.4m (0.1m + 2.3m) was added to the laser altimeter data to determine the transmitter loop height above the ground.

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 -0.9 degrees for pitch and 0.1 degrees for roll. Nose up is positive for pitch, and left wing up is positive for roll.

7.2.2.3 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.

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 (eg tropical parts of Asia, South America and Africa). Additional higher amplitude signals are produced by "local" lightning activity (ie 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). 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.

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 (eg 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.

Powerline Monitor
The powerline monitor gives the amplitude of the received signal at the powerline frequency (50 or 60 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 (or images) 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.

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.

7.2.2.4 Other Sources of EM Noise

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 (eg 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 artifact can still be present in the processed data.

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.

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 (ie 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.

7.2.3 Conductivity Depth Images (CDI)

CDI conductivity sections for TEMPEST data are generally 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” data for each area were input into EMFlow (version 5.10) to calculate Conductivity Depth Images (CDI). Conductivity values were calculated to a depth of 960m below surface at each point, using a depth increment of 5m, then run through *Sigtime* before being made into the CDI products (stacked CDI sections and CDI-multiplots). This processing was completed for both X and Z component data.

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).

7.2.4 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 femtotesla (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 7.2.2.1).

7.2.4.1 Standard Height and Geometry

The “final” EM data have been standardised 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 - the following table summarises the values used to correct the transmitter height/pitch/roll/geometry to.

Table of values used to standardise transmitter loop height, pitch, roll and geometry

Variable	Standardised value
Transmitter loop roll	0 degrees
Transmitter loop pitch	0 degrees
Transmitter loop terrain clearance	areas 1, 2, 3, 7, 8: 110 metres areas 4, 5, 6: 120 metres
Transmitter–receiver geometry: distance behind aircraft distance below aircraft	all areas: 120 metres areas 4, 5, 6, 7: 35 metres areas 1, 2, 3, 8: 38 metres

7.2.4.2 Parallax

The located data files utilise the following parallax values :-

- radar altimeter = 0.6 fiducials (3 observations from the zero parallax position),
- EM X-component = 0.2 fiducials (1 observation from the zero parallax position),
- EM Z-component = 1.4 fiducials (7 observations from the zero parallax position),

These EM parallax values are optimised for aligning the EM response amplitudes for horizontal or broad steeply dipping conductors, which account for the majority of responses in regolith-dominated terrains.

For optimum gridded display of the response for discrete vertical or narrow conductors, the following EM parallax values are appropriate :-

- EM X-component = 1.8 fiducials (9 observations from the zero parallax position, or 8 observations from the “horizontal” parallax position),
- EM Z-component = 0.6 fiducials (3 observations from the zero parallax position, or -4 observations from the “horizontal” parallax position).
-

(NB Positive parallax values are defined in this case as shifting the indicated quantity back along line to smaller fiducial values. Location information remains in the zero parallax state.)

7.2.5 Other Products

Adaptive time constants

An “adaptive time constant” grid is calculated by fitting an exponential decay to the last few windows above a specified threshold. Thus, the calculation does not involve a fixed window range and ‘adapts’ to the nature of the decay at each observation. It summarises the latest time constants that are seen in the data (using a minimum of 2 windows and a maximum of 3 windows to define the time constant). The calculated time constants do not have any criteria applied to them as to how well the data fits an exponential decay model. This method of time constant calculation produces virtually continuous output, limited only by the requirement for at least 2 windows to be above a specified threshold. In resistive areas, this image highlights the long time constants associated with discrete conductors.

Time constant grids were produced for both X and Z component “final” EM data.

7.2.6 Delivered Products

Appendix IV contains a complete list of all data supplied digitally.

Digital flat ascii located data files were produced containing raw and final data for both the X- and Z-components. Magnetics and digital elevation data were included. The header files can be found in Appendix III.

ER-Mapper grids of DTM (with Lidar; levelled onto Mag/Spec DTM), interval conductivities (from 0m to 200m) for X and Z, and unit parameters were also delivered.

7.2.7 Comments on Data from this Survey

Since the “Aurari” TEMPEST survey flown in 2002, substantial modifications to the receiver “bird” were made, resulting in significant improvements to noise levels in this survey. Because of this, no data filters were applied whereas a 13-point median filter followed by a 13-point mean filter, were applied to the 2002 survey data. The advantage of all this is that better resolution at greater depths can be achieved, hence the resulting CDIs showing line-contiguous anomalous bodies at depths of more than 600 metres - primarily in the Z-component conductivities. Unfortunately, owing to less coupling (due to coil orientation and Tx-Rx geometry) and a greater susceptibility from atmospheric activity, the X-component data are not quite as impressive, reaching depths of only 300 to 400 metres. Accordlingly, the Sigtime parameters (see section 7.2.3) were set differently for the X and Z-component data: the *depth factor* being 0.7 for the X-component EM data and 0.8 for the Z-component EM data.

Other differences between the “Aurari” and current surveys were apparent in the Emflow processing (section 7.2.3). For this survey it was deemed advantageous to use the “raw” EM data (see section 7.2.2.1 for explanation) rather than the “final” EM data. This was because it was discovered that in processing the 2002 survey, the transmitter height/pitch/roll correction *overcompensated* thereby producing results that correlated too well with topography. As can be clearly seen in this survey’s CDIs, correlation with topography is nearly non-existent - as one would expect. Appendix VI displays the contents of the Emflow *descriptor* (.dsc) files. The tau range was chosen by the client to cover only the range 0.002ms to 10ms, and the conductivities 0.1mS/m to 100mS/m.

Particular mention must be made regarding the Ranger area, though the same philosophy was applied to the entire survey, and that was in dealing with the X-component data: Emflow was constrained for all areas to the conductivity range 0.1-100mS/m – the calculated conductivities however, reached values higher than 100mS/m in places and so would have been curtailed back to 100mS/m. There are a number of reasons this was done: (1) to be consistent with the Z-component data, which was the data of primary interest and which almost never exceeds 100mS/m; (2) to be consistent with all other areas, since 100mS/m was only rarely surpassed; (3) because it was felt that the noisey nature of the X-component data was only enhanced by shifting or extending the conductivity range (to, say 1-1000mS/m), at the expense of more subtle features, which seemed to be of more interest to the client; and (4) from experience, Fugro has found that using more than 3 decades in EMflow is unwise, primarily when you only have 20 conductivities to span that range.

Atmospheric (or “sferic”) activity was quite significant during acquisition but could not be avoided because of the time of year and latitudes involved. Also, the sferics monitor relies on detecting a short, sharp pulse that may or may not fully describe any particular sferic event thereby failing to be completely removed from the EM signal during processing (see section 7.2.2.3 for more). Fortunately, the Z-component data are virtually free of sferic events as can be seen in the multiplot images.

The procedure for correcting for transmitter pitch, roll and terrain clearance, and transmitter-receiver geometry, requires that values be determined such that all flights contained in the one survey area, be set to the same “standard” value, thereby giving a consistent response irrespective of flight-related factors such as a different pilot or different flying conditions. The table in section 7.2.5.1 indicates that some areas were corrected to different standard terrain clearances and/or transmitter-receiver geometries: this can be explained by virtue of the fact that the correction algorithm does a better job on correcting data that are numerically “close” than correcting to some numerically “distant” value. In this survey, the field processor would have chosen standard values appropriate for each area although ideally, in cases where multiple areas go together to form neighbouring surveys like this one, a set of standard values determined over *all* areas, would probably have been wiser. (Putting such stipulations into the contract might be the only way to ensure this in future).

7.2.8 Additional Comment – Magnetic Data

Despite the fact that magnetic data were not required for this survey, data were still acquired and included in the final located ASCII data. It must be pointed out, however, that no formal processing was performed; also, that the magnetometer failed on a number of lines in the first flight but no reflights were carried out.

8 References

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APPENDIX I - Flight Plans

AREA 1

```
JOB_Number  1622                                                                   *
CLIENT      Cameco                                                                 *
AREA_NAME   Algoda                                                                 *
PLANNED_BY  gps2                                                                   *
|                                                                                  *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                          *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                            *
HEMISPHERE  SOUTH                                                                  *
UTM_ORIGIN  53   135   135                                                         *
BOUNDARY    1   290072  8615682 -12.515438 +133.068147 -123055.6 +1330405.3 12 *
BOUNDARY    2   291906  8615682 -12.515559 +133.085018 -123056.0 +1330506.1 12 *
BOUNDARY    3   291906  8602684 -12.633034 +133.084147 -123758.9 +1330502.9 12 *
BOUNDARY    4   290056  8602684 -12.632911 +133.067122 -123758.5 +1330401.6 12 *
SQUARE_KMS  23.942                                                                 *
|                                                                                  *
NAVTYPE     NOVATEL                                                                *
NAVMODE     U.T.M                                                                  *
PLAN_TYPE   Normal                                                                 *
LINE_TYPE   S.LINE    X.LINE    0         0                                        *
HEADING     0         90                                                           *
SPACING     200       1000      200       200                                      *
OVER_LINE   1         1                                                            *
OVERFLY     0         0                                                            *
MIN_LENGTH  2         2                                                            *
FIRST_LINE  10        10                                                           *
INCREMENT   10        10                                                           *
X_TRACK     100       100                                                          *
MASTER_PT   1   290072  8615682 -12.515438 +133.068147                             *
MASTER_NEW  0  Not implemented.                                                    *
KM_IN_AREA  130       0                                                            *
KM+OVERFLY  130       0                                                            *
```

AREA 2

```
JOB_Number  1622                                                                   *
CLIENT      Cameco                                                                 *
AREA_NAME   Arrarra                                                                *
PLANNED_BY  gps2                                                                   *
|                                                                                  *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                          *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                            *
HEMISPHERE  SOUTH                                                                  *
UTM_ORIGIN  53   135   135                                                         *
BOUNDARY    1   273940  8658240 -12.129727 +132.922789 -120747.0 +1325522.0 12 *
BOUNDARY    2   273940  8644755 -12.251595 +132.921840 -121505.7 +1325518.6 12 *
BOUNDARY    3   263765  8644755 -12.250871 +132.828348 -121503.1 +1324942.1 12 *
BOUNDARY    4   263765  8658240 -12.129011 +132.829340 -120744.4 +1324945.6 12 *
SQUARE_KMS  137.210                                                                *
|                                                                                  *
NAVTYPE     NOVATEL                                                                *
NAVMODE     U.T.M                                                                  *
PLAN_TYPE   Normal                                                                 *
LINE_TYPE   S.LINE    X.LINE    0         0                                        *
HEADING     0         90                                                           *
SPACING     200       2150      200       200                                      *
OVER_LINE   1         1                                                            *
OVERFLY     0         0                                                            *
MIN_LENGTH  2         2                                                            *
FIRST_LINE  10        10                                                           *
INCREMENT   10        10                                                           *
X_TRACK     100       100                                                          *
MASTER_PT   1   273940  8658240 -12.129727 +132.922789                             *
MASTER_NEW  0  Not implemented.                                                    *
KM_IN_AREA  688       71                                                           *
KM+OVERFLY  688       71                                                           *
```

AREA 3

```
JOB_Number  1622                                                                   *
CLIENT      Cameco                                                                 *
AREA_NAME   Caramal                                                                *
PLANNED_BY  gps2                                                                   *
|                                                                                  *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                          *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                            *
HEMISPHERE  SOUTH                                                                  *
UTM_ORIGIN  53   135   135                                                         *
BOUNDARY    1   323324  8620717 -12.471948 +133.374341 -122819.0 +1332227.6 12 *
BOUNDARY    2   323342  8615088 -12.522832 +133.374181 -123122.2 +1332227.1 12 *
BOUNDARY    3   319966  8615088 -12.522642 +133.343120 -123121.5 +1332035.2 12 *
BOUNDARY    4   319948  8620737 -12.471578 +133.343287 -122817.7 +1332035.8 12 *
SQUARE_KMS  19.037                                                                 *
|                                                                                  *
NAVTYPE     NOVATEL                                                                *
NAVMODE     U.T.M                                                                  *
PLAN_TYPE   Normal                                                                 *
LINE_TYPE   S.LINE    X.LINE    0         0                                        *
HEADING     0         90                                                           *
SPACING     200       2500      200       200                                      *
OVER_LINE   1         1                                                            *
OVERFLY     0         0                                                            *
MIN_LENGTH  2         2                                                            *
FIRST_LINE  10        10                                                           *
INCREMENT   10        10                                                           *
X_TRACK     100       100                                                          *
MASTER_PT   1   323324  8620717 -12.471948 +133.374341                             *
MASTER_NEW  0  Not implemented.                                                    *
KM_IN_AREA  96        10                                                           *
KM+OVERFLY  96        10                                                           *
```

AREA 4

```
JOB_Number  1622                                                                   *
CLIENT      Cameco                                                                 *
AREA_NAME   Goomadeer N                                                            *
PLANNED_BY  gps2                                                                   *
|                                                                                  *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                          *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                            *
HEMISPHERE  SOUTH                                                                  *
UTM_ORIGIN  53   135   135                                                         *
BOUNDARY    1   367832  8669926 -12.029196 +133.785833 -120145.1 +1334709.0 12 *
BOUNDARY    2   367832  8665144 -12.072432 +133.785638 -120420.8 +1334708.3 12 *
BOUNDARY    3   359397  8665144 -12.072083 +133.708151 -120419.5 +1334229.3 12 *
BOUNDARY    4   359397  8669926 -12.028849 +133.708358 -120143.9 +1334230.1 12 *
SQUARE_KMS  40.336                                                                 *
|                                                                                  *
NAVTYPE     NOVATEL                                                                *
NAVMODE     U.T.M                                                                  *
PLAN_TYPE   Normal                                                                 *
LINE_TYPE   S.LINE    X.LINE    0         0                                        *
HEADING     90        180                                                          *
SPACING     200       2000      200       200                                      *
OVER_LINE   1         1                                                            *
OVERFLY     0         0                                                            *
MIN_LENGTH  2         2                                                            *
FIRST_LINE  10        10                                                           *
INCREMENT   10        10                                                           *
X_TRACK     100       100                                                          *
MASTER_PT   1   367832  8669926 -12.029196 +133.785833                             *
MASTER_NEW  0  Not implemented.                                                    *
KM_IN_AREA  202       24                                                           *
KM+OVERFLY  202       24                                                           *
```

