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Port Stanley Magnetic Observatory Service Report, March 2006

Seismology and Geomagnetism Programme

Internal Report IR/07/034

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INTERNAL REPORT IR/07/034

Port Stanley Magnetic Observatory Service Report, March 2006

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View of Port Stanley looking South.

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Foreword

The British Geological Survey (BGS) operates seven geomagnetic observatories, four of which are overseas. This report documents the results of the standard annual observatory service visit conducted for Port Stanley Observatory in 2006. Port Stanley Observatory operates with local support from the staff of Cable and Wireless and the Department of Mineral Resources, Port Stanley. Measurements are collated in Edinburgh, UK and are primarily used to model the core magnetic field of the Earth.

Acknowledgements

The continued operation of the magnetic observatory at Port Stanley observatory is only made possible through the assistance and communication with the local staff of Cable and Wireless. Throughout the year and during this service visit David McLeod of Cable and Wireless provided considerable support and dedicated substantial time to training in the process of making absolute observations on-behalf of BGS, in addition to helping locate alternative sites for the observatory in the future. Alex Blake of the Department of Mineral Resources, Port Stanley is also thanked for conducting absolute observations throughout the year. Frequent absolute observations are an essential part of running a magnetic observatory and underpin the quality of the recorded data.

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Summary

This report describes the standard service procedure carried out at Port Stanley Observatory in March 2006. Each section deals with component parts of the observatory where details of any damage or change to the installation are discussed at length. The main part of the report presents the results of the calibrations tests conducted on parts of the instrumentation that make up the Geomagnetic Data Acquisition System (GDAS). Based on the results of this service visit, some recommendations for future services have been made at the end of the report.

1 Introduction

In February 1994, the British Geological Survey (BGS) installed an automated observatory to monitor changes in the geomagnetic field vector at Sapper Hill, near Port Stanley in the Falkland Islands (Riddick and Harris, 1994). The observatory was upgraded in February 2002 (Turbitt & Flower, 2002) using instruments less prone to temperature and humidity variations, and using recording equipment capable of communicating the data in near real-time to Edinburgh in the UK. Flower et al. (2004) document the installation of a second data logger to capture readings from a number of meteorological instruments installed close to the magnetic observatory site.

Absolute observations had been until recently performed by Alex Blake of Mineral Resources, Falkland Islands. In 2005, Alex informed BGS that he would no longer be able to continue to offer his services to us. David Mcleod of Cable and Wireless agreed to take over from Alex for an interim period with a view to finding a more permanent replacement observer from within Cable and Wireless at a later date.

Over the past two years the magnetic observatory on Sapper Hill has suffered sustained difficulties including lightning strikes and data corruption due to local noise, some sources of which have yet to be identified. In general the use of Sapper Hill has increased over the years which have seen a number of new antennas erected and, recently, a new generator installed near the site. With this in mind it was deemed prudent for BGS to investigate other potential sites for the observatory, in the event of more severe disruption to the current site in the future (Section 4.2).

2 Observatory Instrumentation Calibrations

2.1 FLUXGATE MAGNETOMETER

The DMI fluxgate magnetometer electronics (SN: E0215) and sensor head (SN: S0216) have operated without interruption over the past seven months. The results of calibration tests on the fluxgate and digitiser unit (SN: GMAG-FGAD.002) are given in Appendix 1. The digital voltmeter (DVM) used for the calibrations was a portable Fluke 87III unit and does not have a calibration certificate. This DVM was calibrated using a reference DVM (Fluke 45 model) that does have a calibration certificate. The results of this comparison showed that the portable unit was accurate to better than 0.1 % and is therefore suitable for calibrating the magnetometer. The calibration of the voltmeter is also in Appendix 1. The results (corrected against DVM calibration) show the magnetometer scale values are within tolerance (<1 %) of the previous calibration (Table 1) and therefore do not need to be modified in the SDAS configuration files (Appendix 3) on the GDAS PC. The ADC also calibrated to within tolerance (<0.1% error on each sampled channel).

Sensor Component:	2005 Scale values: (μV/0.1 nT)	2006 Scale values: (μV/0.1 nT)	Difference: (%)
H	248.06	247.03	0.42
D	248.09	247.33	0.31
Z	248.47	247.41	0.43

Table 1 Variometer Scale Values

2.2 PROTON PRECESSION MAGNETOMETER

The Port Stanley Observatory operates a GEM GSM90 Proton Precession Magnetometer (PPM) (SN: 4051374, sensor SN: 11119244). This instrument was installed during the previous service visit after the original was damaged by a lightning strike in 2005. The PPM has operated reliably and uninterrupted throughout the year. The condition of the protective enclosure for the instrument remains in good order.

An additional GEM GSM-19 proton magnetometer (SN: 701595) is kept at the observatory so that total field site-difference measurements can be made between the GDAS PPM and absolute observation positions. Despite a series of questionable site difference measurements throughout the year, the calibration results for both instruments indicate that the electronics and sensor for each instrument are in good working order (Appendix 1). This suggests that the scattered site difference measurements are likely to be attributed to operator error.

2.3 GDAS POWER SUPPLY

The calibration of the GDAS system involves testing the integrity of the backup battery. If after two hours of running on battery power, the voltage has dropped below 12.2 Volts, then the battery must be replaced. The battery voltage measured 11. 7 V after two hours and therefore should be replaced during the next service.

2.4 ABSOLUTE INSTRUMENTATION

Since the observatory was repaired in 2005 (Flower and Shanahan, 2005) there have been considerable fluctuations in the baseline values derived from absolute observations. During this service visit some investigations were carried out to determine the source of these discontinuities. The absolute observing position is directly in line with many of the directional antennas mounted on the Sapper Hill radio mast. When making observations with the fluxgate-theodolite, observers have reported abrupt ‘shifts’ in the magnetometer readings that are too rapid to be associated with external field variations. These shifts appear to be dependant on the observer’s position relative to the main radio mast and the theodolite which suggests the source of the noise is related to the antenna’s transmissions. To test this, the theodolite tripod was moved toward a rocky outcrop which fell within the shadow of the antenna signals. In this position, an absolute observation was performed whilst altering the observing position to see if any fluctuation occurred. In all null-field orientations the magnetometer output remained steady, regardless of the observing position. The same process was repeated immediately afterwards at the absolute observing position where the fluctuations were clearly observable as had been previously reported.

Based on the results of this basic test, it is likely that some RF signal is being coupled into the cable connecting the fluxgate sensor to the electronics or into the sensor coil, and that this signal has sufficient power that it is penetrating the filter stage and being integrated in the feedback electronics to produce a dc offset in the reading.

