# GM 64336

HELICOPTER-BORNE AEROMAGNETIC SURVEY, FINAL TECHNICAL REPORT, EASTMAIN SOUTH BLOCK

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# OTISH ENERGY INC.

## HELICOPTER-BORNE AEROMAGNETIC SURVEY

## EASTMAIN SOUTH BLOCK
## Otish Mountains Area, Northern Quebec

**Project Ref.: P08020**

# FINAL TECHNICAL REPORT



**July 2008**

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# 1.0 INTRODUCTION

On May 29th, 2008 **GEO DATA SOLUTIONS GDS INC. (GDS)** was awarded contract P08-020 by **OTISH ENERGY INC.** The contract required **GDS** to carry out a high-resolution helicopter borne aeromagnetic survey on a single block located in the Otish Mountains Area, Northern Quebec.

Traverse lines were flown with a hundred metres spacing while control-lines were flown with a spacing of 1 000 metres (table 2). The helicopter nominal ground clearance was 40 metres. The block flown is shown on figure 1 and table 1 defines its co-ordinates.

The field base of operation was established at the Otish Camp owned by Otish Energy Inc. The camp was located approximately 45 km from the Eastmain South block. Excluding calibration and test flights, 9 flights were needed to cover the survey area. The first production flight began on June 12th, 2008 and the last flight ended on June 19th, 2008. Table 2 presents survey specifications and flight schedule.

This report describes the survey procedures and data verification, which were carried out in the field, and the data processing, which followed at the office.

| Table 1: Survey Co-ordinates (WGS 83, zone 18N) | | |
|---|---|---|
| **Vertex** | **X (UTM)** | **Y (UTM)** |
| 1 | 694972 | 5780600 |
| 2 | 694832 | 5784303 |
| 3 | 692568 | 5784217 |
| 4 | 691478 | 5784175 |
| 5 | 691514 | 5783248 |
| 6 | 686336 | 5783051 |
| 7 | 684557 | 5784840 |
| 8 | 683953 | 5785746 |
| 9 | 683848 | 5788575 |
| 10 | 686654 | 5788684 |
| 11 | 686623 | 5789606 |
| 12 | 687193 | 5790557 |
| 13 | 688877 | 5790624 |
| 14 | 688810 | 5792474 |
| 15 | 694516 | 5792696 |
| 16 | 694480 | 5793622 |
| 17 | 702489 | 5793944 |
| 18 | 702608 | 5790918 |
| 19 | 701883 | 5790890 |
| 20 | 699938 | 5787293 |
| 21 | 699416 | 5785416 |
| 22 | 698390 | 5783522 |
| 23 | 696182 | 5780647 |