AREA 5

```
JOB_Number  1622                                                                    *
CLIENT      Cameco                                                                  *
AREA_NAME   Goomadeer S                                                             *
PLANNED_BY  gps2                                                                    *
|                                                                                   *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                           *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                             *
HEMISPHERE  SOUTH                                                                   *
UTM_ORIGIN  53   135   135                                                          *
BOUNDARY    1   357037  8645423 -12.250277 +133.685596 -121501.0 +1334108.1 12 *
BOUNDARY    2   357037  8649483 -12.213571 +133.685777 -121248.9 +1334108.8 12 *
BOUNDARY    3   359589  8649560 -12.212986 +133.709240 -121246.7 +1334233.3 12 *
BOUNDARY    4   359674  8661235 -12.107436 +133.710530 -120626.8 +1334237.9 12 *
BOUNDARY    5   367966  8661359 -12.106659 +133.786711 -120624.0 +1334712.2 12 *
BOUNDARY    6   367997  8645460 -12.250406 +133.786350 -121501.5 +1334710.9 12 *
SQUARE_KMS  142.974                                                                 *
|                                                                                   *
NAVTYPE     NOVATEL                                                                 *
NAVMODE     U.T.M                                                                   *
PLAN_TYPE   Normal                                                                  *
LINE_TYPE   S.LINE    X.LINE    0         0                                         *
HEADING     90        180                                                           *
SPACING     200       2600      200       200                                       *
OVER_LINE   1         1                                                             *
OVERFLY     0         0                                                             *
MIN_LENGTH  2         2                                                             *
FIRST_LINE  10        10                                                            *
INCREMENT   10        10                                                            *
X_TRACK     100       100                                                           *
MASTER_PT   1   357037  8645423 -12.250277 +133.685596                              *
MASTER_NEW  0  Not implemented.                                                     *
KM_IN_AREA  715       67                                                            *
KM+OVERFLY  715       67                                                            *
```

AREA 6

```
JOB_Number  1622                                                                    *
CLIENT      Cameco                                                                  *
AREA_NAME   Mordijimuk                                                              *
PLANNED_BY  gps2                                                                    *
|                                                                                   *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                           *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                             *
HEMISPHERE  SOUTH                                                                   *
UTM_ORIGIN  53   135   135                                                          *
BOUNDARY    1   306073  8626680 -12.417048 +133.216027 -122501.4 +1331257.7 12 *
BOUNDARY    2   306059  8628924 -12.396764 +133.216030 -122348.4 +1331257.7 12 *
BOUNDARY    3   319002  8628913 -12.397620 +133.335048 -122351.4 +1332006.2 12 *
BOUNDARY    4   319005  8627505 -12.410347 +133.334995 -122437.3 +1332006.0 12 *
BOUNDARY    5   328067  8627497 -12.410919 +133.418338 -122439.3 +1332506.0 12 *
BOUNDARY    6   328067  8626712 -12.418015 +133.418296 -122504.9 +1332505.9 12 *
BOUNDARY    7   318770  8626712 -12.417502 +133.332792 -122503.0 +1331958.1 12 *
SQUARE_KMS  35.900                                                                  *
|                                                                                   *
NAVTYPE     NOVATEL                                                                 *
NAVMODE     U.T.M                                                                   *
PLAN_TYPE   Normal                                                                  *
LINE_TYPE   S.LINE    X.LINE    0         0                                         *
HEADING     90        180                                                           *
SPACING     200       2600      200       200                                       *
OVER_LINE   1         1                                                             *
OVERFLY     0         0                                                             *
MIN_LENGTH  2         2                                                             *
FIRST_LINE  10        10                                                            *
INCREMENT   10        10                                                            *
X_TRACK     100       100                                                           *
MASTER_PT   1   306073  8626680 -12.417048 +133.216027                              *
MASTER_NEW  0  Not implemented.                                                     *
KM_IN_AREA  184       0                                                             *
KM+OVERFLY  184       0                                                             *
```

AREA 7

```
JOB_Number  1622                                                                  *
CLIENT      Cameco                                                                *
AREA_NAME   Ranger                                                                *
PLANNED_BY  gps2                                                                  *
|                                                                                 *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                         *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                           *
HEMISPHERE  SOUTH                                                                 *
UTM_ORIGIN  53   135   135                                                        *
BOUNDARY    1   276446  8595831 -12.693905 +132.941377 -124138.1 +1325629.0 12 *
BOUNDARY    2   276446  8593739 -12.712810 +132.941225 -124246.1 +1325628.4 12 *
BOUNDARY    3   270047  8593739 -12.712346 +132.882323 -124244.4 +1325256.4 12 *
BOUNDARY    4   270047  8595831 -12.693442 +132.882479 -124136.4 +1325256.9 12 *
SQUARE_KMS  13.387                                                                *
|                                                                                 *
NAVTYPE     NOVATEL                                                               *
NAVMODE     U.T.M                                                                 *
PLAN_TYPE   Normal                                                                *
LINE_TYPE   S.LINE    X.LINE    0         0                                       *
HEADING     90        180                                                         *
SPACING     200       2600      200       200                                     *
OVER_LINE   1         1                                                           *
OVERFLY     0         0                                                           *
MIN_LENGTH  2         2                                                           *
FIRST_LINE  10        10                                                          *
INCREMENT   10        10                                                          *
X_TRACK     100       100                                                         *
MASTER_PT   1   276446  8595831 -12.693905 +132.941377                            *
MASTER_NEW  0  Not implemented.                                                   *
KM_IN_AREA  70        0                                                           *
KM+OVERFLY  70        0                                                           *
```

AREA 8

```
JOB_Number  1622                                                                  *
CLIENT      Cameco                                                                *
AREA_NAME   New Area                                                              *
PLANNED_BY  gps2                                                                  *
|                                                                                 *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                         *
DELTAXYZ    0.0 0.0 0.0 0.0 0.0 0.0 0.0                                           *
HEMISPHERE  SOUTH                                                                 *
UTM_ORIGIN  53   135   135                                                        *
BOUNDARY    1   316000  8610300 -12.565694 +133.306352 -123356.5 +1331822.9 12 *
BOUNDARY    2   321000  8610300 -12.565981 +133.352362 -123357.5 +1332108.5 12 *
BOUNDARY    3   321000  8609300 -12.575020 +133.352304 -123430.1 +1332108.3 12 *
BOUNDARY    4   316000  8609300 -12.574733 +133.306293 -123429.0 +1331822.7 12 *
SQUARE_KMS  5.000                                                                 *
|                                                                                 *
NAVTYPE     NOVATEL                                                               *
NAVMODE     U.T.M                                                                 *
PLAN_TYPE   Normal                                                                *
LINE_TYPE   S.LINE    X.LINE    0         0                                       *
HEADING     90        180                                                         *
SPACING     200       1000      200       200                                     *
OVER_LINE   1         1                                                           *
OVERFLY     0         0                                                           *
MIN_LENGTH  2         2                                                           *
FIRST_LINE  10        10                                                          *
INCREMENT   10        10                                                          *
X_TRACK     100       100                                                         *
MASTER_PT   1   316000  8610300 -12.565694 +133.306352                            *
MASTER_NEW  0  Not implemented.                                                   *
KM_IN_AREA  30        0                                                           *
KM+OVERFLY  30        0                                                           *
```

APPENDIX II – Weekly Operations Reports

Week Commencing:	**Monday 27-Oct-03**	Aircraft:	VH-TEM	Operators:	Miller	Pilots:	Haldane, Chappell
Job Number:	1622	Base:	Jabiru	Data Proc:	Hope, Sattel	Techs:	Miller, Cardence
Total km:	2159.2	Country:	Australia	Crew Leader:	Chappell	Client:	Cameco
		Area Name:	Jabiru	Accom:	Kakadu Lodge	Contact #:	0402 841 005

Date		Flight	Crew		Time		M/R	Oil		Fuel	This Flight		To Date		Standby	Comments
		Number	Plt(s)	Op	T/O	Land	Hrs	L	R	Added	Prod	Refly	Prod	Refly	(0, 0.5, 1)	
Monday	27-Oct-03															Weather:
																Remarks:
Julian	300															
Day	1				Hours Today		0.0				0.0	0.0	0.0	0.0		Safety Meeting:
Tuesday	28-Oct-03															Weather:
																Remarks:
Julian	301															
Day	2				Hours Today		0.0				0.0	0.0	0.0	0.0		Safety Meeting:
Wednesday	29-Oct-03															Weather:
																Remarks:
Julian	302															
Day	3				Hours Today		0.0				0.0	0.0	0.0	0.0		Safety Meeting:
Thursday	30-Oct-03	ferry	th	dc	6:10	9:10	3.0			1633						Weather:
																Remarks: Tem mob. To Jabiru via derby
Julian	303															
Day	4				Hours Today		3.0				0.0	0.0	0.0	0.0		Safety Meeting:
Friday	31-Oct-03	pdo														Weather:
																Remarks:Hope, Miller, Sattel mobilise to Jabiru
Julian	304															
Day	5				Hours Today		0.0				0.0	0.0	0.0	0.0		Safety Meeting:
Saturday	1-Nov-03	ferry			22:10	1:20	4.2									Weather:
																Remarks:TEM arrive in Jabiru
Julian	305															
Day	6				Hours Today		4.2				0.0	0.0	0.0	0.0		Safety Meeting:
Sunday	2-Nov-03	1	TH/DC	SM						1549	216.6	0.0			0.0	Weather:Hot and Dry
																Remarks: Area 4 and repeat test lines completed
Julian	306															
Day	7				Hours Today		0.0				216.6	0.0	216.6	0.0		Safety Meeting:
Total Job Hours		7.2	Weekly Totals				7.2	0	0	3182	216.6	0.0			0.0	
			Total Aircraft Hours					Ltrs/Hr		442			Total Standby		0.0	
			Hours to Next Periodic					Running Avg			30.9 km/day		% Complete		10.0 %	
			Anticipated Hours Next week								30.1 km/hr		km Remaining		1942.6 km	

Week Commencing: **Monday 3-Nov-03**
Job Number: 1622
Total km: 2159.2

Aircraft: VH-TEM
Base: Jabiru
Country: Australia
Area Name: Jabiru

Operators: Miller
Data Proc: Hope, Sattel
Crew Leader: Chappell
Accom: Kakadu Lodge

Pilots: Haldane, Chappell
Techs: Miller, Cardence
Client: Cameco
Contact #: 0402 841 005

Date		Flight	Crew		Time		M/R	Oil		Fuel	This Flight		To Date		Standby	Comments
		Number	Plt(s)	Op	T/O	Land	Hrs	L	R	Added	Prod	Refly	Prod	Refly	(0, 0.5, 1)	
Monday	3-Nov-03	2	TH/DC	SM	0:00	0:00	4.0			1376	413.4	0.0			0.0	Weather:Hot and Dry
																Remarks:Commenced area 5, flew repeatable test line
Julian	307															
Day	8				Hours Today		4.0				413.4	0.0	630.0	0.0		Safety Meeting:
Tuesday	4-Nov-03	3	TH/DC	SM			3.3			1168	283.0	47.2			0.0	Weather:Hot/Humid, Heavy thunderstorms in evening
																Remarks: Continued area 5. Scrubs due to HDD operating
Julian	308															at 40c and corrupting data
Day	9				Hours Today		3.3				283.0	47.2	913.0	47.2		Safety Meeting:
Wednesday	5-Nov-03	4	TH/DC	SM			2.5			1150	113.3	39.3			0.0	Weather:Hot/Humid, Heavy thunderstorms in evening
																Remarks:Commenced areas 6,7,8. Scrubs caused by coil+Q36
Julian	309															knocks in turbulance
Day	10				Hours Today		2.5				113.3	39.3	1026.3	86.5		Safety Meeting:
Thursday	6-Nov-03	5	TH/DC	SM			3.0			1288	250.7				0.0	Weather:Hot/humid, thunderstorms in evening
																Remarks: short flight due to turbulence
Julian	310															
Day	11				Hours Today		3.0				250.7	0.0	1277.0	86.5		Safety Meeting:
Friday	7-Nov-03	pdo													0.0	Weather:
																Remarks: Pilot Day Off
Julian	311															
Day	12				Hours Today		0.0				0.0	0.0	1277.0	86.5		Safety Meeting:
Saturday	8-Nov-03	6	TH/DC	SM			4.4			1980	301.0	27.0			0.0	Weather:Hot, overcast.
																Remarks:Area 2 commenced, areas 6 and 8 completed,
Julian	312															data sent to client for sferic assesment
Day	13				Hours Today		4.4				301.0	27.0	1578.0	113.5		Safety Meeting:
Sunday	9-Nov-03	7	TH/DC	SM			2.9			1192	303.4	40.5			0.0	Weather:Humid, overcast
																Remarks:Completed area 7 , continued area 2
Julian	313															Problem with flight planning of extra lines, must have separate
Day	14				Hours Today		2.9				303.4	40.5	1881.4	154.0		file for each line. Navigate program from Geoff Wells works fine
Total Job Hours		27.3	Weekly Totals				20.1	0	0	8154	1664.8	154.0			0.0	

Total Aircraft Hours: | Ltrs/Hr: 406 | Total Standby: 0.0

Hours to Next Periodic: 97.1 | Running Avg: 237.8 km/day | % Complete: 87.1 %

Anticipated Hours Next week: | 82.8 km/hr | km Remaining: 277.8 km

Week Commencing:	**Monday 10-Nov-03**	Aircraft:	VH-TEM	Operators:	Miller	Pilots:	Haldane, Chappell
Job Number:	1622	Base:	Jabiru	Data Proc:	Hope, Sattel	Techs:	Miller, Cardence
Total km:	2159.2	Country:	Australia	Crew Leader:	Chappell	Client:	Cameco
		Area Name:	Jabiru	Accom:	Kakadu Lodge	Contact #:	0402 841 005