To reduce this effect, high-frequency ferrite beads (*chokes*) were attached to the signal cable of the magnetometer near the electronics (as the ferrous content would contaminate the reading at the sensor). The fluctuations observed during subsequent absolute observations showed a tangible improvement in the magnitude of the shifts. The chokes were installed after absolute observation number two and the results from Table 4 confirm that the ferrous content of the beads did not contribute any detectable magnetic influence at the measurement position.

3 Observatory Infrastructure

3.1 LIGHTNING SUPPRESSION COMPONENTS

Since the lightning protection system was installed (Flower and Shanahan, 2005), the sensitive electronics at Port Stanley have continued to operate without interruption. During this time there has been strong evidence that the system has suppressed at least one direct lighting strike to Sapper Hill where other third-party equipment operated on the same site suffered severe damage.

To ensure the system continues to maintain a high level of protection, it is recommended that the impedance of the earthing system is checked at regular intervals. Tests were conducted using an earth-meter supplied by Cable and Wireless. The measurement points in the ground were chosen to approximately match the previous tests conducted at the time of installation. The recommended combined earth impedance is 10 Ω. The results in Table 2 confirm that the earth electrode spikes and copper-mesh matt are still in good condition, providing a low impedance path for transient over-currents to ground. Connections to the earthing system are indicated in Figure 1.

Reference Point:	2005 Impedance (Ω)	2006 Impedance (Ω)
First new electrode:	168.0	165.0
Second new electrode:	160.0	160.0
Copper-mesh matt:	70.0	65.0
Old tube + 2 new electrodes + copper matt:	61.0	Not measured
Cable & Wireless hut earth:	14.0	13.0
Combined earths:	**12.0**	**12.0**

Table 2 Earth Impedance Tests

Figure 1 Earthing Point Connections

3.2 ENCLOSURES AND SURROUNDINGS

During 2006 a new generator was installed on the site to provide backup electricity supply for the equipment operated by Cable and Wireless. The generator is located approximately 30 meters away from the variometer (Figure 2). At the same time as the generator was installed, an air-conditioning system was also installed in the main Cable and Wireless building. The heat exchangers are shown in Figure 6. There is currently no evidence to suggest the operation of the generator or the new air-conditioning unit impacts on the magnetic data. The absolute hut and variometer hut continue to offer good protection from the elements and show no obvious signs of degradation.

Figure 2 Generator Enclosure (Green building)

3.3 FIXED MARKS

In 2003 an auxiliary fixed mark was installed on Sapper Hill to act as a back-up reference object during times when the more distant fixed mark on Tumbledown Hill is obscured by low cloud (Turbitt, 2003). This fixed mark (Appendix 4, Figure 7) has a comparatively short baseline and is therefore more likely to introduce azimuth errors in the event of any lateral shifting of the base. As a matter of routine, the angle between the two fixed marks is measured during a service visit which allows the measured azimuth to be compared with the 2003 surveyed value (281˚ 10’ 22”) to verify that the secondary reference is still of good quality.

Observation No.	Measured Aux. RO:	2006 az.-2003 az.:
1	281˚ 09’ 56”	-26”
2	281˚ 09’ 53”	-29”
3	281˚ 09’ 52”	-29”
4	281˚ 09’ 56”	-26”
5	281˚ 09’ 52”	-30”
Average:	**281˚ 09’ 53”**	**-28”**

Table 3 Fixed Mark Azimuth Comparisons

Comparisons of the survey value with the value measured during the service (Table 3) confirm that the auxiliary fixed mark is still of good quality (<30" difference from azimuth measured in 2003) and remains suitable as an alternative azimuth reference. This difference is likely to be attributed to poor positioning of the theodolite base over its mark in the absolute hut. An error of 1 cm will generate an error of about 30" due to the relatively short 70 m baseline of the auxiliary fixed mark. For this reason, extra care should be taken to align the theodolite base by use of the optical plummet, when using the auxiliary fixed mark for observations.

4 Site Logistics

4.1 ABSOLUTE OBSERVERS

During this service, David McLeod of Cable and Wireless was given training in the process of making absolute observations. David was also supplied with the Guide to Making Absolute Observations Technical Reference (Turbitt, 2004) and a copy of the BGS GDASView software to enable submission of observations in the standard GDASView formatted file.

Alex Blake of Mineral Resources, Falkland Islands agreed to liaise with David with regard to passing on the fluxgate-theodolite and portable GSM-19 PPM. Alex also agreed to have David and potentially Nigel Bishop (also of Cable and Wireless) shadow him whilst performing observations before he leaves.

The GDASView software was also installed on Alex Blake's laptop to allow him to submit any subsequent observations in the standard format.

4.2 ALTERNATIVE SITE FOR FUTURE

Over the years since Port Stanley observatory was installed, there has been a steady increase in activity in the proximity of the instrumentation on Sapper Hill; particularly an increase in the number of communications transmitters installed in the vicinity. One theory on the source of the shifts seen in the baselines is that these transmissions are causing interference with the magnetometers. In light of this theory, an investigation into an alternative site for the future was undertaken during this service visit.

A feasible site must provide access, communications and power. In addition, the site must be located in an area that has low magnetic gradients (to be verified by a site survey) and must remain remote in nature to ensure minimal disturbance from magnetic interference sources. These basic requirements were relayed to David McLeod of Cable and Wireless who then provided BGS with a potential site that might be suitable in the future. This site is planned to accommodate a communications relay mast to provide an alternative link between Mount Pleasant and Port Stanley which will require mains power. Figure 3 shows a photograph of the planned site (marked with a wooden post in the foreground) with the current site (Sapper Hill in the background) circled in red. This site would be well suited for the purposes of operating a magnetic observatory due to its remote location and the existence of numerous, long-range, fixed mark references used in declination observations. David Mcleod assured us that the site would not be developed further.

David suggested that a microwave LAN-extender would provide a good solution for a data communication link. The location has direct line-of-site with the Cable and Wireless main office in Stanley and the microwave link can support distances up to 70 km. Mains power would be available from the Cable and Wireless transmitter supply.

Access to the site, for the purposes of making absolute observations, would need to provided and financed by BGS as Cable and Wireless would not require any regular access to the mast.

Currently, there is no formal access to the site and even the use of a 4x4 vehicle would be problematic across the terrain. Providing an access (stone track) would require consultation with Mineral Resources of the Falkland Islands.