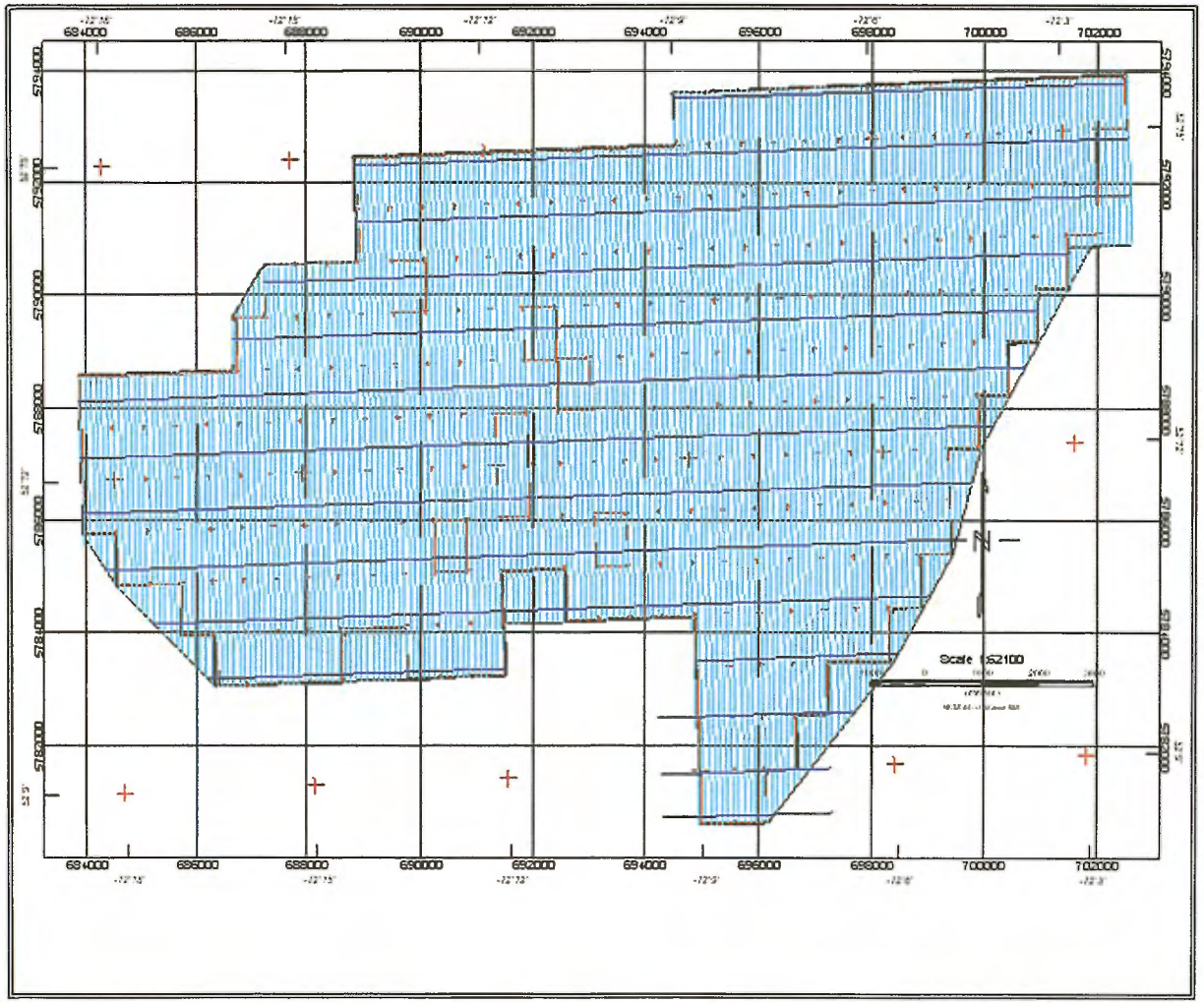



**Figure 1: Eastmain South Project Location**

| Table 2: Survey Specifications and Schedule | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Property** | **Traverse Spacing (m)** | **Traverse orientation** | **Tie-Line Spacing (m)** | **Tie-Line orientation** | **Flying Dates** | **Flight Numbers** | **Line-Km** |
| Eastmain South | 100 | 0° | 1 000 | 90° | June 12 to 19 | 1 to 9 | 1 657 |

## 2.0 SURVEY SPECIFICATIONS

Airborne survey and noise specifications for the **OTISH ENERGY INC.** survey are as follows:

a) traverse spacing and direction
- traverse spacing — 100 metres
- traverse direction: — Az. 0°

b) tie-line spacing and direction
- tie-line spacing: — 1 000 metres
- tie-line direction: — Az. 90°

c) Total number of line-km flown: — 1 657 km

d) terrain clearance
- helicopter nominal terrain clearances: — 40 metres
- magnetometer nominal terrain clearances: — 40 metre

e) magnetic diurnal variation
- A maximum tolerance of 3.0 nT (peak to peak) deviation from a long chord equivalent to a period of one minute for the magnetometer base station

f) magnetometer noise envelope
- in-flight noise envelope could not exceed 0.5 nT, for straight and level flight
- base station noise envelope could not exceed 0.2 nT

g) Re-flights and turns
- all reflights of line segments intersected at least two control lines