Date		Flight	Crew		Time		M/R	Oil		Fuel	This Flight		To Date		Standby	Comments
		Number	Plt(s)	Op	T/O	Land	Hrs	L	R	Added	Prod	Refly	Prod	Refly	(0, 0.5, 1)	
Monday	10-Nov-03										0.0				1.0	Weather:Sferics too high, rain and high temp
																Remarks:No flight
Julian	314															
Day	15				Hours Today		0.0				0.0	0.0	1881.4	154.0		Safety Meeting:
Tuesday	11-Nov-03										0.0				1.0	Weather:Sferics too high, rain and high temp
																Remarks:No flight
Julian	315															
Day	16				Hours Today		0.0				0.0	0.0	1881.4	154.0		Safety Meeting:
Wednesday	12-Nov-03	8	TH/DC	SM			3.7			1654	277.8	27?				Weather:Hot, less humid than previous days
																Remarks:Two lines with coil knocks sent to client to asses refly,
Julian	316															otherwise job completed and demob tommorow
Day	17				Hours Today		3.7				277.8	0.0	2159.2	154.0		Safety Meeting:
Thursday	13-Nov-03															Weather:
																Remarks:
Julian	317															
Day	18				Hours Today		0.0				0.0	0.0	2159.2	154.0		Safety Meeting:
Friday	14-Nov-03															Weather:
Julian	318															Remarks:
Day	19				Hours Today		0.0				0.0	0.0	2159.2	154.0		Safety Meeting:
Saturday	15-Nov-03															Weather:
																Remarks:
Julian	319															
Day	20				Hours Today		0.0				0.0	0.0	2159.2	154.0		Safety Meeting:
Sunday	16-Nov-03															Weather:
Julian	320															Remarks:
Day	21				Hours Today		0.0				0.0	0.0	2159.2	154.0		Safety Meeting:
Total Job Hours		31.0	Weekly Totals				3.7	0	0	1654	277.8	0.0			2.0	
			Total Aircraft Hours					Ltrs/Hr		447			Total Standby		2.0	
			Hours to Next Periodic				93.4	Running Avg			39.7 km/day		% Complete		100.0 %	
			Anticipated Hours Next week								75.1 km/hr		km Remaining		0.0 km	

APPENDIX III – Data Formats (Post Processed Files)

Sample Headers for final data files

Algoda_Tempest_X.hdr

```
COMM CLIENT:                                    CAMECO AUSTRALIA PTY LTD
COMM SURVEY TYPE:                                           25Hz TEMPEST
COMM AREA NAME:                                    Algoda, Arnhem Land
COMM STATE:                                         Northern Territory
COMM COUNTRY:                                                Australia
COMM JOB NUMBER:                                                1622.1
COMM DATE FLOWN:                                         November 2003
COMM SURVEY COMPANY:                           Fugro Airborne Surveys
COMM LOCATED DATA CREATED:                                January 2004
COMM
COMM DATUM:                                                      AGD66
COMM PROJECTION:                                                   AMG
COMM ZONE:                                                          53
COMM
COMM
COMM AIRBORNE EQUIPMENT
COMM ------------------
COMM
COMM AIRCRAFT:                               CASA C212 Turbo Prop, VH-TEM
COMM MAGNETOMETER:                        Cesium Vapour optical absorption
COMM INSTALLATION:                                              Stinger
COMM SENSITIVITY:                                               0.01 nT
COMM RECORDING INTERVAL:               0.2 sec (approx 14 m sampling)
COMM
COMM ELECTROMAGNETIC SYSTEM:                                    TEMPEST
COMM INSTALLATION:              Transmitter loop mounted on the aircraft
COMM                                    receiver coils in a towed bird
COMM COIL ORIENTATION:                                          X and Z
COMM FREQUENCY:                                                   25 Hz
COMM GEOMETRY:                                              (see below)
COMM SAMPLING:                         0.2 sec (approx 13 m sampling)
COMM ALTIMETER:                                     Sperry Stars AA200
COMM RECORDING INTERVAL:                                        0.2 sec
COMM NAVIGATION:     Post-processed differential GPS used in processing,
COMM                 real-time satellite differential GPS used in-flight
COMM RECORDING INTERVAL:                                          1 sec
COMM BASE MAGNETOMETER:                   Cesium vapour optical absorption
COMM RECORDING INTERVAL:                                          1 sec
COMM VIDEO:                                                    Acquired
COMM
COMM ACQUISITION SYSTEM:                                      PDAS-1000
COMM
COMM
COMM AIRBORNE SPECIFICATIONS
COMM -----------------------
COMM
COMM TRAVERSE LINE SPACING:                                       200 m
COMM TRAVERSE LINE DIRECTION:                                   000-180
COMM NOMINAL TERRAIN CLEARANCE:                        110 m (Aircraft)
COMM LINE KILOMETREAGE:                                          133 km
COMM
COMM
COMM SURVEY BOUNDARY (WGS84, UTM53)
COMM -----------------------------
COMM
COMM   290072  8615682
COMM   291906  8615682
COMM   291906  8602684
COMM   290056  8602684
COMM
COMM LINE NUMBERING:
COMM ---------------
COMM
COMM FLIGHT LINE NUMBERS:                               10010 - 10100
COMM
COMM
COMM PROCESSING DETAILS
COMM ===================
COMM
COMM DATA PROCESSING:
COMM ----------------
```

```
COMM
COMM MAGNETIC DATA: (not required for this survey)
COMM SYSTEM PARALLAX REMOVED                              (see below)
COMM
COMM DIGITAL TERRAIN MODEL:
COMM SPIKES REMOVED FROM RADAR ALTIMETER
COMM DTM CALCULATED [DTM = gps_height - radar]
COMM
COMM EM DATA:
COMM SYSTEM PARALLAX REMOVED                              (see below)
COMM DATA CORRECTED FOR            TRANSMITTER HEIGHT, PITCH & ROLL AND
COMM                           TRANSMITTER-RECEIVER GEOMETRY VARIATIONS
COMM CONDUCTIVITY DEPTH INVERSIONS CALCULATED             EMFlow V5.1
COMM MICROLEVELLING APPLIED
COMM
COMM
COMM SYSTEM GEOMETRY:
COMM ----------------
COMM
COMM THE TRANSMITTER-RECEIVER GEOMETRY IS:
COMM
COMM TRANSMITTER TERRAIN CLEARANCE:                        110 metres
COMM DISTANCE BEHIND THE AIRCRAFT:                         120 metres
COMM DISTANCE BELOW THE AIRCRAFT:                           38 metres
COMM
COMM PARALLAX CORRECTIONS:
COMM ----------------------
COMM
COMM FOR THIS DATA SET, THE FOLLOWING PARALLAX VALUES WERE APPLIED:
COMM
COMM X-COMPONENT EM DATA:                                  1 samples
COMM Z-COMPONENT EM DATA:                                  7 samples
COMM RADAR ALIMETER:                                       3 samples
COMM MAGNETOMETER:                                         2 samples
COMM
COMM ELECTROMAGNETIC SYSTEM:
COMM ------------------------
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 (~13 METRES).
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 msec
COMM
```

```
 Output field format : DOS  - Flat ascii
 Number of fields    : 253
```