The distance between the two sites is less than 10 km, which means for the purposes of monitoring long-term, core-field variations, a spatial shift in observatory of this magnitude would still continue to represent the Port Stanley data time-series due to the relatively much larger wavelengths associated with secular variation. Step-values would need to be applied to translate the data from the old site, which would require running the two sites in parallel for a period of time.

By the time the next service is undertaken in 2007, Cable and Wireless should have installed their mast and a re-assessment of the site is recommended to establish if the infrastructure is suitable for a Magnetic Observatory and to perform a PPM site-survey of the area to check for local magnetic anomalies.

Figure 3 Potential Observatory Site (Post) Looking East (Current Site Circled)

5 Absolute Observations

A total of eight absolute observations were made during this service visit. Table 4 presents the processed baseline results for each observation. The close agreement of all the observations indicates that the fluxgate-theodolite instrumentation is in good working order.

Observation	Declination	Horizontal Component	Vertical Component
September 2005	3° 58' 36"	18989.3 nT	-21995.0 nT
1	3° 58' 04"	18993.1 nT	-21961.3 nT
2	3° 57' 59"	18992.8 nT	-21961.4 nT
3	3° 57' 57"	18993.5 nT	-21960.7 nT
4	3° 57' 55"	18993.2 nT	-21961.3 nT
5	3° 58' 02"	18994.2 nT	-21960.2 nT
6	3° 57' 55"	18993.5 nT	-21961.2 nT
7	3° 58' 14"	18994.9 nT	-21960.6 nT
8	3° 58' 04"	18993.9 nT	-21961.6 nT
Mean	**3° 58' 01"**	**18993.6 nT**	**-21961.0 nT**
Standard Dev.	**0° 00' 06"**	**0.6 nT**	**0.4 nT**

Table 4 Absolute Observations Baseline Results

6 Total Field Site Difference

The site difference is measured using two GEM-Systems PPM's run concurrently. This produces a total field site difference between the absolute site and the observatory proton magnetometer site. The value of the site difference should theoretically remain constant over very long time scales. As it is a measure of the spatially varying crustal magnetic field, it is assumed to change only significantly over geological timescales. Any sudden change manifested in the site-difference is likely to be caused by a source of man-made magnetic interference such as objects with large ferrous content, although the site-difference data alone does not provide enough information to determine if the source is associated with the variometer site or the absolute site.

Throughout the year BGS has requested that several site difference measurements be conducted in addition to absolute observations. Analysis of the site-difference readings has frequently shown a lack of coherence in the values. During this service, the site difference was measured once during the day and once during the night to ensure no day-time effect was influencing the results. Both site-difference measurements were in close agreement with an average of -31.3 nT and standard deviations below 0.1 nT. This is in close agreement with the previous value of -31.7 nT measured in 2005 (Flower and Shanahan, 2005).

7 Temperature Data

The enclosure that houses the variometer instrument is not equipped with any temperature regulation and as a result is subject to large oscillations due to the seasonal temperature changes. The variometer sensor is housed inside a thick polystyrene insulating block which provides some filtering of the more rapid temperature variations. The hourly mean values for temperature over the seven months since the previous service, as measured at the fluxgate sensor, are plotted below (Figure 4). It can be seen that during this period, the peak-to-peak temperature variation is as much as 15 ˚C which corresponds to potentially a 4 nT error in the data due to the temperature dependency of the fluxgate instrument (0.25 nT/˚C).

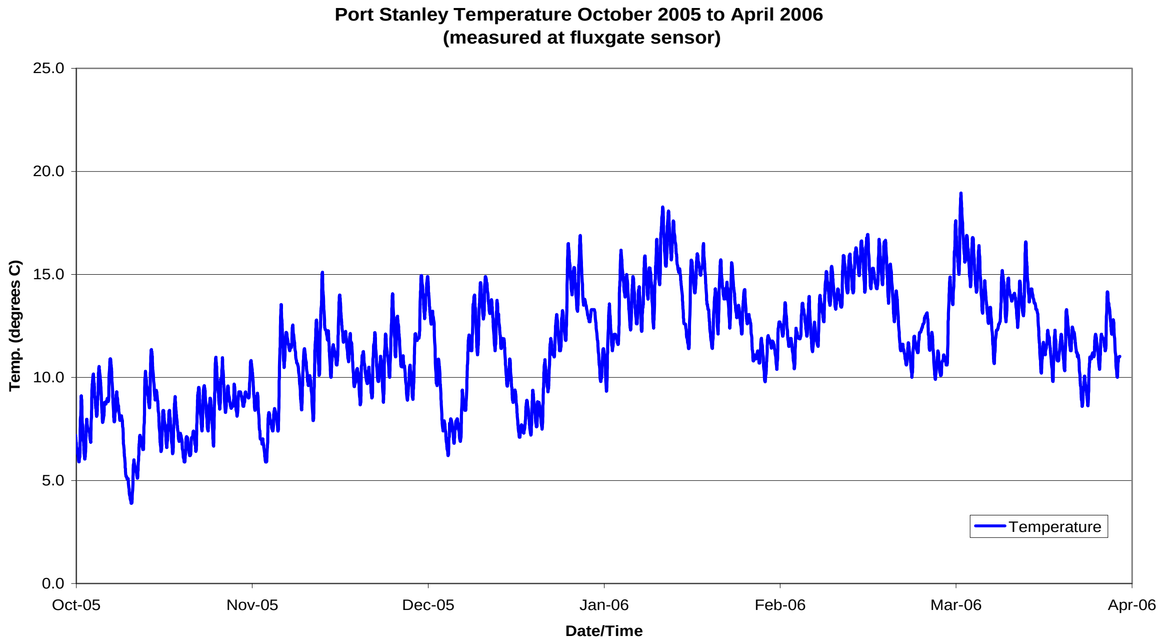

Figure 4 Port Stanley Temperature Variations

Figure 4 shows the temperature variations are significant due to the lack of heating control in the variometer enclosure. It is recommended that during the next service visit, some form of heating regulation, even if basic, be installed to improve this.

8 Conclusions and Recommendations

Port Stanley has suffered severe down-time over the past two years due to the catastrophic effects of lightning strikes. The lightning suppression measures that were implemented in 2005 have been highly successful in alleviating this type of risk. The Observatory has continued to operate without incident since then and can now be regarded as a reliable system.