# 3.0 AIRCRAFT, EQUIPMENT AND PERSONNEL

## 3.1 Aircraft and Equipment

| | |
|---|---|
| Aircraft: | Astar 350-B<br>Mean Survey Speed: 135 km/hr<br>Typical distance between samples: 3.75 metres<br>Nominal Ground Clearance: 40 metres |
| Magnetometer: | Geometrics Cesium vapour sensor, stinger installation, sensitivity of 0.001 nT, sampling rate of 0.1 sec., ambient range 20,000 to 100,000 nT. The general noise level was kept below 0.01 nT. Nominal sensor height of 40 metres above ground. |
| Magnetometer Base Station: | One GEM GSM-19 Overhauser magnetometer base station was mounted in a magnetically quiet area. The base station measured the total intensity of the earth's magnetic field in units of 0.01 nT at intervals of 1 second and within a noise envelope of 0.10 nT. The base station magnetometer was located near the base of operation at the following coordinates:<br>Longitude: -72.2527816°<br>Latitude: 51.7711886° |
| Digital Acquisition System: | RMS Data Acquisition System |
| Radar Altimeter: | TRA-3000, accuracy 5%, sensitivity one foot, range 0 to 2,500 feet, 1 sec. recording interval |
| Electronic Navigation: | Real-Time Differentially Corrected Omnistar System, 1.0 sec. recording interval, accuracy of ±5 metres. |
| Ancillary Equipment: | Computer workstation, complement of spare parts and test equipment |


**Figure 2: Stinger Installation of the Magnetometer**

## 3.2 Personnel

The project management was monitored offsite by Mr. Mouhamed Moussaoui, **GDS**'s President. Mr. Saleh Elmoussaoui was responsible for the field data processing to ensure that the work was carried out according to contractual specifications. The final data evaluation and processing was carried out at the Laval **GDS** office by Mr. Saleh Elmoussaoui. Survey crew and office personnel are listed in table 3.

**Table 3: Field and Office Crew**

| Position | Name |
|---|---|
| Project Manager | Mr. Mouhamed Moussaoui, P.Eng. |
| Data quality control | Mr. Saleh Elmoussaoui |
| Field Operator | Mr. Jean-Yves Bernier |
| Pilot | Mr. Julien Trumont |
| Final Processing | Mr. Saleh Elmoussaoui |
| Survey Report | Mr. Camille St-Hilaire, P.Geo |

## 4.0 SURVEY SCHEDULE

The survey was flown over a single mining block with flight line bearing selected to run perpendicular to the average trend of the local geological structures. The field base of operation was located at the Otish Camp owned by Otish Energy Inc. and located approximately 45 km from the Eastmain South property.

The survey steps were:

| | |
|---|---|
| Mobilization: | June 11th, 2008 |
| Survey: | June 12th to 19th, 2008 |
| Demobilization: | June 22nd, 2008 |
| Flights: | 1 to 9 |

Preliminary results were sent to **OTISH ENERGY INC.** progressively during the field works while final maps and data were sent early in June 2008.

## 5.0 DATA ACQUISITION

The following tests and calibrations were performed prior the commencement and during the survey flying:

- Magnetometer Figure of Merit (FOM)
- Altimeter calibration

These calibrations and tests were flown either on the Bourget test site located near Ottawa and over the survey site, as part of the start-up and monitoring procedures. Details of each test and their results are given in Appendix A.

After each day, profiles were examined as a preliminary assessment of the noise level on the recorded data. Altimeter deviations from the prescribed flying altitudes were also closely examined as well as the magnetic diurnal activity, as recorded on the base station.

All digital data were verified for validity and continuity. The data from the helicopter and base station were transferred to the PC's hard disk. Basic statistics were generated for each parameter recorded. These included the minimum, maximum and mean values, the standard deviation and any null values located. Editing of all recorded parameters for spikes or datum shifts was done, followed by final data verification via an interactive graphic screen with on-screen editing and interpolation routines.

The quality of the GPS navigation was controlled on a daily basis by recovering the helicopter flight path.

Checking all data for adherence to specifications was carried out before crew and aircraft demobilization by **GDS**'s geophysicist.

# 6.0 DATA COMPILATION AND PROCESSING

## 6.1 Base maps

Base maps of the survey area were plotted from topographic maps of the Department of Natural Resources Canada at a scale of 1:50 000.