Field	Columns	Type	Format	Channel	Description		
1	1 - 6	int	(i 6)	LINE	[Line		]
2	7 - 10	int	(i 4)	FLIGHT	[Flight		]
3	11 - 18	real	(f 8.1)	FID	[Fiducial	(s)	]
4	19 - 27	int	(i 9)	EASTING	[Easting AGD66	(m)	]
5	28 - 37	int	(i10)	NORTHING	[Northing AGD66	(m)	]
6	38 - 50	real	(f13.6)	LATITUDE	[Latitude AGD66	(deg)	]
7	51 - 63	real	(f13.6)	LONGITUDE	[Longitude AGD66	(deg)	]
8	64 - 72	int	(i 9)	EASTING	[Easting WGS84	(m)	]
9	73 - 82	int	(i10)	NORTHING	[Northing WGS84	(m)	]
10	83 - 90	real	(f 8.2)	TxHeight	[GPS height	(m)	]
11	91 - 98	real	(f 8.2)	TxRalt_raw	[Raw Radar Altimeter	(m)	]
12	99 - 106	real	(f 8.2)	TxRalt_final	[Final Radar Altimeter	(m)	]
13	107 - 114	real	(f 8.2)	DTM	[DTM	(m)	]
14	115 - 124	real	(f10.3)	MAG	[Final TMI	(nT)	]
15	125 - 136	real	(f12.5)	MAG_1VD	[Final TMI 1VD	(nT/m)	]

```
 16   137 - 146  real (f10.5) Pitch_Raw          [Raw Tx loop pitch                   (deg) ]
 17   147 - 156  real (f10.5) Roll_Raw           [Raw Tx loop roll                    (deg) ]
 18   157 - 164  real (f 8.2) HSep_Raw           [Raw Tx-Rx horizontal separation       (m) ]
 19   165 - 172  real (f 8.2) VSep_Raw           [Raw Tx-Rx vertical separation         (m) ]
 20   173 - 184  real (f12.6) EMX_Raw[1]         [Window X01 Raw                   (fT)    ]
 21   185 - 196  real (f12.6) EMX_Raw[2]         [Window X02 Raw                   (fT)    ]
 22   197 - 208  real (f12.6) EMX_Raw[3]         [Window X03 Raw                   (fT)    ]
 23   209 - 220  real (f12.6) EMX_Raw[4]         [Window X04 Raw                   (fT)    ]
 24   221 - 232  real (f12.6) EMX_Raw[5]         [Window X05 Raw                   (fT)    ]
 25   233 - 244  real (f12.6) EMX_Raw[6]         [Window X06 Raw                   (fT)    ]
 26   245 - 256  real (f12.6) EMX_Raw[7]         [Window X07 Raw                   (fT)    ]
 27   257 - 268  real (f12.6) EMX_Raw[8]         [Window X08 Raw                   (fT)    ]
 28   269 - 280  real (f12.6) EMX_Raw[9]         [Window X09 Raw                   (fT)    ]
 29   281 - 292  real (f12.6) EMX_Raw[10]        [Window X10 Raw                   (fT)    ]
 30   293 - 304  real (f12.6) EMX_Raw[11]        [Window X11 Raw                   (fT)    ]
 31   305 - 316  real (f12.6) EMX_Raw[12]        [Window X12 Raw                   (fT)    ]
 32   317 - 328  real (f12.6) EMX_Raw[13]        [Window X13 Raw                   (fT)    ]
 33   329 - 340  real (f12.6) EMX_Raw[14]        [Window X14 Raw                   (fT)    ]
 34   341 - 352  real (f12.6) EMX_Raw[15]        [Window X15 Raw                   (fT)    ]
 35   353 - 362  real (f10.5) Pitch_Final        [Final Tx loop pitch                 (deg) ]
 36   363 - 372  real (f10.5) Roll_Final         [Final Tx loop roll                  (deg) ]
 37   373 - 380  real (f 8.2) HSep_Final         [Final Tx-Rx horizontal separation     (m) ]
 38   381 - 388  real (f 8.2) VSep_Final         [Final Tx-Rx vertical separation       (m) ]
 39   389 - 400  real (f12.6) EMX_Final[1]       [Window X01 Final                 (fT)    ]
 40   401 - 412  real (f12.6) EMX_Final[2]       [Window X02 Final                 (fT)    ]
 41   413 - 424  real (f12.6) EMX_Final[3]       [Window X03 Final                 (fT)    ]
 42   425 - 436  real (f12.6) EMX_Final[4]       [Window X04 Final                 (fT)    ]
 43   437 - 448  real (f12.6) EMX_Final[5]       [Window X05 Final                 (fT)    ]
 44   449 - 460  real (f12.6) EMX_Final[6]       [Window X06 Final                 (fT)    ]
 45   461 - 472  real (f12.6) EMX_Final[7]       [Window X07 Final                 (fT)    ]
 46   473 - 484  real (f12.6) EMX_Final[8]       [Window X08 Final                 (fT)    ]
 47   485 - 496  real (f12.6) EMX_Final[9]       [Window X09 Final                 (fT)    ]
 48   497 - 508  real (f12.6) EMX_Final[10]      [Window X10 Final                 (fT)    ]
 49   509 - 520  real (f12.6) EMX_Final[11]      [Window X11 Final                 (fT)    ]
 50   521 - 532  real (f12.6) EMX_Final[12]      [Window X12 Final                 (fT)    ]
 51   533 - 544  real (f12.6) EMX_Final[13]      [Window X13 Final                 (fT)    ]
 52   545 - 556  real (f12.6) EMX_Final[14]      [Window X14 Final                 (fT)    ]
 53   557 - 568  real (f12.6) EMX_Final[15]      [Window X15 Final                 (fT)    ]
 54   569 - 578  real (f10.3) X_Sferics          [X_Sferics                                ]
 55   579 - 588  real (f10.3) X_Lowfreq          [X_Lowfreq                                ]
 56   589 - 598  real (f10.3) X_Powerline        [X_Powerline                              ]
 57   599 - 608  real (f10.3) X_kHz_182          [X_kHz_18.2                               ]
 58   609 - 618  real (f10.3) X_kHz_198          [X_kHz_19.8                               ]
 59   619 - 628  real (f10.3) X_kHz_214          [X_kHz_21.4                               ]
 60   629 - 638  real (f10.3) X_kHz_222          [X_kHz_22.2                               ]
 61   639 - 648  int  (i10)   X_Geofact          [X_Geometric factor                       ]
 62   649 - 658  real (f10.3) CNDX[1]            [Conductivity_X01 0- 5 m          (mS/m)  ]
 63   659 - 668  real (f10.3) CNDX[2]            [Conductivity_X02 5- 10 m         (mS/m)  ]
 64   669 - 678  real (f10.3) CNDX[3]            [Conductivity_X03 10- 15 m        (mS/m)  ]
 65   679 - 688  real (f10.3) CNDX[4]            [Conductivity_X04 15- 20 m        (mS/m)  ]
 66   689 - 698  real (f10.3) CNDX[5]            [Conductivity_X05 20- 25 m        (mS/m)  ]
 67   699 - 708  real (f10.3) CNDX[6]            [Conductivity_X06 25- 30 m        (mS/m)  ]
 68   709 - 718  real (f10.3) CNDX[7]            [Conductivity_X07 30- 35 m        (mS/m)  ]
 69   719 - 728  real (f10.3) CNDX[8]            [Conductivity_X08 35- 40 m        (mS/m)  ]
 70   729 - 738  real (f10.3) CNDX[9]            [Conductivity_X09 40- 45 m        (mS/m)  ]
 71   739 - 748  real (f10.3) CNDX[10]           [Conductivity_X10 45- 50 m        (mS/m)  ]
 72   749 - 758  real (f10.3) CNDX[11]           [Conductivity_X11 50- 55 m        (mS/m)  ]
 73   759 - 768  real (f10.3) CNDX[12]           [Conductivity_X12 55- 60 m        (mS/m)  ]
 74   769 - 778  real (f10.3) CNDX[13]           [Conductivity_X13 60- 65 m        (mS/m)  ]
 75   779 - 788  real (f10.3) CNDX[14]           [Conductivity_X14 65- 70 m        (mS/m)  ]
 76   789 - 798  real (f10.3) CNDX[15]           [Conductivity_X15 70- 75 m        (mS/m)  ]
 77   799 - 808  real (f10.3) CNDX[16]           [Conductivity_X16 75- 80 m        (mS/m)  ]
 78   809 - 818  real (f10.3) CNDX[17]           [Conductivity_X17 80- 85 m        (mS/m)  ]
 79   819 - 828  real (f10.3) CNDX[18]           [Conductivity_X18 85- 90 m        (mS/m)  ]
 80   829 - 838  real (f10.3) CNDX[19]           [Conductivity_X19 90- 95 m        (mS/m)  ]
 81   839 - 848  real (f10.3) CNDX[20]           [Conductivity_X20 95-100 m        (mS/m)  ]
 82   849 - 858  real (f10.3) CNDX[21]           [Conductivity_X21 100-105 m       (mS/m)  ]
 83   859 - 868  real (f10.3) CNDX[22]           [Conductivity_X22 105-110 m       (mS/m)  ]
 84   869 - 878  real (f10.3) CNDX[23]           [Conductivity_X23 110-115 m       (mS/m)  ]
 85   879 - 888  real (f10.3) CNDX[24]           [Conductivity_X24 115-120 m       (mS/m)  ]
 86   889 - 898  real (f10.3) CNDX[25]           [Conductivity_X25 120-125 m       (mS/m)  ]
 87   899 - 908  real (f10.3) CNDX[26]           [Conductivity_X26 125-130 m       (mS/m)  ]
 88   909 - 918  real (f10.3) CNDX[27]           [Conductivity_X27 130-135 m       (mS/m)  ]
 89   919 - 928  real (f10.3) CNDX[28]           [Conductivity_X28 135-140 m       (mS/m)  ]
 90   929 - 938  real (f10.3) CNDX[29]           [Conductivity_X29 140-145 m       (mS/m)  ]
 91   939 - 948  real (f10.3) CNDX[30]           [Conductivity_X30 145-150 m       (mS/m)  ]
 92   949 - 958  real (f10.3) CNDX[31]           [Conductivity_X31 150-155 m       (mS/m)  ]
 93   959 - 968  real (f10.3) CNDX[32]           [Conductivity_X32 155-160 m       (mS/m)  ]
 94   969 - 978  real (f10.3) CNDX[33]           [Conductivity_X33 160-165 m       (mS/m)  ]
 95   979 - 988  real (f10.3) CNDX[34]           [Conductivity_X34 165-170 m       (mS/m)  ]
 96   989 - 998  real (f10.3) CNDX[35]           [Conductivity_X35 170-175 m       (mS/m)  ]
 97   999 -1008  real (f10.3) CNDX[36]           [Conductivity_X36 175-180 m       (mS/m)  ]
 98  1009 -1018  real (f10.3) CNDX[37]           [Conductivity_X37 180-185 m       (mS/m)  ]
 99  1019 -1028  real (f10.3) CNDX[38]           [Conductivity_X38 185-190 m       (mS/m)  ]
100  1029 -1038  real (f10.3) CNDX[39]           [Conductivity_X39 190-195 m       (mS/m)  ]
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101  1039 -1048  real (f10.3) CNDX[40]         [Conductivity_X40 195-200 m     (mS/m)  ]
102  1049 -1058  real (f10.3) CNDX[41]         [Conductivity_X41 200-205 m     (mS/m)  ]
103  1059 -1068  real (f10.3) CNDX[42]         [Conductivity_X42 205-210 m     (mS/m)  ]
104  1069 -1078  real (f10.3) CNDX[43]         [Conductivity_X43 210-215 m     (mS/m)  ]
105  1079 -1088  real (f10.3) CNDX[44]         [Conductivity_X44 215-220 m     (mS/m)  ]
106  1089 -1098  real (f10.3) CNDX[45]         [Conductivity_X45 220-225 m     (mS/m)  ]
107  1099 -1108  real (f10.3) CNDX[46]         [Conductivity_X46 225-230 m     (mS/m)  ]
108  1109 -1118  real (f10.3) CNDX[47]         [Conductivity_X47 230-235 m     (mS/m)  ]
109  1119 -1128  real (f10.3) CNDX[48]         [Conductivity_X48 235-240 m     (mS/m)  ]
110  1129 -1138  real (f10.3) CNDX[49]         [Conductivity_X49 240-245 m     (mS/m)  ]
111  1139 -1148  real (f10.3) CNDX[50]         [Conductivity_X50 245-250 m     (mS/m)  ]
112  1149 -1158  real (f10.3) CNDX[51]         [Conductivity_X51 250-255 m     (mS/m)  ]
113  1159 -1168  real (f10.3) CNDX[52]         [Conductivity_X52 255-260 m     (mS/m)  ]
114  1169 -1178  real (f10.3) CNDX[53]         [Conductivity_X53 260-265 m     (mS/m)  ]
115  1179 -1188  real (f10.3) CNDX[54]         [Conductivity_X54 265-270 m     (mS/m)  ]
116  1189 -1198  real (f10.3) CNDX[55]         [Conductivity_X55 270-275 m     (mS/m)  ]
117  1199 -1208  real (f10.3) CNDX[56]         [Conductivity_X56 275-280 m     (mS/m)  ]
118  1209 -1218  real (f10.3) CNDX[57]         [Conductivity_X57 280-285 m     (mS/m)  ]
119  1219 -1228  real (f10.3) CNDX[58]         [Conductivity_X58 285-290 m     (mS/m)  ]
120  1229 -1238  real (f10.3) CNDX[59]         [Conductivity_X59 290-295 m     (mS/m)  ]
121  1239 -1248  real (f10.3) CNDX[60]         [Conductivity_X60 295-300 m     (mS/m)  ]
122  1249 -1258  real (f10.3) CNDX[61]         [Conductivity_X61 300-305 m     (mS/m)  ]
123  1259 -1268  real (f10.3) CNDX[62]         [Conductivity_X62 305-310 m     (mS/m)  ]
124  1269 -1278  real (f10.3) CNDX[63]         [Conductivity_X63 310-315 m     (mS/m)  ]
125  1279 -1288  real (f10.3) CNDX[64]         [Conductivity_X64 315-320 m     (mS/m)  ]
126  1289 -1298  real (f10.3) CNDX[65]         [Conductivity_X65 320-325 m     (mS/m)  ]
127  1299 -1308  real (f10.3) CNDX[66]         [Conductivity_X66 325-330 m     (mS/m)  ]
128  1309 -1318  real (f10.3) CNDX[67]         [Conductivity_X67 330-335 m     (mS/m)  ]
129  1319 -1328  real (f10.3) CNDX[68]         [Conductivity_X68 335-340 m     (mS/m)  ]
130  1329 -1338  real (f10.3) CNDX[69]         [Conductivity_X69 340-345 m     (mS/m)  ]
131  1339 -1348  real (f10.3) CNDX[70]         [Conductivity_X70 345-350 m     (mS/m)  ]
132  1349 -1358  real (f10.3) CNDX[71]         [Conductivity_X71 350-355 m     (mS/m)  ]
133  1359 -1368  real (f10.3) CNDX[72]         [Conductivity_X72 355-360 m     (mS/m)  ]
134  1369 -1378  real (f10.3) CNDX[73]         [Conductivity_X73 360-365 m     (mS/m)  ]
135  1379 -1388  real (f10.3) CNDX[74]         [Conductivity_X74 365-370 m     (mS/m)  ]
136  1389 -1398  real (f10.3) CNDX[75]         [Conductivity_X75 370-375 m     (mS/m)  ]
137  1399 -1408  real (f10.3) CNDX[76]         [Conductivity_X76 375-380 m     (mS/m)  ]
138  1409 -1418  real (f10.3) CNDX[77]         [Conductivity_X77 380-385 m     (mS/m)  ]
139  1419 -1428  real (f10.3) CNDX[78]         [Conductivity_X78 385-390 m     (mS/m)  ]
140  1429 -1438  real (f10.3) CNDX[79]         [Conductivity_X79 390-395 m     (mS/m)  ]
141  1439 -1448  real (f10.3) CNDX[80]         [Conductivity_X80 395-400 m     (mS/m)  ]
142  1449 -1458  real (f10.3) CNDX[81]         [Conductivity_X81 400-405 m     (mS/m)  ]
143  1459 -1468  real (f10.3) CNDX[82]         [Conductivity_X82 405-410 m     (mS/m)  ]
144  1469 -1478  real (f10.3) CNDX[83]         [Conductivity_X83 410-415 m     (mS/m)  ]
145  1479 -1488  real (f10.3) CNDX[84]         [Conductivity_X84 415-420 m     (mS/m)  ]
146  1489 -1498  real (f10.3) CNDX[85]         [Conductivity_X85 420-425 m     (mS/m)  ]
147  1499 -1508  real (f10.3) CNDX[86]         [Conductivity_X86 425-430 m     (mS/m)  ]
148  1509 -1518  real (f10.3) CNDX[87]         [Conductivity_X87 430-435 m     (mS/m)  ]
149  1519 -1528  real (f10.3) CNDX[88]         [Conductivity_X88 435-440 m     (mS/m)  ]
150  1529 -1538  real (f10.3) CNDX[89]         [Conductivity_X89 440-445 m     (mS/m)  ]
151  1539 -1548  real (f10.3) CNDX[90]         [Conductivity_X90 445-450 m     (mS/m)  ]
152  1549 -1558  real (f10.3) CNDX[91]         [Conductivity_X91 450-455 m     (mS/m)  ]
153  1559 -1568  real (f10.3) CNDX[92]         [Conductivity_X92 455-460 m     (mS/m)  ]
154  1569 -1578  real (f10.3) CNDX[93]         [Conductivity_X93 460-465 m     (mS/m)  ]
155  1579 -1588  real (f10.3) CNDX[94]         [Conductivity_X94 465-470 m     (mS/m)  ]
156  1589 -1598  real (f10.3) CNDX[95]         [Conductivity_X95 470-475 m     (mS/m)  ]
157  1599 -1608  real (f10.3) CNDX[96]         [Conductivity_X96 475-480 m     (mS/m)  ]
158  1609 -1618  real (f10.3) CNDX[97]         [Conductivity_X97 480-485 m     (mS/m)  ]
159  1619 -1628  real (f10.3) CNDX[98]         [Conductivity_X98 485-490 m     (mS/m)  ]
160  1629 -1638  real (f10.3) CNDX[99]         [Conductivity_X99 490-495 m     (mS/m)  ]
161  1639 -1648  real (f10.3) CNDX[100]        [Conductivity_X100 495-500 m    (mS/m)  ]
162  1649 -1658  real (f10.3) CNDX[101]        [Conductivity_X101 500-505 m    (mS/m)  ]
163  1659 -1668  real (f10.3) CNDX[102]        [Conductivity_X102 550-510 m    (mS/m)  ]
164  1669 -1678  real (f10.3) CNDX[103]        [Conductivity_X103 510-515 m    (mS/m)  ]
165  1679 -1688  real (f10.3) CNDX[104]        [Conductivity_X104 515-520 m    (mS/m)  ]
166  1689 -1698  real (f10.3) CNDX[105]        [Conductivity_X105 520-525 m    (mS/m)  ]
167  1699 -1708  real (f10.3) CNDX[106]        [Conductivity_X106 525-530 m    (mS/m)  ]
168  1709 -1718  real (f10.3) CNDX[107]        [Conductivity_X107 530-535 m    (mS/m)  ]
169  1719 -1728  real (f10.3) CNDX[108]        [Conductivity_X108 535-540 m    (mS/m)  ]
170  1729 -1738  real (f10.3) CNDX[109]        [Conductivity_X109 540-545 m    (mS/m)  ]
171  1739 -1748  real (f10.3) CNDX[110]        [Conductivity_X110 545-550 m    (mS/m)  ]
172  1749 -1758  real (f10.3) CNDX[111]        [Conductivity_X111 550-555 m    (mS/m)  ]
173  1759 -1768  real (f10.3) CNDX[112]        [Conductivity_X112 555-560 m    (mS/m)  ]
174  1769 -1778  real (f10.3) CNDX[113]        [Conductivity_X113 560-565 m    (mS/m)  ]
175  1779 -1788  real (f10.3) CNDX[114]        [Conductivity_X114 565-570 m    (mS/m)  ]
176  1789 -1798  real (f10.3) CNDX[115]        [Conductivity_X115 570-575 m    (mS/m)  ]
177  1799 -1808  real (f10.3) CNDX[116]        [Conductivity_X116 575-580 m    (mS/m)  ]
178  1809 -1818  real (f10.3) CNDX[117]        [Conductivity_X117 580-585 m    (mS/m)  ]
179  1819 -1828  real (f10.3) CNDX[118]        [Conductivity_X118 585-590 m    (mS/m)  ]
180  1829 -1838  real (f10.3) CNDX[119]        [Conductivity_X119 590-595 m    (mS/m)  ]
181  1839 -1848  real (f10.3) CNDX[120]        [Conductivity_X120 595-600 m    (mS/m)  ]
182  1849 -1858  real (f10.3) CNDX[121]        [Conductivity_X121 600-605 m    (mS/m)  ]
183  1859 -1868  real (f10.3) CNDX[122]        [Conductivity_X122 605-610 m    (mS/m)  ]
184  1869 -1878  real (f10.3) CNDX[123]        [Conductivity_X123 610-615 m    (mS/m)  ]
185  1879 -1888  real (f10.3) CNDX[124]        [Conductivity_X124 615-620 m    (mS/m)  ]
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 186  1889 -1898  real (f10.3) CNDX[125]         [Conductivity_X125 620-625 m      (mS/m)   ]
 187  1899 -1908  real (f10.3) CNDX[126]         [Conductivity_X126 625-630 m      (mS/m)   ]
 188  1909 -1918  real (f10.3) CNDX[127]         [Conductivity_X127 630-635 m      (mS/m)   ]
 189  1919 -1928  real (f10.3) CNDX[128]         [Conductivity_X128 635-640 m      (mS/m)   ]
 190  1929 -1938  real (f10.3) CNDX[129]         [Conductivity_X129 640-645 m      (mS/m)   ]
 191  1939 -1948  real (f10.3) CNDX[130]         [Conductivity_X130 645-650 m      (mS/m)   ]
 192  1949 -1958  real (f10.3) CNDX[131]         [Conductivity_X131 650-655 m      (mS/m)   ]
 193  1959 -1968  real (f10.3) CNDX[132]         [Conductivity_X132 655-660 m      (mS/m)   ]
 194  1969 -1978  real (f10.3) CNDX[133]         [Conductivity_X133 660-665 m      (mS/m)   ]
 195  1979 -1988  real (f10.3) CNDX[134]         [Conductivity_X134 665-670 m      (mS/m)   ]
 196  1989 -1998  real (f10.3) CNDX[135]         [Conductivity_X135 670-675 m      (mS/m)   ]
 197  1999 -2008  real (f10.3) CNDX[136]         [Conductivity_X136 675-680 m      (mS/m)   ]
 198  2009 -2018  real (f10.3) CNDX[137]         [Conductivity_X137 680-685 m      (mS/m)   ]
 199  2019 -2028  real (f10.3) CNDX[138]         [Conductivity_X138 685-690 m      (mS/m)   ]
 200  2029 -2038  real (f10.3) CNDX[139]         [Conductivity_X139 690-695 m      (mS/m)   ]
 201  2039 -2048  real (f10.3) CNDX[140]         [Conductivity_X140 695-700 m      (mS/m)   ]
 202  2049 -2058  real (f10.3) CNDX[141]         [Conductivity_X141 700-705 m      (mS/m)   ]
 203  2059 -2068  real (f10.3) CNDX[142]         [Conductivity_X142 705-710 m      (mS/m)   ]
 204  2069 -2078  real (f10.3) CNDX[143]         [Conductivity_X143 710-715 m      (mS/m)   ]
 205  2079 -2088  real (f10.3) CNDX[144]         [Conductivity_X144 715-720 m      (mS/m)   ]
 206  2089 -2098  real (f10.3) CNDX[145]         [Conductivity_X145 720-725 m      (mS/m)   ]
 207  2099 -2108  real (f10.3) CNDX[146]         [Conductivity_X146 725-730 m      (mS/m)   ]
 208  2109 -2118  real (f10.3) CNDX[147]         [Conductivity_X147 730-735 m      (mS/m)   ]
 209  2119 -2128  real (f10.3) CNDX[148]         [Conductivity_X148 735-740 m      (mS/m)   ]
 210  2129 -2138  real (f10.3) CNDX[149]         [Conductivity_X149 740-745 m      (mS/m)   ]
 211  2139 -2148  real (f10.3) CNDX[150]         [Conductivity_X150 745-750 m      (mS/m)   ]
 212  2149 -2158  real (f10.3) CNDX[151]         [Conductivity_X151 750-755 m      (mS/m)   ]
 213  2159 -2168  real (f10.3) CNDX[152]         [Conductivity_X152 755-760 m      (mS/m)   ]
 214  2169 -2178  real (f10.3) CNDX[153]         [Conductivity_X153 760-765 m      (mS/m)   ]
 215  2179 -2188  real (f10.3) CNDX[154]         [Conductivity_X154 765-770 m      (mS/m)   ]
 216  2189 -2198  real (f10.3) CNDX[155]         [Conductivity_X155 770-775 m      (mS/m)   ]
 217  2199 -2208  real (f10.3) CNDX[156]         [Conductivity_X156 775-780 m      (mS/m)   ]
 218  2209 -2218  real (f10.3) CNDX[157]         [Conductivity_X157 780-785 m      (mS/m)   ]
 219  2219 -2228  real (f10.3) CNDX[158]         [Conductivity_X158 785-790 m      (mS/m)   ]
 220  2229 -2238  real (f10.3) CNDX[159]         [Conductivity_X159 790-795 m      (mS/m)   ]
 221  2239 -2248  real (f10.3) CNDX[160]         [Conductivity_X160 795-800 m      (mS/m)   ]
 222  2249 -2258  real (f10.3) CNDX[161]         [Conductivity_X161 800-805 m      (mS/m)   ]
 223  2259 -2268  real (f10.3) CNDX[162]         [Conductivity_X162 805-810 m      (mS/m)   ]
 224  2269 -2278  real (f10.3) CNDX[163]         [Conductivity_X163 810-815 m      (mS/m)   ]
 225  2279 -2288  real (f10.3) CNDX[164]         [Conductivity_X164 815-820 m      (mS/m)   ]
 226  2289 -2298  real (f10.3) CNDX[165]         [Conductivity_X165 820-825 m      (mS/m)   ]
 227  2299 -2308  real (f10.3) CNDX[166]         [Conductivity_X166 825-830 m      (mS/m)   ]
 228  2309 -2318  real (f10.3) CNDX[167]         [Conductivity_X167 830-835 m      (mS/m)   ]
 229  2319 -2328  real (f10.3) CNDX[168]         [Conductivity_X168 835-840 m      (mS/m)   ]
 230  2329 -2338  real (f10.3) CNDX[169]         [Conductivity_X169 840-845 m      (mS/m)   ]
 231  2339 -2348  real (f10.3) CNDX[170]         [Conductivity_X170 845-850 m      (mS/m)   ]
 232  2349 -2358  real (f10.3) CNDX[171]         [Conductivity_X171 850-855 m      (mS/m)   ]
 233  2359 -2368  real (f10.3) CNDX[172]         [Conductivity_X172 855-860 m      (mS/m)   ]
 234  2369 -2378  real (f10.3) CNDX[173]         [Conductivity_X173 860-865 m      (mS/m)   ]
 235  2379 -2388  real (f10.3) CNDX[174]         [Conductivity_X174 865-870 m      (mS/m)   ]
 236  2389 -2398  real (f10.3) CNDX[175]         [Conductivity_X175 870-875 m      (mS/m)   ]
 237  2399 -2408  real (f10.3) CNDX[176]         [Conductivity_X176 875-880 m      (mS/m)   ]
 238  2409 -2418  real (f10.3) CNDX[177]         [Conductivity_X177 880-885 m      (mS/m)   ]
 239  2419 -2428  real (f10.3) CNDX[178]         [Conductivity_X178 885-890 m      (mS/m)   ]
 240  2429 -2438  real (f10.3) CNDX[179]         [Conductivity_X179 890-895 m      (mS/m)   ]
 241  2439 -2448  real (f10.3) CNDX[180]         [Conductivity_X180 895-900 m      (mS/m)   ]
 242  2449 -2458  real (f10.3) CNDX[181]         [Conductivity_X181 900-905 m      (mS/m)   ]
 243  2459 -2468  real (f10.3) CNDX[182]         [Conductivity_X182 905-910 m      (mS/m)   ]
 244  2469 -2478  real (f10.3) CNDX[183]         [Conductivity_X183 910-915 m      (mS/m)   ]
 245  2479 -2488  real (f10.3) CNDX[184]         [Conductivity_X184 915-920 m      (mS/m)   ]
 246  2489 -2498  real (f10.3) CNDX[185]         [Conductivity_X185 920-925 m      (mS/m)   ]
 247  2499 -2508  real (f10.3) CNDX[186]         [Conductivity_X186 925-930 m      (mS/m)   ]
 248  2509 -2518  real (f10.3) CNDX[187]         [Conductivity_X187 930-935 m      (mS/m)   ]
 249  2519 -2528  real (f10.3) CNDX[188]         [Conductivity_X188 935-940 m      (mS/m)   ]
 250  2529 -2538  real (f10.3) CNDX[189]         [Conductivity_X189 940-945 m      (mS/m)   ]
 251  2539 -2548  real (f10.3) CNDX[190]         [Conductivity_X190 945-950 m      (mS/m)   ]
 252  2549 -2558  real (f10.3) CNDX[191]         [Conductivity_X191 950-955 m      (mS/m)   ]
 253  2559 -2568  real (f10.3) CNDX[192]         [Conductivity_X192 955-960 m      (mS/m)   ]
      2569 -2570 <newline>
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Total number of lines :   10

Flt	Line	Start X	Start Y	End X	End Y	Kms
6	10100	291755	8615698	291751	8602430	13.27
6	10030	290369	8602342	290364	8615642	13.30
6	10080	291333	8615687	291358	8602387	13.30
6	10010	289950	8602336	289968	8615617	13.28
6	10060	290948	8615677	290971	8602435	13.24
6	10090	291541	8602354	291557	8615620	13.27
6	10040	290567	8615703	290538	8602415	13.29
6	10070	291149	8602338	291146	8615637	13.30
6	10020	290192	8615693	290135	8602393	13.30
6	10050	290743	8602318	290770	8615661	13.34

Total Kilometres : 132.89

Algoda_Tempest_Z.hdr