To improve the quality of the recorded data, Section 7 highlighted the need to establish a form of temperature control for the variometer enclosure. Before the next service, equipment and materials that will constitute the basic requirements for a temperature controlled system, need to be shipped to Port Stanley. An additional cable and trench may need to be installed to accommodate delivery of power to a heating device. The GDAS power supply battery should be replaced during the next service and this will also require shipping in advance.

Since David McLeod has indicated that someone else will inevitably take on the role of performing absolute observations, it would be advisable to conduct a refresher course in the observation procedure for this individual during the next service visit.

A further investigation into the relocation of the observatory to the potential location described in Section 4.2 is recommended for the next service visit, by which time Cable and Wireless will have installed their own equipment and a more detailed assessment of the site will be possible.

Glossary

ADC Analog-to-digital converter – Used to convert the analog output of an instrument to a digital record for recording and transmission.

DVM Digital Voltmeter – a device used to measure voltage, current and electrical resistance.

Fluxgate Abbreviation of fluxgate magnetometer – a vector magnetometer, here composed of three orthogonally mounted elements.

GDAS Geomagnetic Data Acquisition System – The proprietary data recording system of the British Geological Survey, developed specifically for operation at unmanned observatories. This system supersedes the FLARE Plus data logger.

GPS Global Positioning System – A system consisting of an array of satellites, base stations and remote receivers which has been designed to give accurate position and time.

PC Personal Computer – a term used to describe a computer capable of operating independently of other computers, typically based on the Intel 8086 chipset.

PPM Proton Precession Magnetometer – a scalar, full-field instrument, capable of giving a quasi-absolute measurement of the magnetic field.

PSU Power Supply Unit – A device for providing electrical power to another device or instrument, usually by conditioning another electrical power source.

SDAS Simple Data Acquisition Software – The name of the software used to record and retransmit data at the observatory.

UTC Coordinated Universal Time – a global time reference, used to relate observations between observatories.

Variometer An instrument which only measures variations of a natural element with respect to an arbitrary offset value, rather than measuring the true (absolute) value.

References

Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

RIDDICK, J.C., & HARRIS, T.J., 1994, FALKLAND ISLANDS MAGNETIC OBSERVATORY INSTALLATION REPORT, *BGS TECHNICAL REPORT,* WM/94/18

TURBITT, C.W. & FLOWER, S.M., 2002, PORT STANLEY MAGNETIC OBSERVATORY INSTALLATION REPORT 13-15 FEBRUARY 2002, *BGS INTERNAL REPORT,* IR/02/14

FLOWER, S. M., HARRIS, T. J., & RIDDICK, J. C., 2004, ENVIRONMENTAL MONITORS FOR THE PUBLIC WORKS DEPARTMENT, FALKLAND ISLANDS GOVERNMENT, *BGS INTERNAL REPORT,* IR/04/050R

TURBITT, C.W., 2004, GUIDE TO MAKING ABSOLUTE MAGNETIC OBSERVATIONS, *BGS TECHNICAL REPORT* (DRAFT)

TURBITT, C.W., 2003, PORT STANLEY MAGNETIC OBSERVATORY SERVICE REPORT 2003, *BGS INTERNAL REPORT,* IR/04/041R

FLOWER, S. M., & SHANAHAN, T.J.G., 2005, PORT STANLEY OBSERVATORY SERVICE REPORT 3-10 SEPTEMBER 2005, *BGS INTERNAL REPORT,* IR/05/152R

Appendix 1 Calibration Results

PRE-SERVICE CALIBRATIONS

The results of the pre-service calibrations carried in the UK are made against reference sources to provide correction values for the portable instruments when used overseas (Table 1, Table 2).

Voltage (Volts)		
Fluke 45	Fluke 87III	Diff. (F45-F87III)
1.00720	1.00710	0.00010
2.01580	2.01500	0.00080
3.01380	3.01200	0.00180
4.01860	4.01700	0.00160
5.02710	5.02500	0.00210
6.02030	6.01800	0.00230
7.02320	7.02100	0.00220
8.01450	8.01100	0.00350
9.01310	9.01000	0.00310
10.03100	10.02800	0.00300
-10.03200	-10.02600	-0.00600
-9.01210	-9.00700	-0.00510
-8.00550	-8.00000	-0.00550
-7.00860	-7.00400	-0.00460
-6.02590	-6.02100	-0.00490
-5.03140	-5.02700	-0.00440
-4.00940	-4.00500	-0.00440
-3.01430	-3.01000	-0.00430
-2.00980	-2.00600	-0.00380
-1.00500	-1.00450	-0.00050
0.00351	0.00370	-0.00019
Resistance (Ohms)		
Fluke 45	Fluke 87III	Diff. (F45-F87III)
1000.10	1000.20	-0.10

Table 5 DVM Calibration

Test Frequency (Hz)	F (nT) Portable Source	F (nT) NPL Source	Diff. (nT) (P-S)
833.33	19572.60	19572.66	-0.06
1000.00	23487.09	23487.19	-0.10
1666.67	39145.12	39145.32	-0.20
2000.00	46974.10	46974.36	-0.26
2500.00	58717.64	58717.95	-0.31
3333.33	78290.14	78290.64	-0.50

Table 6 Frequency Source Calibration

Calibration Parameters:

SDAS System	fkqa	Observatory	pst	Date	27-Mar-06	
Observer	TJGS	DVM Type	Fluke 85 III	DVM S/N	85300255	DVM Cal. Date
Flux Elect. S/N	S0216	Flux. Sensor S/N	E0215			
ADC S/N	GMAG_FGAD.0(	Resistor Temp.	9.3	Resistor Value	1000.3	
X-coil constant	38600			Approx. H-Field	0	
Y-coil constant	38593			Approx. Z-Field	0	
Z-coil constant	38601					

DMI Fluxgate Magnetometer Calibration:

Applied Voltage	H		Resistor Voltage	D	Resistor Voltage	Z	Resistor Voltage
+	8.5105		90.260	8.3895	90.230	8.5595	90.240
0	-0.0943			-0.2246		-0.0700	
-	-8.6935		-90.220	-8.8295	-90.220	-8.6685	-90.210
Output Range	17.204			17.219		17.228	
Resistor Current	0.180425872			0.18039588		0.1803959	
Generated Field	6964.438668			6962.01824		6963.4614	
Calibration	404.82	nT/V		404.32	nT/V	404.19	nT/V
	247.03	uV/0.1nT		247.33	uV/0.1nT	247.41	uV/0.1nT
SDAS Setting	248.06	uV/0.1nT		248.09	uV/0.1nT	248.47	uV/0.1nT
% Error	0.42	%		0.31	%	0.43	%
Temperature Probe							
Temperature	9.3	deg. C					
Scale	0.005	V/K					
ADC Output	1.5063	Volts					
ADC Offset	1459800	uVolts					