**Projection description**

| | |
|---|---|
| Datum: | WGS83 |
| Projection: | Universal Transverse Mercador, UTM Zone 18N |
| False Easting: | 500 000 |
| False Northing: | 0 |
| Scale Factor: | 0.9996 |

## 6.2 Processing of Base Station data

Recorded magnetic diurnal data from the magnetometer base station were reformatted and loaded into the OASIS database. After initial verification of the integrity of the data from statistical analysis, the appropriate portion of the data was selected to correspond to the exact start and end time of the flight. The data were then checked and corrected for spikes using a fourth difference editing routine. Following this, interactive editing of the data was done, via a graphic editing tool, to remove events caused by man-made disturbances. A small low pass noise filter (30 seconds) was then applied. The final processing step consisted of subtracting result from the airborne magnetic data as a pre-leveling step. The average of the Total Field Magnetic Intensity measured at the Base Station was 56 611.87 nT.

## 6.3 Processing of the Positioning Data (GPS)

The raw GPS data were recovered and corrected from spikes. The resulting corrected latitudes and longitudes were then converted to the local map projection and datum (WGS84). A point-to-point speed calculation was then done from the final X, Y coordinates and reviewed as part of the quality control. The flight data were then cut back to the proper survey line limits and a preliminary plot of the flight path was done and compared to the planned flight path to verify the navigation. The positioning data were then exported to the other processing files.

## 6.4 Processing of the Altimeter data

The altimeter data, which includes the radar altimeter and the GPS elevation values were checked and corrected for spikes using a fourth difference editing routine. A small low pass filter of 2 seconds was then applied to the data. Following this, a digital terrain trace was computed by subtracting the radar altimeter values from the corrected GPS elevation values. All resulting parameters were then checked, in profile form, for integrity and consistency, using a graphic

viewing editor.

Aircraft ground clearance was well maintained during this survey with an average of 37.6 metres. Figure 3 shows a histogram of the ground clearances obtained from the radar altimeter.

## 6.5 Processing of Magnetic data

The airborne magnetic data were reformatted and loaded into the OASIS database. After initial verification of the data by statistical analysis, the values were adjusted for system lag. The data were then checked and corrected for any spikes using a fourth difference editing routine and inspected on the screen using a graphic profile display. Interactive editing, if necessary, was done at this stage. Following this, the long wavelength component of the diurnal was subtracted from the data as a pre-leveling step. A preliminary grid of the values was then created and verified for obvious problems, such as errors in positioning or bad diurnal. Appropriate corrections were then applied to the data, as required.

The final leveling process was undertaken. This consisted of calculating the positions of the control points (intersections of lines and tie lines), calculating the magnetic differences at the control points and applying a series of leveling corrections to reduce the misclosures to zero. A new grid of the values was then created and checked for residual errors. Any gross errors detected were corrected in the profile database and the leveling process repeated. Finally, a micro leveling routine was applied to the magnetic data.