```
COMM CLIENT:                                          CAMECO AUSTRALIA PTY LTD
COMM SURVEY TYPE:                                                 25Hz TEMPEST
COMM AREA NAME:                                           Algoda, Arnhem Land
COMM STATE:                                               Northern Territory
COMM COUNTRY:                                                      Australia
COMM JOB NUMBER:                                                      1622.1
COMM DATE FLOWN:                                               November 2003
COMM SURVEY COMPANY:                                  Fugro Airborne Surveys
COMM LOCATED DATA CREATED:                                      January 2004
COMM
COMM DATUM:                                                            AGD66
COMM PROJECTION:                                                         AMG
COMM ZONE:                                                                53
COMM
COMM
COMM AIRBORNE EQUIPMENT
COMM ------------------
COMM
COMM AIRCRAFT:                                    CASA C212 Turbo Prop, VH-TEM
COMM MAGNETOMETER:                            Cesium Vapour optical absorption
COMM INSTALLATION:                                                   Stinger
COMM SENSITIVITY:                                                    0.01 nT
COMM RECORDING INTERVAL:                    0.2 sec (approx 14 m sampling)
COMM
COMM ELECTROMAGNETIC SYSTEM:                                         TEMPEST
COMM INSTALLATION:                  Transmitter loop mounted on the aircraft
COMM                                          receiver coils in a towed bird
COMM COIL ORIENTATION:                                               X and Z
COMM FREQUENCY:                                                        25 Hz
COMM GEOMETRY:                                                   (see below)
COMM SAMPLING:                              0.2 sec (approx 13 m sampling)
COMM ALTIMETER:                                           Sperry Stars AA200
COMM RECORDING INTERVAL:                                             0.2 sec
COMM NAVIGATION:     Post-processed differential GPS used in processing,
COMM                 real-time satellite differential GPS used in-flight
COMM RECORDING INTERVAL:                                               1 sec
COMM BASE MAGNETOMETER:                       Cesium vapour optical absorption
COMM RECORDING INTERVAL:                                               1 sec
COMM VIDEO:                                                         Acquired
COMM
COMM ACQUISITION SYSTEM:                                           PDAS-1000
COMM
COMM
COMM AIRBORNE SPECIFICATIONS
COMM -----------------------
COMM
COMM TRAVERSE LINE SPACING:                                            200 m
COMM TRAVERSE LINE DIRECTION:                                        000-180
COMM NOMINAL TERRAIN CLEARANCE:                              110 m (Aircraft)
COMM LINE KILOMETREAGE:                                               133 km
COMM
COMM
COMM SURVEY BOUNDARY (WGS84, UTM53)
COMM ------------------------------
COMM
COMM   290072  8615682
COMM   291906  8615682
COMM   291906  8602684
COMM   290056  8602684
COMM
COMM LINE NUMBERING:
COMM ---------------
COMM
COMM FLIGHT LINE NUMBERS:                                    10010 - 10100
COMM
COMM
COMM PROCESSING DETAILS
COMM ===================
COMM
COMM DATA PROCESSING:
COMM ----------------
COMM
COMM MAGNETIC DATA: (not required for this survey)
COMM SYSTEM PARALLAX REMOVED                                     (see below)
COMM
COMM DIGITAL TERRAIN MODEL:
COMM SPIKES REMOVED FROM RADAR ALTIMETER
COMM DTM CALCULATED [DTM = gps_height - radar]
COMM
COMM EM DATA:
COMM SYSTEM PARALLAX REMOVED                                     (see below)
COMM DATA CORRECTED FOR            TRANSMITTER HEIGHT, PITCH & ROLL AND
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COMM                            TRANSMITTER-RECEIVER GEOMETRY VARIATIONS
COMM CONDUCTIVITY DEPTH INVERSIONS CALCULATED                EMFlow V5.1
COMM MICROLEVELLING APPLIED
COMM
COMM
COMM SYSTEM GEOMETRY:
COMM ----------------
COMM
COMM THE TRANSMITTER-RECEIVER GEOMETRY IS:
COMM
COMM TRANSMITTER TERRAIN CLEARANCE:                           110 metres
COMM DISTANCE BEHIND THE AIRCRAFT:                            120 metres
COMM DISTANCE BELOW THE AIRCRAFT:                              38 metres
COMM
COMM PARALLAX CORRECTIONS:
COMM ----------------------
COMM
COMM FOR THIS DATA SET, THE FOLLOWING PARALLAX VALUES WERE APPLIED:
COMM
COMM X-COMPONENT EM DATA:                                      1 samples
COMM Z-COMPONENT EM DATA:                                      7 samples
COMM RADAR ALIMETER:                                           3 samples
COMM MAGNETOMETER:                                             2 samples
COMM
COMM ELECTROMAGNETIC SYSTEM:
COMM ------------------------
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 (~13 METRES).
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 msec
COMM
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Output field format : DOS - Flat ascii
Number of fields : 253