Analogue to Digital Converter Calibration:

ADC #01		ADC Channel			
Applied Voltage	H	D	Z	T	
4.0110	4.0162	4.0121	4.0117	4.0118	
0.0000	0.0000	0.0000	0.0000	0.0002	
-4.0100	-4.0147	-4.0115	-4.0095	-4.0118	
ADC Calibration	1.0012	1.0003	1.0000	1.0003	
+ve % Error	-0.1	0.0	0.0	0.0	
+ve % Error	-0.1	0.0	0.0	0.0	
ADC #02		ADC Channel			
Applied Voltage	H	D	Z	T	
8.135	8.141	8.138	8.138	8.138	
0.000	0.001	0.001	0.001	0.001	
-8.136	-8.144	-8.139	-8.140	-8.141	
ADC Calibration	1.001	1.000	1.000	1.000	
+ve % Error	-0.1	0.0	0.0	0.0	
+ve % Error	-0.1	0.0	0.0	-0.1	

Proton Precession Magnetometer Calibraion:

PPM Sensor		PPM Electronics			
Serial Number		Type		S/N	
Cal Box	C2				
Proton Gyromagnetic Ratio			267515250	±40 T-1s-1	
Switch Setting	Input Freq.	Cal Value	PPM Output	Error	
7	833.33333	19572.67	19572.72		-0.05
9	1000	23487.20	23487.25		-0.05
6	1666.6667	39145.34	39145.39		-0.05
5	2000	46974.41	46974.39		0.02
4	2500	58718.01	58717.93		0.08
3	3333.3333	78290.68	78290.55		0.13

Table 7 GDAS Calibration (Fluxgate, Digitiser and PPM)

Appendix 2 Absolute Observations

ABSOLUTE OBSERVATION 1

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 27 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:         067°  55'  42"
        CL 1:         247°  55'  44"
        CR 2:         067°  55'  37"
        CL 2:         247°  55'  41"
        Mean:         157°  55'  41"

     FM True:         281°  31'  01"
   TN Circle:         146°  24'  40"

DECLINATION OBSERVATION
                                                           VarD(nT)
          WU: 17:26   240°  10'  18"   240.1717°              -67.7
          ED: 17:28   240°  13'  29"   240.2247°              -67.5
          WD: 17:30   060°  08'  35"    60.1431°              -67.0
          EU: 17:31   060°  09'  42"    60.1617°              -67.3
        Mean: 17:28   150°  10'  31"

 Declination: 17:28   003°  45'  51"     3.7641°

INCLINATION OBSERVATION
                                                  PPMF(nT) VarH(nT) VarZ(nT)
          NU: 17:37   130°  49'  56"   -49.1678°   29023.9    -32.4     27.6
          SD: 17:39   310°  48'  49"   -49.1864°   29024.4    -31.7     27.6
          ND: 17:41   229°  07'  40"   -49.1278°   29025.4    -30.1     27.6
          SU: 17:42   049°  08'  29"   -49.1414°   29025.5    -30.0     27.6

 Inclination: 17:39  -049°  09'  21"   -49.1558°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    28994.0   29024.8     -30.8
D(deg):     3.7641   -0.2036    3.9677  003°  58'  04"
H (nT):    18962.2     -31.1   18993.1
Z (nT):   -21933.7      27.6  -21961.3
I (deg):  -49.1558

COLLIMATION ERRORS

Declination Delta:      000°  00'  31"
Declination Epsilon:    000°  01'  11"
Declination Zo (nT):    5.9
Inclination Epsilon:    000°  01'  17"
Inclination Zo (nT):    4.1
```

ABSOLUTE OBSERVATION 2

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 27 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:         067°  55'  42"
        CL 1:         247°  55'  51"
        CR 2:         067°  55'  43"
        CL 2:         247°  55'  52"
        Mean:         157°  55'  47"

     FM True:         281°  31'  01"
   TN Circle:         146°  24'  46"

DECLINATION OBSERVATION
                                                            VarD(nT)
          WU: 19:22   240°  09'  39"   240.1608°               -68.4
          ED: 19:23   240°  13'  47"   240.2297°               -68.4
          WD: 19:24   060°  07'  41"    60.1281°               -68.6
          EU: 19:25   060°  10'  13"    60.1703°               -68.9
        Mean: 19:23   150°  10'  20"

 Declination: 19:23   003°  45'  34"     3.7594°

INCLINATION OBSERVATION
                                                   PPMF(nT) VarH(nT) VarZ(nT)
          NU: 19:29   130°  51'  36"   -49.1400°    29030.5    -19.8     29.6
          SD: 19:30   310°  49'  38"   -49.1728°    29030.6    -19.5     29.8
          ND: 19:32   229°  05'  51"   -49.0975°    29031.1    -18.5     29.9
          SU: 19:33   049°  07'  52"   -49.1311°    29031.6    -17.7     29.9

 Inclination: 19:31  -049°  08'  07"   -49.1353°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    29000.2   29031.0     -30.8
D(deg):     3.7594   -0.2071    3.9665  003°  57'  59"
H (nT):    18974.1     -18.9   18992.8
Z (nT):   -21931.6      29.8  -21961.4
I (deg):  -49.1353

COLLIMATION ERRORS

Declination Delta:     000°  00'  24"
Declination Epsilon:   000°  01'  12"
Declination Zo (nT):   9.2
Inclination Epsilon:   000°  01'  16"
Inclination Zo (nT):   8.4
```

ABSOLUTE OBSERVATION 3

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 27 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:         067°  55'  43"
        CL 1:         247°  55'  52"
        CR 2:         067°  55'  43"
        CL 2:         247°  55'  52"
        Mean:         157°  55'  48"

     FM True:         281°  31'  01"
   TN Circle:         146°  24'  47"

DECLINATION OBSERVATION
                                                            VarD(nT)
          WU: 19:43   240°  08'  59"   240.1497°               -73.0
          ED: 19:45   240°  12'  54"   240.2150°               -73.4
          WD: 19:46   060°  06'  59"    60.1164°               -73.6
          EU: 19:47   060°  08'  51"    60.1475°               -73.6
        Mean: 19:45   150°  09'  26"