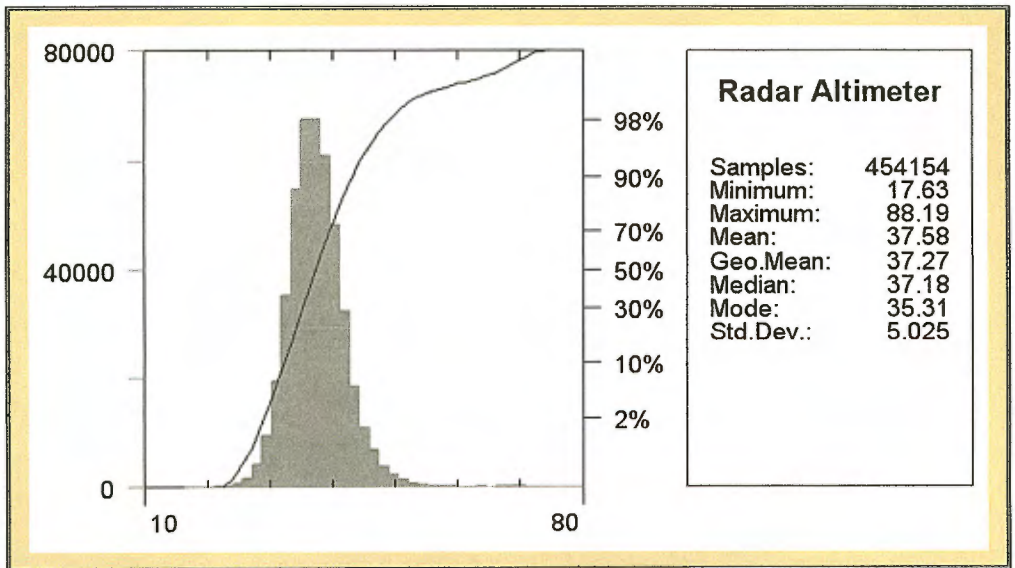



**Figure 3: Helicopter and Mag./Spec. Ground Clearance**

### 6.6 Total Magnetic field and First Vertical Derivative Grids

The reprocessed total field magnetic grid was calculated from the final reprocessed profiles by a minimum curvature algorithm. The accuracy standard for gridding was that the grid values fit the profile data to within 0.01 nT for 99.99% of the profile data points. The grid cell size was 25 metres.

Minimum curvature gridding provides the smoothest possible grid surface that also honours the profile line data. However, sometimes this can cause narrow linear anomalies cutting across flight lines to appear as a series of isolated spots.

The first vertical derivative of the total magnetic field was computed to enhance small and weak near-surface anomalies and as an aid to delineate the geologic contacts having contrasting susceptibilities. The calculation was done in the frequency domain, using Win-Trans FFT algorithms.

## 7.0 FINAL PRODUCTS

### 7.1 Maps:

**GDS** made base maps from information present on published topographic maps. Each map was produce at a scale of 1:20 000 and displaying base-map features, flight path and UTM co-ordinates. One paper copy of the following final maps was delivered to **OTISH ENERGY INC.**:

(a) Shaded Magnetic Total Field (colour interval)
(b) Shaded Magnetic First Vertical Derivative (colour interval)

### 7.2 Final digital archive of line data:

**GDS** produced three copies of a CD-ROM containing digital archives and maps (PDF, Map format). Digital archives, described in Appendix B, contain Geosoft databases of all survey data. Databases are referenced to the standard UTM co-ordinates for the area.

**GDS** will store a copy of the digital archive for one year after the production of the final products. On request by **OTISH ENERGY INC.**, **GDS** will supply the raw data from the survey with the survey products. Otherwise, **GDS** will store the raw data with the copy of the digital archive.

### 7.3 Miscellaneous

Three paper copies of this technical report, with the corresponding digital PDF file, have been produced and delivered to **OTISH ENERGY INC.**..

## 8.0 CONCLUSION

Flown from June 12th to 19th, 2008, the helicopter borne aeromagnetic survey was completed inside the estimated time frame.

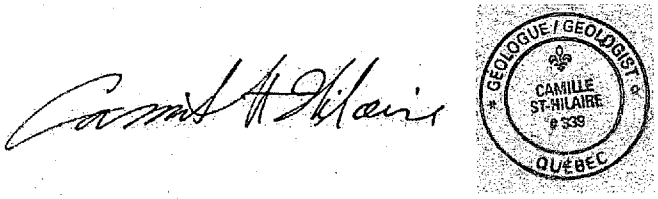
All airborne and ground-based records were of excellent quality. Magnetic data acquisition was done in good diurnal conditions. It was found that even though diurnal was within specifications, diurnal subtraction was not good enough to level the data and, in fact, good intersections were required to produce a reliable final data set.

The noise level for the measured Total Magnetic Field was well within the accepted limits, determined from the fourth difference of the lagged, edited airborne magnetic data.

GPS results proved to be of high quality. The flight path was surveyed accurately and the speed checks showed no abnormal jumps in the data.

It is hoped that the information presented in this report, and on the accompanying products, will be useful both in planning subsequent exploration efforts and in the interpretation of related exploration data.

Respectfully Submitted,




Camille St-Hilaire, M.Sc.A.
P.Geo.

