BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

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MACQUARIE ISLAND GEOMAGNETIC OBSERVATORY

ANNUAL REPORT, 1986

BY

WENDY WELSH

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FIGURES

1 Macquarie Island photo-electric magnetograph system
2 Magnetic observations - Macquarie Island

SUMMARY

Geomagnetic recordings were continued at the Macquarie Island geophysical observatory during 1986. The work described in this report was part of the Bureau of Mineral Resources' and Antarctic Division's contribution to the 1986 Australian National Antarctic Research Expeditions.

The photo-electronic magnetograph system recorded X, Y, Z and F in digital and analogue modes throughout the year. Control observations were performed weekly.

Unprocessed control observations were forwarded weekly, and variometer data were forwarded in January and December 1986, to BMR Canberra.

CHAPTER 1: INTRODUCTION

The geophysical observatory on Macquarie Island has recorded geomagnetic activity since 1950. An outline of the observatory history is given in Appendix A, and the coordinates of the magnetic station are listed in Table 1.

The observatory was operated by Bob Lachal, the Officer in Charge from the Antarctic Division, Department of Science, as part of the Australian National Antarctic Research Expedition's (ANARE) station on the island. He took over the geomagnetic observatory routines from Phil Barnaart on 8 December 1985. Sjoerd Jongens, the Upper Atmosphere Physics (UAP) engineer, took over the equipment maintenance from Dave Barrett on 12 April 1986. Ian Jacobsen took over the observatory routines for 1987 on 11 December 1986.

CHAPTER 2: PHOTO-ELECTRONIC MAGNETOGRAPH

2.1 Magnetograph system

The photo-electronic magnetograph (PEM) system (Figure 1) consists of four variometers which monitor the geographic north (X), geographic east (Y), vertical (Z, positive downwards), and the total field (F) components of the geomagnetic field. The magnetograph records the variations of these components, plus temperature, in analogue mode at 20 mm/hr on a 6 channel W+W chart recorder, and digitally as minute averages on an Edas2 data logger with internal analogue to digital conversion.

The total field, measured with an MNS2 proton precession magnetometer (PPM), was recorded as 2 components: 0-990 nT and 0-99 nT. Temperature was monitored by a Doric with the thermistor near the X variometer. Y, X, Z, F(0-990), F(0-99) and T were recorded on channels 1-6 respectively until 1 March 1986, 00 U.T.. Thereafter, X, Y, Z, F(0-990), F(0-99) and T were recorded on channels 1-6 respectively. The construction and operation of the photo-electronic magnetometers is outlined in Seers and Black (1985).

2.2 Wiring

The PEM wiring was incorrectly modified during the 1984 changeover (Welsh, 1987). Dave Barrett swapped the X and Y PEM output cables back on 1 March 1986. That is, from 1 March 1986, 0000 U.T., X was recorded on channel 1 and Y was recorded on channel 2. However, the reversed polarity of the X, Y and Z PEMs remained undetected until later in the year. That is, X was recorded as -X up, Y was recorded as -Y up, and Z was recorded as |Z| up from 24 October 1984, 0500 U.T. to 6 December 1986, 2100 U.T., when the variometer wiring was corrected to record +X up, +Y up, and +Z up.

The relevant corrections are included in all baselines in this report and in the 1985 annual report (Welsh, 1987).

2.3 Magnetograph system tests

2.3.1 Scale values

X, Y and Z scale value pulses of 39.65 mA were initiated through the MCC-1 PEM controller daily as a system check, and weekly with the control observations.

F scale values were carried out weekly by recording 996-999 nT and 0 nT. Simultaneous temperature and Edas2 temperature counts were also monitored weekly. Calibration constants and scale values are listed in Table 2. The measured MCC-1 scale value currents for each current setting are listed in Table 3.

2.3.2 Temperature coefficients

The temperature coefficients were initially determined from linear regression analyses. The final values listed in Table 2 gave the minimum baseline value scatters.

2.4 Data reduction and Publication

Absolute observations of H, D and F were used to calibrate digitally recorded X, Y and Z. Raw observation data were telexed weekly; Figure 2 shows the observation/telex form used.

Preliminary monthly mean values derived from the mean of each month's absolute observations were published in BMR's Geophysical Observatory Reports. Preliminary instrument and pier difference corrections were applied to these data:

Element	Correction added
H	-6 nT instrument correction
D	A collimation angle of 82.58' was used with alpha calculated separately for each observation.
F	-1 nT instrument correction -1 nT pier difference correction

The PEM baseline values listed in Table 4 do not include instrument or pier difference corrections. Alpha was calculated separately for each observation.

The preliminary monthly mean values listed in Table 5 were derived from the International Quiet Days in each month. The preliminary corrections adopted were:

Element	Correction added
H	-10 nT instrument correction
D	as above
F	0 nT

Data recovery from the Edas2 system during 1986 was poor due to substandard data cassettes. The percentages of data lost for the months December 1985 to November 1986 were: 0.6, 1.8, 7.4, 55.3, 13.2, 26.0, 26.3, 22.0, 40.4, 23.6, 45.4, 11.8.