 Declination: 19:45   003°  44'  39"     3.7442°

INCLINATION OBSERVATION
                                                   PPMF(nT) VarH(nT) VarZ(nT)
          NU: 19:53   130°  51'  35"   -49.1403°    29031.7    -17.1     30.2
          SD: 19:54   310°  50'  00"   -49.1667°    29031.7    -17.2     30.2
          ND: 19:56   229°  05'  39"   -49.0942°    29031.9    -16.8     30.2
          SU: 19:57   049°  07'  07"   -49.1186°    29032.1    -16.5     30.3

 Inclination: 19:55  -049°  07'  48"   -49.1299°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    29001.0   29031.8     -30.8
D(deg):     3.7442   -0.2216    3.9658  003°  57'  57"
H (nT):    18976.7     -16.9   18993.5
Z (nT):   -21930.5      30.2  -21960.7
I (deg):  -49.1299

COLLIMATION ERRORS

Declination Delta:     000°  00'  31"
Declination Epsilon:   000°  01'  19"
Declination Zo (nT):   8.0
Inclination Epsilon:   000°  01'  25"
Inclination Zo (nT):   6.4
```

ABSOLUTE OBSERVATION 4

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 28 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:         306°  29'  38"
        CL 1:         126°  29'  44"
        CR 2:         306°  29'  38"
        CL 2:         126°  29'  44"
        Mean:         216°  29'  41"

     FM True:         281°  31'  01"
   TN Circle:         204°  58'  40"

DECLINATION OBSERVATION
                                                            VarD(nT)
          WU: 13:49   118°  34'  36"   118.5767°              -119.7
          ED: 13:51   118°  38'  16"   118.6378°              -119.3
          WD: 13:52   298°  32'  26"   298.5406°              -119.9
          EU: 13:53   298°  34'  22"   298.5728°              -119.3
        Mean: 13:51   208°  34'  55"

 Declination: 13:51   003°  36'  15"     3.6041°

INCLINATION OBSERVATION
                                                   PPMF(nT) VarH(nT) VarZ(nT)
          NU: 13:56   130°  50'  04"   -49.1656°    29022.8    -33.4     28.5
          SD: 13:57   310°  48'  36"   -49.1900°    29022.2    -34.0     28.8
          ND: 13:59   229°  07'  52"   -49.1311°    29022.0    -34.3     28.8
          SU: 14:00   049°  08'  45"   -49.1458°    29022.1    -34.0     28.9

 Inclination: 13:58  -049°  09'  29"   -49.1581°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    28991.5   29022.3     -30.8
D(deg):     3.6041   -0.3613    3.9654  003°  57'  55"
H (nT):    18959.7     -33.9   18993.2
Z (nT):   -21932.6      28.8  -21961.3
I (deg):  -49.1581

COLLIMATION ERRORS

Declination Delta:     000°  00'  26"
Declination Epsilon:   000°  01'  19"
Declination Zo (nT):   7.7
Inclination Epsilon:   000°  01'  11"
Inclination Zo (nT):   5.0
```

ABSOLUTE OBSERVATION 5

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 28 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:          306°  29'  37"
        CL 1:          126°  29'  47"
        CR 2:          306°  29'  43"
        CL 2:          126°  29'  49"
        Mean:          216°  29'  44"

     FM True:          281°  31'  01"
   TN Circle:          204°  58'  43"

DECLINATION OBSERVATION
                                                            VarD(nT)
          WU: 14:06   118°  35'  04"   118.5844°              -116.6
          ED: 14:07   118°  39'  00"   118.6500°              -116.1
          WD: 14:08   298°  33'  27"   298.5575°              -115.3
          EU: 14:09   298°  35'  36"   298.5933°              -114.5
        Mean: 14:07   208°  35'  47"

 Declination: 14:07   003°  37'  04"     3.6177°

INCLINATION OBSERVATION
                                                   PPMF(nT) VarH(nT) VarZ(nT)
          NU: 14:13   130°  50'  12"   -49.1633°    29021.0    -36.0     28.6
          SD: 14:14   310°  48'  27"   -49.1925°    29020.6    -36.5     28.6
          ND: 14:16   229°  07'  54"   -49.1317°    29020.3    -37.0     28.5
          SU: 14:17   049°  09'  02"   -49.1506°    29020.3    -37.3     28.4

 Inclination: 14:15  -049°  09'  34"   -49.1595°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    28989.8   29020.6     -30.8
D(deg):     3.6177   -0.3494    3.9671  003°  58'  02"
H (nT):    18958.0     -36.7   18994.3
Z (nT):   -21931.7      28.5  -21960.2
I (deg):  -49.1595

COLLIMATION ERRORS

Declination Delta:      000°  00'  27"
Declination Epsilon:    000°  01'  05"
Declination Zo (nT):    8.4
Inclination Epsilon:    000°  01'  06"
Inclination Zo (nT):    6.1
```

ABSOLUTE OBSERVATION 6

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 28 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:          306°  30'  24"
        CL 1:          126°  30'  32"
        CR 2:          306°  30'  20"
        CL 2:          126°  30'  26"
        Mean:          216°  30'  26"

     FM True:          281°  31'  01"
   TN Circle:          204°  59'  25"

DECLINATION OBSERVATION
                                                            VarD(nT)
          WU: 17:00    118°  44'  31"   118.7419°               -69.4
          ED: 17:08    118°  48'  40"   118.8111°               -67.5
          WD: 17:13    298°  43'  35"   298.7264°               -65.6
          EU: 17:17    298°  44'  07"   298.7353°               -64.5
        Mean: 17:09    208°  45'  13"

 Declination: 17:09    003°  45'  49"     3.7635°

INCLINATION OBSERVATION
                                                    PPMF(nT) VarH(nT) VarZ(nT)
          NU: 17:33    130°  51'  18"   -49.1450°    29022.1    -27.3     34.6
          SD: 17:38    310°  49'  50"   -49.1694°    29023.6    -26.3     33.7
          ND: 17:45    229°  07'  07"   -49.1186°    29023.8    -26.4     33.2
          SU: 17:48    049°  07'  47"   -49.1297°    29024.0    -26.4     33.0

 Inclination: 17:41   -049°  08'  26"   -49.1407°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    28992.6   29023.4     -30.8
D(deg):     3.7635   -0.2016    3.9651  003°  57'  55"
H (nT):    18967.1     -26.6   18993.5
Z (nT):   -21927.6      33.6  -21961.2
I (deg):  -49.1407

COLLIMATION ERRORS

Declination Delta:      000°  00'  54"
Declination Epsilon:    000°  01'  11"
Declination Zo (nT):    6.5
Inclination Epsilon:    000°  00'  59"
Inclination Zo (nT):    4.5
```