Field	Columns	Type	Format	Channel	Description		
1	1 - 6	int	(i 6)	LINE	[Line		]
2	7 - 10	int	(i 4)	FLIGHT	[Flight		]
3	11 - 18	real	(f 8.1)	FID	[Fiducial	(s)	]
4	19 - 27	int	(i 9)	EASTING	[Easting AGD66	(m)	]
5	28 - 37	int	(i10)	NORTHING	[Northing AGD66	(m)	]
6	38 - 50	real	(f13.6)	LATITUDE	[Latitude AGD66	(deg)	]
7	51 - 63	real	(f13.6)	LONGITUDE	[Longitude AGD66	(deg)	]
8	64 - 72	int	(i 9)	EASTING	[Easting WGS84	(m)	]
9	73 - 82	int	(i10)	NORTHING	[Northing WGS84	(m)	]
10	83 - 90	real	(f 8.2)	TxHeight	[GPS height	(m)	]
11	91 - 98	real	(f 8.2)	TxRalt_raw	[Raw Radar Altimeter	(m)	]
12	99 - 106	real	(f 8.2)	TxRalt_final	[Final Radar Altimeter	(m)	]
13	107 - 114	real	(f 8.2)	DTM	[DTM	(m)	]
14	115 - 124	real	(f10.3)	MAG	[Final TMI	(nT)	]
15	125 - 136	real	(f12.5)	MAG_1VD	[Final TMI 1VD	(nT/m)	]
16	137 - 146	real	(f10.5)	Pitch_Raw	[Raw Tx loop pitch	(deg)	]
17	147 - 156	real	(f10.5)	Roll_Raw	[Raw Tx loop roll	(deg)	]
18	157 - 164	real	(f 8.2)	HSep_Raw	[Raw Tx-Rx horizontal separation	(m)	]
19	165 - 172	real	(f 8.2)	VSep_Raw	[Raw Tx-Rx vertical separation	(m)	]
20	173 - 184	real	(f12.6)	EMZ_Raw[1]	[Window Z01 Raw	(fT)	]
21	185 - 196	real	(f12.6)	EMZ_Raw[2]	[Window Z02 Raw	(fT)	]
22	197 - 208	real	(f12.6)	EMZ_Raw[3]	[Window Z03 Raw	(fT)	]
23	209 - 220	real	(f12.6)	EMZ_Raw[4]	[Window Z04 Raw	(fT)	]
24	221 - 232	real	(f12.6)	EMZ_Raw[5]	[Window Z05 Raw	(fT)	]
25	233 - 244	real	(f12.6)	EMZ_Raw[6]	[Window Z06 Raw	(fT)	]
26	245 - 256	real	(f12.6)	EMZ_Raw[7]	[Window Z07 Raw	(fT)	]

27	257 - 268	real	(f12.6)	EMZ_Raw[8]	[Window Z08 Raw	(fT)	]
28	269 - 280	real	(f12.6)	EMZ_Raw[9]	[Window Z09 Raw	(fT)	]
29	281 - 292	real	(f12.6)	EMZ_Raw[10]	[Window Z10 Raw	(fT)	]
30	293 - 304	real	(f12.6)	EMZ_Raw[11]	[Window Z11 Raw	(fT)	]
31	305 - 316	real	(f12.6)	EMZ_Raw[12]	[Window Z12 Raw	(fT)	]
32	317 - 328	real	(f12.6)	EMZ_Raw[13]	[Window Z13 Raw	(fT)	]
33	329 - 340	real	(f12.6)	EMZ_Raw[14]	[Window Z14 Raw	(fT)	]
34	341 - 352	real	(f12.6)	EMZ_Raw[15]	[Window Z15 Raw	(fT)	]
35	353 - 362	real	(f10.5)	Pitch_Final	[Final Tx loop pitch	(deg)	]
36	363 - 372	real	(f10.5)	Roll_Final	[Final Tx loop roll	(deg)	]
37	373 - 380	real	(f 8.2)	HSep_Final	[Final Tx-Rx horizontal separation	(m)	]
38	381 - 388	real	(f 8.2)	VSep_Final	[Final Tx-Rx vertical separation	(m)	]
39	389 - 400	real	(f12.6)	EMZ_Final[1]	[Window Z01 Final	(fT)	]
40	401 - 412	real	(f12.6)	EMZ_Final[2]	[Window Z02 Final	(fT)	]
41	413 - 424	real	(f12.6)	EMZ_Final[3]	[Window Z03 Final	(fT)	]
42	425 - 436	real	(f12.6)	EMZ_Final[4]	[Window Z04 Final	(fT)	]
43	437 - 448	real	(f12.6)	EMZ_Final[5]	[Window Z05 Final	(fT)	]
44	449 - 460	real	(f12.6)	EMZ_Final[6]	[Window Z06 Final	(fT)	]
45	461 - 472	real	(f12.6)	EMZ_Final[7]	[Window Z07 Final	(fT)	]
46	473 - 484	real	(f12.6)	EMZ_Final[8]	[Window Z08 Final	(fT)	]
47	485 - 496	real	(f12.6)	EMZ_Final[9]	[Window Z09 Final	(fT)	]
48	497 - 508	real	(f12.6)	EMZ_Final[10]	[Window Z10 Final	(fT)	]
49	509 - 520	real	(f12.6)	EMZ_Final[11]	[Window Z11 Final	(fT)	]
50	521 - 532	real	(f12.6)	EMZ_Final[12]	[Window Z12 Final	(fT)	]
51	533 - 544	real	(f12.6)	EMZ_Final[13]	[Window Z13 Final	(fT)	]
52	545 - 556	real	(f12.6)	EMZ_Final[14]	[Window Z14 Final	(fT)	]
53	557 - 568	real	(f12.6)	EMZ_Final[15]	[Window Z15 Final	(fT)	]
54	569 - 578	real	(f10.3)	Z_Sferics	[Z_Sferics		]
55	579 - 588	real	(f10.3)	Z_Lowfreq	[Z_Lowfreq		]
56	589 - 598	real	(f10.3)	Z_Powerline	[Z_Powerline		]
57	599 - 608	real	(f10.3)	Z_kHz_182	[Z_kHz_18.2		]
58	609 - 618	real	(f10.3)	Z_kHz_198	[Z_kHz_19.8		]
59	619 - 628	real	(f10.3)	Z_kHz_214	[Z_kHz_21.4		]
60	629 - 638	real	(f10.3)	Z_kHz_222	[Z_kHz_22.2		]
61	639 - 648	int	(i10)	Z_Geofact	[Z_Geometric factor		]
62	649 - 658	real	(f10.3)	CNDZ[1]	[Conductivity_Z01 0- 5 m	(mS/m)	]
63	659 - 668	real	(f10.3)	CNDZ[2]	[Conductivity_Z02 5- 10 m	(mS/m)	]
64	669 - 678	real	(f10.3)	CNDZ[3]	[Conductivity_Z03 10- 15 m	(mS/m)	]
65	679 - 688	real	(f10.3)	CNDZ[4]	[Conductivity_Z04 15- 20 m	(mS/m)	]
66	689 - 698	real	(f10.3)	CNDZ[5]	[Conductivity_Z05 20- 25 m	(mS/m)	]
67	699 - 708	real	(f10.3)	CNDZ[6]	[Conductivity_Z06 25- 30 m	(mS/m)	]
68	709 - 718	real	(f10.3)	CNDZ[7]	[Conductivity_Z07 30- 35 m	(mS/m)	]
69	719 - 728	real	(f10.3)	CNDZ[8]	[Conductivity_Z08 35- 40 m	(mS/m)	]
70	729 - 738	real	(f10.3)	CNDZ[9]	[Conductivity_Z09 40- 45 m	(mS/m)	]
71	739 - 748	real	(f10.3)	CNDZ[10]	[Conductivity_Z10 45- 50 m	(mS/m)	]
72	749 - 758	real	(f10.3)	CNDZ[11]	[Conductivity_Z11 50- 55 m	(mS/m)	]
73	759 - 768	real	(f10.3)	CNDZ[12]	[Conductivity_Z12 55- 60 m	(mS/m)	]
74	769 - 778	real	(f10.3)	CNDZ[13]	[Conductivity_Z13 60- 65 m	(mS/m)	]
75	779 - 788	real	(f10.3)	CNDZ[14]	[Conductivity_Z14 65- 70 m	(mS/m)	]
76	789 - 798	real	(f10.3)	CNDZ[15]	[Conductivity_Z15 70- 75 m	(mS/m)	]
77	799 - 808	real	(f10.3)	CNDZ[16]	[Conductivity_Z16 75- 80 m	(mS/m)	]
78	809 - 818	real	(f10.3)	CNDZ[17]	[Conductivity_Z17 80- 85 m	(mS/m)	]
79	819 - 828	real	(f10.3)	CNDZ[18]	[Conductivity_Z18 85- 90 m	(mS/m)	]
80	829 - 838	real	(f10.3)	CNDZ[19]	[Conductivity_Z19 90- 95 m	(mS/m)	]
81	839 - 848	real	(f10.3)	CNDZ[20]	[Conductivity_Z20 95-100 m	(mS/m)	]
82	849 - 858	real	(f10.3)	CNDZ[21]	[Conductivity_Z21 100-105 m	(mS/m)	]
83	859 - 868	real	(f10.3)	CNDZ[22]	[Conductivity_Z22 105-110 m	(mS/m)	]
84	869 - 878	real	(f10.3)	CNDZ[23]	[Conductivity_Z23 110-115 m	(mS/m)	]
85	879 - 888	real	(f10.3)	CNDZ[24]	[Conductivity_Z24 115-120 m	(mS/m)	]
86	889 - 898	real	(f10.3)	CNDZ[25]	[Conductivity_Z25 120-125 m	(mS/m)	]
87	899 - 908	real	(f10.3)	CNDZ[26]	[Conductivity_Z26 125-130 m	(mS/m)	]
88	909 - 918	real	(f10.3)	CNDZ[27]	[Conductivity_Z27 130-135 m	(mS/m)	]
89	919 - 928	real	(f10.3)	CNDZ[28]	[Conductivity_Z28 135-140 m	(mS/m)	]
90	929 - 938	real	(f10.3)	CNDZ[29]	[Conductivity_Z29 140-145 m	(mS/m)	]
91	939 - 948	real	(f10.3)	CNDZ[30]	[Conductivity_Z30 145-150 m	(mS/m)	]
92	949 - 958	real	(f10.3)	CNDZ[31]	[Conductivity_Z31 150-155 m	(mS/m)	]
93	959 - 968	real	(f10.3)	CNDZ[32]	[Conductivity_Z32 155-160 m	(mS/m)	]
94	969 - 978	real	(f10.3)	CNDZ[33]	[Conductivity_Z33 160-165 m	(mS/m)	]
95	979 - 988	real	(f10.3)	CNDZ[34]	[Conductivity_Z34 165-170 m	(mS/m)	]
96	989 - 998	real	(f10.3)	CNDZ[35]	[Conductivity_Z35 170-175 m	(mS/m)	]
97	999 -1008	real	(f10.3)	CNDZ[36]	[Conductivity_Z36 175-180 m	(mS/m)	]
98	1009 -1018	real	(f10.3)	CNDZ[37]	[Conductivity_Z37 180-185 m	(mS/m)	]
99	1019 -1028	real	(f10.3)	CNDZ[38]	[Conductivity_Z38 185-190 m	(mS/m)	]
100	1029 -1038	real	(f10.3)	CNDZ[39]	[Conductivity_Z39 190-195 m	(mS/m)	]
101	1039 -1048	real	(f10.3)	CNDZ[40]	[Conductivity_Z40 195-200 m	(mS/m)	]
102	1049 -1058	real	(f10.3)	CNDZ[41]	[Conductivity_Z41 200-205 m	(mS/m)	]
103	1059 -1068	real	(f10.3)	CNDZ[42]	[Conductivity_Z42 205-210 m	(mS/m)	]
104	1069 -1078	real	(f10.3)	CNDZ[43]	[Conductivity_Z43 210-215 m	(mS/m)	]
105	1079 -1088	real	(f10.3)	CNDZ[44]	[Conductivity_Z44 215-220 m	(mS/m)	]
106	1089 -1098	real	(f10.3)	CNDZ[45]	[Conductivity_Z45 220-225 m	(mS/m)	]
107	1099 -1108	real	(f10.3)	CNDZ[46]	[Conductivity_Z46 225-230 m	(mS/m)	]
108	1109 -1118	real	(f10.3)	CNDZ[47]	[Conductivity_Z47 230-235 m	(mS/m)	]
109	1119 -1128	real	(f10.3)	CNDZ[48]	[Conductivity_Z48 235-240 m	(mS/m)	]
110	1129 -1138	real	(f10.3)	CNDZ[49]	[Conductivity_Z49 240-245 m	(mS/m)	]
111	1139 -1148	real	(f10.3)	CNDZ[50]	[Conductivity_Z50 245-250 m	(mS/m)	]