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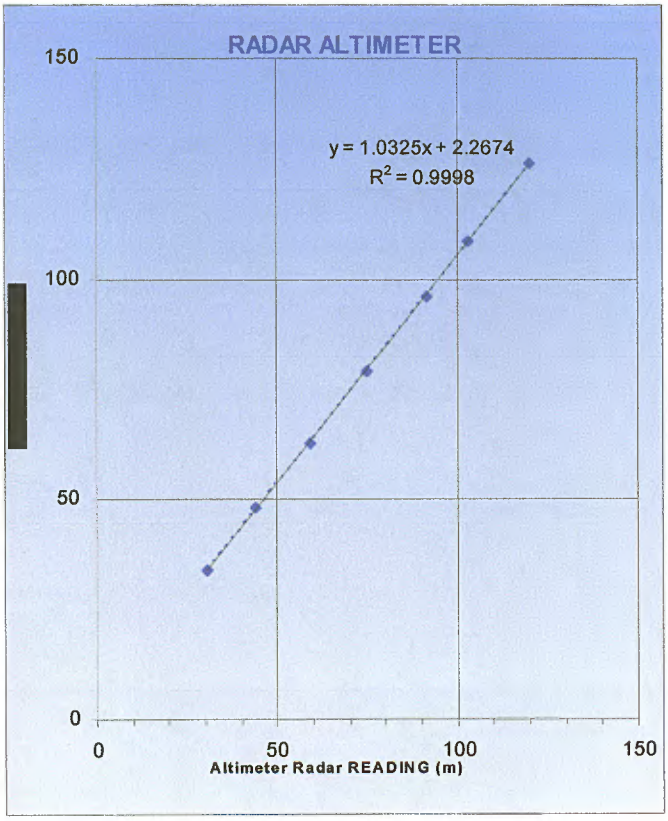
# APPENDIX A

# TESTING AND CALIBRATION

# 1.0 RADAR ALTIMETER CALIBRATION

| RADAR ALTIMETER TEST | | | |
|---|---|---|---|
| **Project #:** | P08020 | **Date:** | June 9th, 2008 |
| **Client:** | OTISH ENERGY INC. | **Location:** | Ottawa, ON |
| **Radar** | TRA-3000 | **Helicopter:** | Astar 250-B |
| **Compiled By:** | Saleh Elmoussaoui | **Configuration:** | Stinger mag |

| Planned Radar Altitude ( meter ) | Radar Altitude (m) | GPS Height (m) | Z-GPS Values (m) |
|---|---|---|---|
| 0 | 0.000 | 0.000 | 62.000 |
| 100 | 30.558 | 33.882 | 95.882 |
| 150 | 43.822 | 48.248 | 110.248 |
| 200 | 59.190 | 62.880 | 124.880 |
| 250 | 74.894 | 78.987 | 140.987 |
| 300 | 91.183 | 96.168 | 158.168 |
| 350 | 102.910 | 108.721 | 170.721 |
| 400 | 119.927 | 126.454 | 188.454 |



## 2.0 FOM TEST

| F. O. M. TEST | | | |
|---|---|---|---|
| **Project #:** | P08020 | **Date:** | May 15th, 2008 |
| **Client:** | OTISH ENERGY INC. | **Location:** | Otish Mountains, QC |
| **Operator:** | Jean-Yves Bernier | **Helicopter:** | Astar 350-B |
| **Compiled By:** | Saleh Elmoussaoui | **Configuration:** | Stinger mag |

MAGRAW = UNCOMPENSATED MAG TAIL SENSOR
MAGCOMP = COMPENSATED MAG TAIL SENSOR
VALUES DETERMINED USING 12 SECONDS ( 12 FIDUCIALS) HIGH PASS FILTER
VALUES DETERMINED USING MAXIMUM PEAK TO PEAK OF EACH MANEUVER

| NORTH (360°) | Pick_Max | Pick_Min | magraw | Pick_Max | Pick_Min | magcomp |
|---|---|---|---|---|---|---|
| PITCH | 5.2896 | -5.1864 | 10.476 | 0.085 | -0.108 | 0.194 |
| ROLL | 5.91385 | -5.9413 | 11.855 | 0.116 | -0.064 | 0.180 |
| YAW | 1.35327 | -1.2584 | 2.612 | 0.064 | -0.060 | 0.124 |
| TOTAL | | | 24.943 | | | 0.497 |