ABSOLUTE OBSERVATION 7

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 29 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:         067°  36'  24"
        CL 1:         247°  36'  34"
        CR 2:         067°  36'  25"
        CL 2:         247°  36'  34"
        Mean:         157°  36'  29"

     FM True:         281°  31'  01"
   TN Circle:         146°  05'  28"

DECLINATION OBSERVATION
                                                            VarD(nT)
          WU: 15:27   239°  46'  12"   239.7700°               -93.6
          ED: 15:29   239°  49'  39"   239.8275°               -93.9
          WD: 15:30   059°  44'  34"    59.7428°               -93.3
          EU: 15:31   059°  46'  39"    59.7775°               -93.0
        Mean: 15:29   149°  46'  46"

 Declination: 15:29   003°  41'  18"     3.6882°

INCLINATION OBSERVATION
                                                   PPMF(nT) VarH(nT) VarZ(nT)
          NU: 15:36   130°  50'  28"   -49.1589°    29018.4    -33.5     34.8
          SD: 15:38   310°  49'  09"   -49.1808°    29019.8    -32.5     33.7
          ND: 15:40   229°  06'  49"   -49.1136°    29020.2    -32.7     33.3
          SU: 15:41   049°  08'  05"   -49.1347°    29020.0    -33.0     33.3

 Inclination: 15:38  -049°  08'  49"   -49.1470°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    28988.8   29019.6     -30.8
D(deg):     3.6882   -0.2824    3.9706  003°  58'  14"
H (nT):    18962.2     -32.9   18994.9
Z (nT):   -21926.9      33.8  -21960.6
I (deg):  -49.1470

COLLIMATION ERRORS

Declination Delta:     000°  00'  20"
Declination Epsilon:   000°  01'  00"
Declination Zo (nT):   7.6
Inclination Epsilon:   000°  01'  22"
Inclination Zo (nT):   5.4
```

ABSOLUTE OBSERVATION 8

```
Observatory: Port Stanley
Logger: gd1_pst
Observer: TS
Date: 29 Mar 2006
Site Difference:    -30.8
Theodolite serial number: 108003
Fluxgate serial number: 886H

FIXED MARK READING

        CR 1:         067°  36'  26"
        CL 1:         247°  36'  34"
        CR 2:         067°  36'  20"
        CL 2:         247°  36'  33"
        Mean:         157°  36'  28"

     FM True:         281°  31'  01"
   TN Circle:         146°  05'  27"

DECLINATION OBSERVATION
                                                          VarD(nT)
          WU: 16:02   239°  48'  05"   239.8014°             -82.9
          ED: 16:03   239°  51'  34"   239.8594°             -82.5
          WD: 16:04   059°  46'  47"    59.7797°             -82.4
          EU: 16:05   059°  47'  53"    59.7981°             -82.0
        Mean: 16:03   149°  48'  35"

 Declination: 16:03   003°  43'  07"     3.7187°

INCLINATION OBSERVATION
                                                  PPMF(nT) VarH(nT) VarZ(nT)
          NU: 16:12   130°  50'  39"   -49.1558°    29022.1    -29.7     33.4
          SD: 16:13   310°  49'  03"   -49.1825°    29022.1    -29.7     33.4
          ND: 16:15   229°  06'  42"   -49.1117°    29022.3    -29.6     33.2
          SU: 16:16   049°  07'  57"   -49.1325°    29022.3    -29.8     33.1

 Inclination: 16:14  -049°  08'  44"   -49.1456°

BASELINES

          Absolute      GDAS  Baseline
F (nT):    28991.4   29022.2     -30.8
D(deg):     3.7187   -0.2491    3.9678  003°  58'  04"
H (nT):    18964.4     -29.7   18993.9
Z (nT):   -21928.4      33.3  -21961.6
I (deg):  -49.1456

COLLIMATION ERRORS

Declination Delta:     000°  00'  36"
Declination Epsilon:   000°  01'  05"
Declination Zo (nT):   6.3
Inclination Epsilon:   000°  01'  25"
Inclination Zo (nT):   6.0
```

Appendix 3 QNX and SDAS Configuration Files

SDAS CONFIGURATION FILES FOR GEOMAGNETIC DATA LOGGER

Acquisition configuration (acquire.cfg):

```
# an entry for an ADAM 4017 adc running at 1Hz
0 adc /dev/ser2 -1 "baud=9600 +raw -osflow -ihflow -ohflow -lkhflow" ADAM_4017 1s 0x01 yes 0
1 ppm /dev/ser4 -1 "baud=9600 +raw -osflow -ihflow -ohflow -lkhflow" GSM90 6m 29 yes 0
2 filter /dev/null -1 "" COSINE_60S -1 0 no 0
3 filter /dev/null -1 "" COSINE_60S -1 1 no 0
4 filter /dev/null -1 "" COSINE_60S -1 2 no 0
5 filter /dev/null -1 "" COSINE_60S -1 3 no 0
6 filter /dev/null -1 "" COSINE_60S -1 4 no 0
7 closing_err /dev/null -1 "" "19000,-22000" -1 "5,7,9" no 0
```

Channel configuration (channels.cfg)

```
0   PST     "H"          "0.1nT"  0.0  248.06   0     main  0
1   PST     "D"          "0.1nT"  0.0  248.09   0     main  1
2   PST     "Z"          "0.1nT"  0.0  -248.47   0    main  2
3   PST     "T"          "0.1dg.C"  1448000  500.0   0 main    3
4   PST     "F"           "0.1nT"  0.0  10.0   1 main    0
5   PST     "H filter"    "0.1nT"  0.0  1.0   2 main    0
6   PST     "D filter"    "0.1nT"  0.0  1.0   3 main    0
7   PST     "Z filter"    "0.1nT"  0.0  1.0   4 main    0
8   PST     "T filter"    "0.1dg.C"  0.0  1.0   5 main    0
9   PST     "F filter"    "0.1nT"  0.0  1.0   6 main    0
10  PST     "Closing Err" "0.1nT" 0.0  1.0   7 main    0
```

General configuration (general.cfg)

```
ring_buffer_size 40000
log_buffer_size 30

sdas_clock_params "-s /dev/ser1 -l '4800 -osflow -ihflow -ohflow -lkhflow +raw' -q -c -f700"

SDAS_EXTRACT_DIR $SDAS_REC_DIR/data/archive
SDAS_DS_PORT 6801

CHANNEL_GROUP_0        "Geomag                0,1,2,3,4,5,6,7,8,9,10"
```

QNX CONFIGURATION FILES FOR GEOMAGNETIC DATA LOGGER

IP address list (/etc/hosts)