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112  1149 -1158  real (f10.3) CNDZ[51]        [Conductivity_Z51 250-255 m     (mS/m)  ]
113  1159 -1168  real (f10.3) CNDZ[52]        [Conductivity_Z52 255-260 m     (mS/m)  ]
114  1169 -1178  real (f10.3) CNDZ[53]        [Conductivity_Z53 260-265 m     (mS/m)  ]
115  1179 -1188  real (f10.3) CNDZ[54]        [Conductivity_Z54 265-270 m     (mS/m)  ]
116  1189 -1198  real (f10.3) CNDZ[55]        [Conductivity_Z55 270-275 m     (mS/m)  ]
117  1199 -1208  real (f10.3) CNDZ[56]        [Conductivity_Z56 275-280 m     (mS/m)  ]
118  1209 -1218  real (f10.3) CNDZ[57]        [Conductivity_Z57 280-285 m     (mS/m)  ]
119  1219 -1228  real (f10.3) CNDZ[58]        [Conductivity_Z58 285-290 m     (mS/m)  ]
120  1229 -1238  real (f10.3) CNDZ[59]        [Conductivity_Z59 290-295 m     (mS/m)  ]
121  1239 -1248  real (f10.3) CNDZ[60]        [Conductivity_Z60 295-300 m     (mS/m)  ]
122  1249 -1258  real (f10.3) CNDZ[61]        [Conductivity_Z61 300-305 m     (mS/m)  ]
123  1259 -1268  real (f10.3) CNDZ[62]        [Conductivity_Z62 305-310 m     (mS/m)  ]
124  1269 -1278  real (f10.3) CNDZ[63]        [Conductivity_Z63 310-315 m     (mS/m)  ]
125  1279 -1288  real (f10.3) CNDZ[64]        [Conductivity_Z64 315-320 m     (mS/m)  ]
126  1289 -1298  real (f10.3) CNDZ[65]        [Conductivity_Z65 320-325 m     (mS/m)  ]
127  1299 -1308  real (f10.3) CNDZ[66]        [Conductivity_Z66 325-330 m     (mS/m)  ]
128  1309 -1318  real (f10.3) CNDZ[67]        [Conductivity_Z67 330-335 m     (mS/m)  ]
129  1319 -1328  real (f10.3) CNDZ[68]        [Conductivity_Z68 335-340 m     (mS/m)  ]
130  1329 -1338  real (f10.3) CNDZ[69]        [Conductivity_Z69 340-345 m     (mS/m)  ]
131  1339 -1348  real (f10.3) CNDZ[70]        [Conductivity_Z70 345-350 m     (mS/m)  ]
132  1349 -1358  real (f10.3) CNDZ[71]        [Conductivity_Z71 350-355 m     (mS/m)  ]
133  1359 -1368  real (f10.3) CNDZ[72]        [Conductivity_Z72 355-360 m     (mS/m)  ]
134  1369 -1378  real (f10.3) CNDZ[73]        [Conductivity_Z73 360-365 m     (mS/m)  ]
135  1379 -1388  real (f10.3) CNDZ[74]        [Conductivity_Z74 365-370 m     (mS/m)  ]
136  1389 -1398  real (f10.3) CNDZ[75]        [Conductivity_Z75 370-375 m     (mS/m)  ]
137  1399 -1408  real (f10.3) CNDZ[76]        [Conductivity_Z76 375-380 m     (mS/m)  ]
138  1409 -1418  real (f10.3) CNDZ[77]        [Conductivity_Z77 380-385 m     (mS/m)  ]
139  1419 -1428  real (f10.3) CNDZ[78]        [Conductivity_Z78 385-390 m     (mS/m)  ]
140  1429 -1438  real (f10.3) CNDZ[79]        [Conductivity_Z79 390-395 m     (mS/m)  ]
141  1439 -1448  real (f10.3) CNDZ[80]        [Conductivity_Z80 395-400 m     (mS/m)  ]
142  1449 -1458  real (f10.3) CNDZ[81]        [Conductivity_Z81 400-405 m     (mS/m)  ]
143  1459 -1468  real (f10.3) CNDZ[82]        [Conductivity_Z82 405-410 m     (mS/m)  ]
144  1469 -1478  real (f10.3) CNDZ[83]        [Conductivity_Z83 410-415 m     (mS/m)  ]
145  1479 -1488  real (f10.3) CNDZ[84]        [Conductivity_Z84 415-420 m     (mS/m)  ]
146  1489 -1498  real (f10.3) CNDZ[85]        [Conductivity_Z85 420-425 m     (mS/m)  ]
147  1499 -1508  real (f10.3) CNDZ[86]        [Conductivity_Z86 425-430 m     (mS/m)  ]
148  1509 -1518  real (f10.3) CNDZ[87]        [Conductivity_Z87 430-435 m     (mS/m)  ]
149  1519 -1528  real (f10.3) CNDZ[88]        [Conductivity_Z88 435-440 m     (mS/m)  ]
150  1529 -1538  real (f10.3) CNDZ[89]        [Conductivity_Z89 440-445 m     (mS/m)  ]
151  1539 -1548  real (f10.3) CNDZ[90]        [Conductivity_Z90 445-450 m     (mS/m)  ]
152  1549 -1558  real (f10.3) CNDZ[91]        [Conductivity_Z91 450-455 m     (mS/m)  ]
153  1559 -1568  real (f10.3) CNDZ[92]        [Conductivity_Z92 455-460 m     (mS/m)  ]
154  1569 -1578  real (f10.3) CNDZ[93]        [Conductivity_Z93 460-465 m     (mS/m)  ]
155  1579 -1588  real (f10.3) CNDZ[94]        [Conductivity_Z94 465-470 m     (mS/m)  ]
156  1589 -1598  real (f10.3) CNDZ[95]        [Conductivity_Z95 470-475 m     (mS/m)  ]
157  1599 -1608  real (f10.3) CNDZ[96]        [Conductivity_Z96 475-480 m     (mS/m)  ]
158  1609 -1618  real (f10.3) CNDZ[97]        [Conductivity_Z97 480-485 m     (mS/m)  ]
159  1619 -1628  real (f10.3) CNDZ[98]        [Conductivity_Z98 485-490 m     (mS/m)  ]
160  1629 -1638  real (f10.3) CNDZ[99]        [Conductivity_Z99 490-495 m     (mS/m)  ]
161  1639 -1648  real (f10.3) CNDZ[100]       [Conductivity_Z100 495-500 m    (mS/m)  ]
162  1649 -1658  real (f10.3) CNDZ[101]       [Conductivity_Z101 500-505 m    (mS/m)  ]
163  1659 -1668  real (f10.3) CNDZ[102]       [Conductivity_Z102 550-510 m    (mS/m)  ]
164  1669 -1678  real (f10.3) CNDZ[103]       [Conductivity_Z103 510-515 m    (mS/m)  ]
165  1679 -1688  real (f10.3) CNDZ[104]       [Conductivity_Z104 515-520 m    (mS/m)  ]
166  1689 -1698  real (f10.3) CNDZ[105]       [Conductivity_Z105 520-525 m    (mS/m)  ]
167  1699 -1708  real (f10.3) CNDZ[106]       [Conductivity_Z106 525-530 m    (mS/m)  ]
168  1709 -1718  real (f10.3) CNDZ[107]       [Conductivity_Z107 530-535 m    (mS/m)  ]
169  1719 -1728  real (f10.3) CNDZ[108]       [Conductivity_Z108 535-540 m    (mS/m)  ]
170  1729 -1738  real (f10.3) CNDZ[109]       [Conductivity_Z109 540-545 m    (mS/m)  ]
171  1739 -1748  real (f10.3) CNDZ[110]       [Conductivity_Z110 545-550 m    (mS/m)  ]
172  1749 -1758  real (f10.3) CNDZ[111]       [Conductivity_Z111 550-555 m    (mS/m)  ]
173  1759 -1768  real (f10.3) CNDZ[112]       [Conductivity_Z112 555-560 m    (mS/m)  ]
174  1769 -1778  real (f10.3) CNDZ[113]       [Conductivity_Z113 560-565 m    (mS/m)  ]
175  1779 -1788  real (f10.3) CNDZ[114]       [Conductivity_Z114 565-570 m    (mS/m)  ]
176  1789 -1798  real (f10.3) CNDZ[115]       [Conductivity_Z115 570-575 m    (mS/m)  ]
177  1799 -1808  real (f10.3) CNDZ[116]       [Conductivity_Z116 575-580 m    (mS/m)  ]
178  1809 -1818  real (f10.3) CNDZ[117]       [Conductivity_Z117 580-585 m    (mS/m)  ]
179  1819 -1828  real (f10.3) CNDZ[118]       [Conductivity_Z118 585-590 m    (mS/m)  ]
180  1829 -1838  real (f10.3) CNDZ[119]       [Conductivity_Z119 590-595 m    (mS/m)  ]
181  1839 -1848  real (f10.3) CNDZ[120]       [Conductivity_Z120 595-600 m    (mS/m)  ]
182  1849 -1858  real (f10.3) CNDZ[121]       [Conductivity_Z121 600-605 m    (mS/m)  ]
183  1859 -1868  real (f10.3) CNDZ[122]       [Conductivity_Z122 605-610 m    (mS/m)  ]
184  1869 -1878  real (f10.3) CNDZ[123]       [Conductivity_Z123 610-615 m    (mS/m)  ]
185  1879 -1888  real (f10.3) CNDZ[124]       [Conductivity_Z124 615-620 m    (mS/m)  ]
186  1889 -1898  real (f10.3) CNDZ[125]       [Conductivity_Z125 620-625 m    (mS/m)  ]
187  1899 -1908  real (f10.3) CNDZ[126]       [Conductivity_Z126 625-630 m    (mS/m)  ]
188  1909 -1918  real (f10.3) CNDZ[127]       [Conductivity_Z127 630-635 m    (mS/m)  ]
189  1919 -1928  real (f10.3) CNDZ[128]       [Conductivity_Z128 635-640 m    (mS/m)  ]
190  1929 -1938  real (f10.3) CNDZ[129]       [Conductivity_Z129 640-645 m    (mS/m)  ]
191  1939 -1948  real (f10.3) CNDZ[130]       [Conductivity_Z130 645-650 m    (mS/m)  ]
192  1949 -1958  real (f10.3) CNDZ[131]       [Conductivity_Z131 650-655 m    (mS/m)  ]
193  1959 -1968  real (f10.3) CNDZ[132]       [Conductivity_Z132 655-660 m    (mS/m)  ]
194  1969 -1978  real (f10.3) CNDZ[133]       [Conductivity_Z133 660-665 m    (mS/m)  ]
195  1979 -1988  real (f10.3) CNDZ[134]       [Conductivity_Z134 665-670 m    (mS/m)  ]
196  1989 -1998  real (f10.3) CNDZ[135]       [Conductivity_Z135 670-675 m    (mS/m)  ]
```