| EAST (90°) | Pick_Max | Pick_Min | magraw | Pick_Max | Pick_Min | magcomp |
|---|---|---|---|---|---|---|
| PITCH | 3.55526 | -3.56031 | 7.116 | 0.062 | -0.050 | 0.112 |
| ROLL | 6.499422 | -6.10253 | 12.602 | 0.127 | -0.106 | 0.233 |
| YAW | 0.723 | -1.25843 | 1.981 | 0.038 | -0.034 | 0.072 |
| TOTAL | | | 21.699 | | | 0.417 |

| SOUTH (180°) | Pick_Max | Pick_Min | magraw | Pick_Max | Pick_Min | magcomp |
|---|---|---|---|---|---|---|
| PITCH | 2.73244 | -2.414767 | 5.147 | 0.053 | -0.049 | 0.102 |
| ROLL | 7.5554 | -8.139 | 15.694 | 0.144 | -0.150 | 0.294 |
| YAW | 3.36741 | -3.0498 | 6.417 | 0.054 | -0.033 | 0.087 |
| TOTAL | | | 27.259 | | | 0.483 |

| WEST ( 270°) | Pick_Max | Pick_Min | magraw | Pick_Max | Pick_Min | magcomp |
|---|---|---|---|---|---|---|
| PITCH | 3.98043 | -3.7568 | 7.737 | 0.040 | -0.091 | 0.131 |
| ROLL | 11.1788 | -11.885 | 23.064 | 0.075 | -0.061 | 0.136 |
| YAW | 4.7029 | -4.4516 | 9.155 | 0.029 | -0.037 | 0.067 |
| TOTAL | | | 39.956 | | | 0.334 |

| | magraw | magcomp |
|---|---|---|
| Total FOM Values | 113.856 | 1.730 |
| Improve Ratio | 65.8 | |

# APPENDIX B

# PROFILE DATABASE ARCHIVE CHANNEL DEFINITIONS AND GRID ARCHIVE DEFINITIONS

# Magnetic Channels
## (Oasis Montaj GDB format)

**General line information:**

| | | |
|---|---|---|
| Line | Unit | Line number |
| Flt | | Flight number |
| Date | | Flight date (yyyy/mm/dd) |

**Clocks and system synchronization:**

| | | |
|---|---|---|
| Fiducial | Sec | Fiducial |
| TimeGPS | Sec | Edited GPS time (second after midnight) |

**Edited GPS channels**

| | | |
|---|---|---|
| X84_Zone15 | Metre | Easting, WGS-84 UTM Z15N |
| Y84_Zone15 | Metre | Northing, WGS-84 UTM Z15N |
| X84_Zone14 | Metre | Easting, WGS-84 UTM Z14N |
| X84_Zone14 | Metre | Easting, WGS-84 UTM Z14N |
| Longitude | Deg | Longitude, WGS-84 |
| Latitude | Deg | Latitude, WGS-84 |

**Radar altimeter**

| | | |
|---|---|---|
| radar | Metre | Radar Altimeter |
| DTM | Metre | Digital Terrain Model (from Zgps and Radar) |

**Ground Mag base station data**

| | | |
|---|---|---|
| Base | nT | Original, (in Block area) unedited primary mag base station |
| Basef | nT | Filtered Base |

**Mag TMF data**

| | | |
|---|---|---|
| Magc | nT | Mag despiked |
| MagL | nT | Lagged magc |
| drift | nT | Diurnal correction removed |
| Magbc | nT | Diurnal corrected Mag (magc-drift) |
| IGRF | nT | Inter. Geomagnetic Reference Feild |
| Residc | nT | Residual Magnetic Field (IGRF Removed) |
| MagcResid | nT | Total Magnetic Field ( IGRF Corrected) |
| Corlev | nT | Tie line levelling correction |
| Maglev | nT | Tie line leveled Mag |
| Cormicro | nT | Microleveling correction |
| Magmicro | nT | Micro leveled Mag |

| | |
|---|---|
| Mag_Final.grd | Total Magnetic Field grid |
| Grad_Final.grd | Total Magnetic Field first vertical derivative grid |
| OTISH ENERGY_final.gdb | Magnetic Geosoft database |

All grids have a grid cell size of 25