```
127.1        localhost localhost.my.domain
63.130.248.243 fkqa fkqa.horizon.co.fk
```

DNS configuration (/etc/resolv.conf)

```
domain horizon.co.fk
nameserver 195.248.193.250
```

System startup (/etc/config/sysinit.1)

```
#Image: /boot/sys/boot -v
#Image: /boot/sys/Proc32 -l 1
#Image: /boot/sys/Slib32
#Image: /boot/sys/Slib16
#Image: /bin/Fsys
#Image: /bin/Fsys.eide fsys -Ndsk0 -n0=hd0. -n5=cd0. eide -a1f0 -i14
#Image: /bin/mount -p /dev/hd0.0 /dev/hd0.0t77 /
#Image: /bin/sinit TERM=qnxm
#export NODE=1

# This file (/etc/config/sysinit.1) is the system initialisation file for
# QNX 4.25j (Patch E) running on a DSP Design TP400 PC configured for
# Geomag logging
# Chris Turbitt 11 October 2001

###########################################################################
# This section is the basic operating system setup
# Set the region and language for the keyboard (including Photon)
export KBD=en_GB_102.kbd
export ABLANG=en
export CON_KBD=UnitedKingdom

# Timezone set to GMT (all year). lso set QNX time to real time clock (hw)
# time
export TZ=wet00west-01,M3.5.0/2,M10.5.0/2
/bin/rtc hw

# Start the device manager - this must be started before any Dev.* devices
Dev -n 100 &
Dev.ansi -Q -n6 &
reopen /dev/con1

kbd $CON_KBD

# Start the serial port, parallel port and pseudo-tty drivers
/bin/Dev.ser -N/dev/ser1 3f8,4 &
/bin/Dev.ser -N/dev/ser2 2f8,3 &
/bin/Dev.ser -N/dev/ser3 3e8,11 &
/bin/Dev.ser -N/dev/ser4 2e8,10 &

Dev.par &
Dev.pty -n20 &

# Start the cron server
cron &

# Start the floppy disk driver and the DOS file system manager for
# the floppy drive
/bin/Fsys.floppy -a3f0 -i6
Dosfsys  a=/dev/fd0 &

# Start the CD-ROM driver and set the CD-ROM drive to /cd0
#/bin/Iso9660fsys /cd0=/dev/cd0.0 &

# Make pipes faster by running them in memory
Pipe &

# Start the 8087 emulator
emu87 &

# Start the network name locator
nameloc &

# Add an alias to the pathname prefix tree for the default console
prefix -A /dev/console=/dev/con1

# Perform a consistency check on the QNX filesystem
chkfsys -uPr /


###########################################################################
# This section starts the network drivers and services. It should be
# entirely commented out unless a network card and TCP/IP software
# are installed

# Start the network device manager. This must be started before any Net.*
# devices
/bin/Net &
```

```
sleep 1

# Start the card-specific device driver by uncommenting one of the following
# Ethernet drivers
# Ethernet driver option 1: Intel PRO/100+ Ethernet card
#Net.ether82557 -pef00 -l1 -v &

# Ethernet driver option 2: DSP Design TB486 Ethernet port
#Net.crys8900 -l1 -v &

# Ethernet driver option 3: DSP Design TP400 Ethernet port
#Net.ns83815 -pf800 -i11 -I0 -l1 &

# Ethernet driver option 4: DSP Design Arcom SBC-GX1 Ethernet port
Net.ns83815 &

sleep 1

# Start the network manager's logical-to-physical node ID mapping table
netmap -f

# If the file '/etc/config/bin/tcpip.1 exists, then execute it. This script
# starts the QNX TCP-IP managers
if test -f /etc/config/bin/tcpip.$NODE
then
sleep 2
. /etc/config/bin/tcpip.$NODE

fi

# Setup /dev/ser3 for ppp via modem, and start modem2 to
# auto-answer an incoming call. These settings are for a
# Multitech Multimodem V.90
tinit -c '/home/sdas/current/bin/modem2 -i AT&FS0=5$BA0$SB38400&W0 -b38400 -t vt100' -t /dev/ser3
&

###########################################################################
# This section is used to automatically launch any applications at boot
# time

# start the SDAS acquisition
Mqueue &
su sdas -c /home/sdas/current/bin/sdas.boot

# If the file /etc/config/bin/ph.1 exists, start Photon
if test -f /etc/config/bin/ph.$NODE
then
. /etc/config/bin/ph.$NODE
else
tinit -t /dev/con1 &
tinit -T /dev/con[2-6] &
fi
```

TCP/IP startup (/etc/config/bin/tcpip.1)

```
#! /bin/ksh

export SOCK=$NODE

/usr/ucb/Socket -p1 fkqa &
/usr/ucb/ifconfig lo0 localhost up
/usr/ucb/ifconfig en1 fkqa netmask 255.255.255.248 up
/usr/ucb/inetd /etc/config/inetd.1 &

/usr/ucb/route add default 63.130.248.241

# Attempt to map the users disk on mhub to /users. This will only be
# successful on the MH LAN
sleep 5
```

Hostname configuration (/etc/uucpname)

```
fkqa
```

SDAS CONFIGURATION FILES FOR ENVIRONMENTAL DATA LOGGER

Acquisition configuration (acquire.cfg):

```
0  lpt_irq_counter   ""        -1 ""          ""    1m "0x378,7,1000" yes 0
1  mini_met          /dev/ser1  0 "baud=9600" "PST" 1s ""             yes 0
```

Channel configuration (channels.cfg)

```
0      "PST"    "Rain"        0.2mm     0.0     1.0   0 main 0

100  "PST"    "Wind Speed"  "Counts"  0.0     2.575 1 main 0
101  "PST"    "Wind Dir"    "Counts"  0.0     2.8   1 main 1
102  "PST"    "Rel Humid"   "Counts"  0.0     10.0  1 main 2
103  "PST"    "Temperature" "Counts"  400.0   1.0   1 main 3
```

General configuration (general.cfg)

```
ring_buffer_size 40000
log_buffer_size 30

sdas_clock_params "-s /dev/null -q"
```

Appendix 4 Photographed Equipment

Figure 5 Variometer Hut (front), Absolute Hut (back)

Figure 6 New Air Conditioning Exchangers

Figure 7 Auxiliary Fixed Mark Reference

Figure 8 GDAS PSU (middle shelf), GDAS Logger (bottom shelf)