```
 197  1999 -2008  real (f10.3) CNDZ[136]          [Conductivity_Z136 675-680 m     (mS/m)   ]
 198  2009 -2018  real (f10.3) CNDZ[137]          [Conductivity_Z137 680-685 m     (mS/m)   ]
 199  2019 -2028  real (f10.3) CNDZ[138]          [Conductivity_Z138 685-690 m     (mS/m)   ]
 200  2029 -2038  real (f10.3) CNDZ[139]          [Conductivity_Z139 690-695 m     (mS/m)   ]
 201  2039 -2048  real (f10.3) CNDZ[140]          [Conductivity_Z140 695-700 m     (mS/m)   ]
 202  2049 -2058  real (f10.3) CNDZ[141]          [Conductivity_Z141 700-705 m     (mS/m)   ]
 203  2059 -2068  real (f10.3) CNDZ[142]          [Conductivity_Z142 705-710 m     (mS/m)   ]
 204  2069 -2078  real (f10.3) CNDZ[143]          [Conductivity_Z143 710-715 m     (mS/m)   ]
 205  2079 -2088  real (f10.3) CNDZ[144]          [Conductivity_Z144 715-720 m     (mS/m)   ]
 206  2089 -2098  real (f10.3) CNDZ[145]          [Conductivity_Z145 720-725 m     (mS/m)   ]
 207  2099 -2108  real (f10.3) CNDZ[146]          [Conductivity_Z146 725-730 m     (mS/m)   ]
 208  2109 -2118  real (f10.3) CNDZ[147]          [Conductivity_Z147 730-735 m     (mS/m)   ]
 209  2119 -2128  real (f10.3) CNDZ[148]          [Conductivity_Z148 735-740 m     (mS/m)   ]
 210  2129 -2138  real (f10.3) CNDZ[149]          [Conductivity_Z149 740-745 m     (mS/m)   ]
 211  2139 -2148  real (f10.3) CNDZ[150]          [Conductivity_Z150 745-750 m     (mS/m)   ]
 212  2149 -2158  real (f10.3) CNDZ[151]          [Conductivity_Z151 750-755 m     (mS/m)   ]
 213  2159 -2168  real (f10.3) CNDZ[152]          [Conductivity_Z152 755-760 m     (mS/m)   ]
 214  2169 -2178  real (f10.3) CNDZ[153]          [Conductivity_Z153 760-765 m     (mS/m)   ]
 215  2179 -2188  real (f10.3) CNDZ[154]          [Conductivity_Z154 765-770 m     (mS/m)   ]
 216  2189 -2198  real (f10.3) CNDZ[155]          [Conductivity_Z155 770-775 m     (mS/m)   ]
 217  2199 -2208  real (f10.3) CNDZ[156]          [Conductivity_Z156 775-780 m     (mS/m)   ]
 218  2209 -2218  real (f10.3) CNDZ[157]          [Conductivity_Z157 780-785 m     (mS/m)   ]
 219  2219 -2228  real (f10.3) CNDZ[158]          [Conductivity_Z158 785-790 m     (mS/m)   ]
 220  2229 -2238  real (f10.3) CNDZ[159]          [Conductivity_Z159 790-795 m     (mS/m)   ]
 221  2239 -2248  real (f10.3) CNDZ[160]          [Conductivity_Z160 795-800 m     (mS/m)   ]
 222  2249 -2258  real (f10.3) CNDZ[161]          [Conductivity_Z161 800-805 m     (mS/m)   ]
 223  2259 -2268  real (f10.3) CNDZ[162]          [Conductivity_Z162 805-810 m     (mS/m)   ]
 224  2269 -2278  real (f10.3) CNDZ[163]          [Conductivity_Z163 810-815 m     (mS/m)   ]
 225  2279 -2288  real (f10.3) CNDZ[164]          [Conductivity_Z164 815-820 m     (mS/m)   ]
 226  2289 -2298  real (f10.3) CNDZ[165]          [Conductivity_Z165 820-825 m     (mS/m)   ]
 227  2299 -2308  real (f10.3) CNDZ[166]          [Conductivity_Z166 825-830 m     (mS/m)   ]
 228  2309 -2318  real (f10.3) CNDZ[167]          [Conductivity_Z167 830-835 m     (mS/m)   ]
 229  2319 -2328  real (f10.3) CNDZ[168]          [Conductivity_Z168 835-840 m     (mS/m)   ]
 230  2329 -2338  real (f10.3) CNDZ[169]          [Conductivity_Z169 840-845 m     (mS/m)   ]
 231  2339 -2348  real (f10.3) CNDZ[170]          [Conductivity_Z170 845-850 m     (mS/m)   ]
 232  2349 -2358  real (f10.3) CNDZ[171]          [Conductivity_Z171 850-855 m     (mS/m)   ]
 233  2359 -2368  real (f10.3) CNDZ[172]          [Conductivity_Z172 855-860 m     (mS/m)   ]
 234  2369 -2378  real (f10.3) CNDZ[173]          [Conductivity_Z173 860-865 m     (mS/m)   ]
 235  2379 -2388  real (f10.3) CNDZ[174]          [Conductivity_Z174 865-870 m     (mS/m)   ]
 236  2389 -2398  real (f10.3) CNDZ[175]          [Conductivity_Z175 870-875 m     (mS/m)   ]
 237  2399 -2408  real (f10.3) CNDZ[176]          [Conductivity_Z176 875-880 m     (mS/m)   ]
 238  2409 -2418  real (f10.3) CNDZ[177]          [Conductivity_Z177 880-885 m     (mS/m)   ]
 239  2419 -2428  real (f10.3) CNDZ[178]          [Conductivity_Z178 885-890 m     (mS/m)   ]
 240  2429 -2438  real (f10.3) CNDZ[179]          [Conductivity_Z179 890-895 m     (mS/m)   ]
 241  2439 -2448  real (f10.3) CNDZ[180]          [Conductivity_Z180 895-900 m     (mS/m)   ]
 242  2449 -2458  real (f10.3) CNDZ[181]          [Conductivity_Z181 900-905 m     (mS/m)   ]
 243  2459 -2468  real (f10.3) CNDZ[182]          [Conductivity_Z182 905-910 m     (mS/m)   ]
 244  2469 -2478  real (f10.3) CNDZ[183]          [Conductivity_Z183 910-915 m     (mS/m)   ]
 245  2479 -2488  real (f10.3) CNDZ[184]          [Conductivity_Z184 915-920 m     (mS/m)   ]
 246  2489 -2498  real (f10.3) CNDZ[185]          [Conductivity_Z185 920-925 m     (mS/m)   ]
 247  2499 -2508  real (f10.3) CNDZ[186]          [Conductivity_Z186 925-930 m     (mS/m)   ]
 248  2509 -2518  real (f10.3) CNDZ[187]          [Conductivity_Z187 930-935 m     (mS/m)   ]
 249  2519 -2528  real (f10.3) CNDZ[188]          [Conductivity_Z188 935-940 m     (mS/m)   ]
 250  2529 -2538  real (f10.3) CNDZ[189]          [Conductivity_Z189 940-945 m     (mS/m)   ]
 251  2539 -2548  real (f10.3) CNDZ[190]          [Conductivity_Z190 945-950 m     (mS/m)   ]
 252  2549 -2558  real (f10.3) CNDZ[191]          [Conductivity_Z191 950-955 m     (mS/m)   ]
 253  2559 -2568  real (f10.3) CNDZ[192]          [Conductivity_Z192 955-960 m     (mS/m)   ]
      2569 -2570 <newline>
```

Total number of lines : 10

Flt	Line	Start X	Start Y	End X	End Y	Kms
6	10100	291755	8615698	291751	8602430	13.27
6	10030	290369	8602342	290364	8615642	13.30
6	10080	291333	8615687	291358	8602387	13.30
6	10010	289950	8602336	289968	8615617	13.28
6	10060	290948	8615677	290971	8602435	13.24
6	10090	291541	8602354	291557	8615620	13.27
6	10040	290567	8615703	290538	8602415	13.29
6	10070	291149	8602338	291146	8615637	13.30
6	10020	290192	8615693	290135	8602393	13.30
6	10050	290743	8602318	290770	8615661	13.34

Total Kilometres : 132.89

APPENDIX IV – List of all Supplied Digital Data

List of ASCII located data files and document files

Located File	Description
<area_name>_Tempest_X.asc	ASCII located (X-component) EM, CDI and ancillary data
<area_name>_Tempest_X.hdr	ASCII located (X-component) EM, CDI and ancillary header
<area_name>_Tempest_X.i3	ASCII located (X-component) EM, CDI and ancillary data Geosoft import template
<area_name>_Tempest_Z.asc	ASCII located (Z-component) EM, CDI and ancillary data
<area_name>_Tempest_Z.hdr	ASCII located (Z-component) EM, CDI and ancillary data header
<area_name>_Tempest_Z.i3	ASCII located (Z-component) EM, CDI and ancillary data Geosoft import template
<area_name>_Tempest_XZ.gdb	Combined X and Z component EM, CDI and ancillary data Profile Analyst database

List of gridded data files (in ER-mapper format)

Grid Name	Description
<area>_emx	X-component EM (all 15 windows as multi-layered grid)
<area>_emx.ers	X-component EM header
<area>_emz	Z-component EM (all 15 windows as multi-layered grid)
<area>_emz.ers	Z-component EM header
<area>_tconX	X-component Time Constant (in milliseconds)
<area>_tconX.ers	X-component Time Constant header
<area>_tconZ	Z-component Time Constant (in milliseconds)
<area>_tconZ.ers	Z-component Time Constant header
Dtm	Derived topography
Dtm.ers	Derived topography header

APPENDIX V – List of all Supplied Products

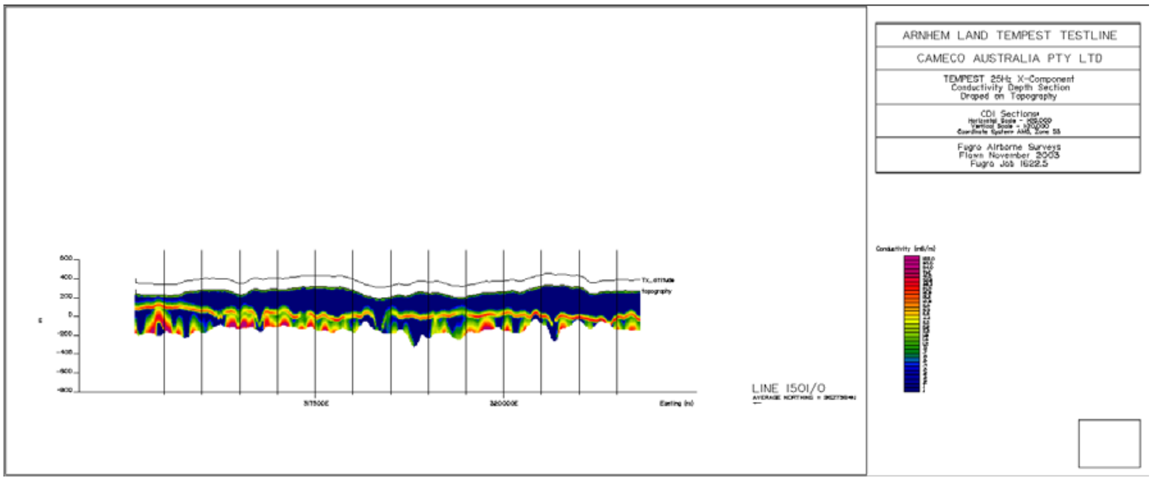
As detailed in appendix IV:

1 CD-ROM containing
- final ER-mapper grids
- final EM, CDI and ancillary data in Profile Analyst databases
- final ASCII located data, headers and import templates (zipped)
- image files (.png) of stacked and multiplot-style CDI sections
- digital copy of acquisition and processing report

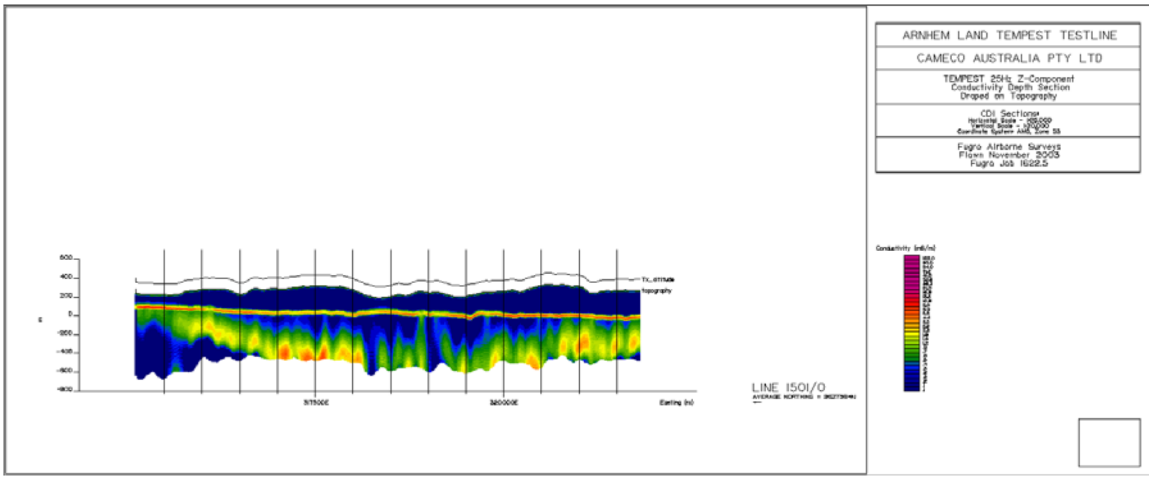
Hardcopy of acquisition and processing report.

APPENDIX VI – CDI Sections of Testline

CDI Section for X-Component of Testline (after Sigtime)



CDI Section for Z-Component of Testline (after Sigtime)



APPENDIX VII – EMflow Description Files

X-Component Descriptor File: 1622_x.dsc

```
FILE FORMAT VERSION
9
SYSTEM NAME
TEMPEST 25 Hz X component
VERSION
1.0
DEFINED BY
MCO
DATE DEFINED
20040210
TIME SCALING
1500  0.02   [sec]
WAVEFORM TYPE
halfperiod
0.02   [sec]
WAVEFORM NORMALIZED BY
total field
_________________________________________________________
  TxRx  TxRy  TxRz  TyRx  TyRy  TyRz  TzRx  TzRy  TzRz
     0     0     0     0     0     0    15     0     0
_________________________________________________________
                         ++++++++
                         + TzRx +
                         ++++++++
_________________________________________________________
TRANSMITTER CURRENT WAVEFORM
undefined
_________________________________________________________
RECEIVER PRIMARY FIELD
calibrated
AMPLITUDE SCALING
1  1   [---]
4
        TIME      CURRENT        ERROR  [ppm]
           0            0            0
           1       28.452            0
        1499       28.452            0
        1500            0            0
_________________________________________________________
RECEIVER SAMPLING
15
       START          END       WEIGHT
         0.5          1.5            1
         2.5          3.5            1
         4.5          5.5            1
         6.5          9.5            1
        10.5         15.5            1
        16.5         25.5            1
        26.5         41.5            1
        42.5         65.5            1
        66.5        101.5            1
       102.5        157.5            1
       158.5        245.5            1
       246.5        383.5            1
       384.5        599.5            1
       600.5        929.5            1
       930.5       1499.5            1
_________________________________________________________
TRANSMITTER GEOMETRY
moving dipole
z
      0       0       1
XYZ POSITION:
      0       0       0
```

```
_________________________________________________________
RECEIVER GEOMETRY
moving dipole
x
      1       0       0
XYZ POSITION:
   -120       0     -35
_________________________________________________________
DATA FORMAT
Geosoft format (1 yes, 0 no)
     0
Sample file name (if available)
D:\J1544_testlines\emfemflowX.asc
Number of comment lines at the beginning of each data file
     0
Number of items in each data record
    39
POSITION (INDEX) OF CHANNELS IN EACH DATA RECORD
channel   ????  TxRx  TxRy  TxRz  TyRx  TyRy  TyRz  TzRx  TzRy  TzRz
     1     0     0     0     0     0     0     0    15     0     0
     2     0     0     0     0     0     0     0    16     0     0
     3     0     0     0     0     0     0     0    17     0     0
     4     0     0     0     0     0     0     0    18     0     0
     5     0     0     0     0     0     0     0    19     0     0
     6     0     0     0     0     0     0     0    20     0     0
     7     0     0     0     0     0     0     0    21     0     0
     8     0     0     0     0     0     0     0    22     0     0
     9     0     0     0     0     0     0     0    23     0     0
    10     0     0     0     0     0     0     0    24     0     0
    11     0     0     0     0     0     0     0    25     0     0
    12     0     0     0     0     0     0     0    26     0     0
    13     0     0     0     0     0     0     0    27     0     0
    14     0     0     0     0     0     0     0    28     0     0
    15     0     0     0     0     0     0     0    29     0     0
----------------------
line          1   1
FID           3   1
east          4   1
north         5   1
z_topo        11  1
altitude      12  1
Rx_pitch      0   0
Rx_roll       0   0
Rx_yaw        0   0
Tx_pitch      0   0
Tx_roll       0   0
Tx_yaw        0   0
TMI           0   2
z(ASL)        0   2
----------------------
```

Z-Component Descriptor File: 1622_z.dsc

```
FILE FORMAT VERSION
9
SYSTEM NAME
TEMPEST 25 Hz Z component
VERSION
1.0
DEFINED BY
MCO
DATE DEFINED
20040211
TIME SCALING
1500  0.02   [sec]
WAVEFORM TYPE
halfperiod
0.02   [sec]
WAVEFORM NORMALIZED BY
total field
```

```
_________________________________________________________
  TxRx  TxRy  TxRz  TyRx  TyRy  TyRz  TzRx  TzRy  TzRz
     0     0     0     0     0     0     0     0    15
_________________________________________________________
                         ++++++++
                         + TzRz +
                         ++++++++
_________________________________________________________
TRANSMITTER CURRENT WAVEFORM
undefined
_________________________________________________________
RECEIVER PRIMARY FIELD
calibrated
AMPLITUDE SCALING
1  1   [---]
4
        TIME      CURRENT        ERROR  [ppm]
           0            0            0
           1       28.452            0
        1499       28.452            0
        1500            0            0
_________________________________________________________
RECEIVER SAMPLING
15
       START          END       WEIGHT
         0.5          1.5            1
         2.5          3.5            1
         4.5          5.5            1
         6.5          9.5            1
        10.5         15.5            1
        16.5         25.5            1
        26.5         41.5            1
        42.5         65.5            1
        66.5        101.5            1
       102.5        157.5            1
       158.5        245.5            1
       246.5        383.5            1
       384.5        599.5            1
       600.5        929.5            1
       930.5       1499.5            1
_________________________________________________________
TRANSMITTER GEOMETRY
moving dipole
z
      0       0       1
XYZ POSITION:
      0       0       0
_________________________________________________________
RECEIVER GEOMETRY
moving dipole
x
      1       0       0
XYZ POSITION:
   -120       0     -35
_________________________________________________________
DATA FORMAT
Geosoft format (1 yes, 0 no)
     0
Sample file name (if available)
E:\J1544_23\emflow\emflowZ.asc
Number of comment lines at the beginning of each data file
     0
Number of items in each data record
    39
POSITION (INDEX) OF CHANNELS IN EACH DATA RECORD
channel   ????  TxRx  TxRy  TxRz  TyRx  TyRy  TyRz  TzRx  TzRy  TzRz
     1     0     0     0     0     0     0     0     0     0    15
     2     0     0     0     0     0     0     0     0     0    16
     3     0     0     0     0     0     0     0     0     0    17
     4     0     0     0     0     0     0     0     0     0    18
     5     0     0     0     0     0     0     0     0     0    19
     6     0     0     0     0     0     0     0     0     0    20
     7     0     0     0     0     0     0     0     0     0    21
     8     0     0     0     0     0     0     0     0     0    22
     9     0     0     0     0     0     0     0     0     0    23
    10     0     0     0     0     0     0     0     0     0    24
```

```
    11     0      0      0      0      0      0      0      0      0     25
    12     0      0      0      0      0      0      0      0      0     26
    13     0      0      0      0      0      0      0      0      0     27
    14     0      0      0      0      0      0      0      0      0     28
    15     0      0      0      0      0      0      0      0      0     29
----------------------
line          1   1
FID           3   1
east          4   1
north         5   1
z_topo        11  1
altitude      12  1
Rx_pitch      0   0
Rx_roll       0   0
Rx_yaw        0   0
Tx_pitch      0   0
Tx_roll       0   0
Tx_yaw        0   0
TMI           0   2
z(ASL)        0   2
----------------------
```