Geomagnetic annual mean values for 1975 to 1985 are listed in Table 6.

CHAPTER 3: MAGNETOMETERS

3.1 Absolute instruments

Control observations for H, D and F were made weekly using the following magnetometers

H and D: QHM 179 (therm. 1651) with Askania circle 640616 until 10 April 1986, then with Askania circle 640620.
F: PPM Austral 525.

Observations of H and D were made on pier E, and F on pier W. The reference mark for D was North Mark Inner (NMI).

3.2 External pier (pier X)

An external pier was established to the west of the absolute hut on 9 December 1986 prior to the hut's demolition. The pier is a concrete filled terracotta pipe with non-magnetic grade (316) stainless steel reinforcing. It is enclosed by a Copper's Log fence with hand-made nuts and bolts.

Several observations were carried out from this pier. Buffetting winds carrying salt spray, and poor light made the observations difficult.

3.3 Pier differences

F pier difference observations were carried out between pier X and pier W, and between pier W and the standard, pier E:

F (pier E - W) = -1 +/- 0.5 nT
F (pier W - X) = -41 +/- 0.5 nT
then, F (pier E - X) = -42 nT

From observations in 1984:

F (pier E - N) = +8 +/- 0.5 nT

H and D pier difference observations were carried out between piers X and E, and reduced to X and Y baselines:

X (pier E - X) = 25 +/- 2 nT
Y (pier E - X) = 16 +/- 4 nT

3.4 Reference marks

The azimuth from pier X to the old auroral camera stand (NM/X/I) was measured by surveyors from the Tasmanian Lands

Department during the 1986 changeover to be

39° 01' 45"

using as datum the azimuth from NM/X/I to The Nuggets determined in 1976.

Rounds of angles from both pier E and pier X were carried out - see Table 7. Where azimuths are not stated they have not been accurately determined.

3.5 Comparisons

QHM 179 was returned to Australia and compared with QHMs 460, 461, and 462, the Australian standards. Austral 525 was compared with Geometrics 816/1024 which had previously been compared with the standard PPM, MNS2.3. Austral 524, the backup for Austral 525, was compared with MNS2.3 prior to being sent down in the April 1987 airdrop. The magnetometer comparison results are listed in Table 8.

CHAPTER 4: BUILDINGS

4.1 Absolute hut

The original 1950 absolute hut was dismantled and removed in mid-December 1986. The new piers are within a millimetre or two of the old piers in location and height. The piers are non-magnetic aggregate concrete-filled terracotta pipes with grade 316 stainless steel reinforcing to not less than 500 mm from the pier tops. The non-magnetic aggregate concrete slab floor also has grade 316 reinforcing. The hut has a shingle roof and weatherboard cladding of treated timber with melthoid, then an internal lining of plasterboard. Magnetic observations were resumed in late January 1987.

4.2 Variometer hut

The exterior of the variometer hut has continued to deteriorate. New cladding was available for repair work in 1986 but none was attempted.

The interior of the hut was damp and draughty, and harboured some rats/mice which seemed to have been doing well on Ratsack. They had not begun chewing the cables, but had spent some time on the PEM baseboards. Aluminium angle was fixed over the floor-wall joins to decrease the number of probable rodent entrances. However, much of the timber is so rotten that this could not be a total success.

4.3 PPM hut

The paintwork on the windward fibro cladding had been completely removed by weathering and a panel had been broken presumably by an elephant seal. The boards cannot be repainted because they do not get a chance to dry. This damage was repaired during the 1986/7 summer.

The interior of the hut was damp: the walls and ceiling were coated with mould. The mould was removed and the paintwork underneath found to be good. There were rodent droppings on the pier and the cable had been chewed, although not through to the wires. The rodents' entrance, the pier-floor gap, was filled with mastik during the 1986/7 summer.

ACKNOWLEDGEMENTS

The author and the BMR thank Bob Lachal and Sjoerd Jongens for undertaking the observatory tasks with precision and dedication. These tasks were additional to their routine duties. The author also thanks Murray Price and his workers for a job well done building the new absolute hut.

REFERENCES

Seers, K.J. and Black, G.W., 1985, Handbook for MPE-1 photo-electronic magnetometer (horizontal), MPE-2 photo-electronic magnetometer (vertical), and MCC-1 magnetometer controller, 3rd edition. Bureau of Mineral Resources, Australia, Record 1985/39.

Welsh, W.D., 1987, Macquarie Island geomagnetic observatory annual report, 1985. Bureau of Mineral Resources, Australia, Record 1987/38.

APPENDIX A: Geomagnetic obervatory history, Macquarie Island

Buildings

1948 - Start of ANARE station on Macquarie Island.

1950 - Magnetic variometer and absolute huts erected.

1968 - Geophysics office constructed.

1979 - Science building constructed - included geophysics office, Upper Atmosphere Physics laboratory and office for the Officer in Charge.

1984 - Proton precession magnetometer hut constructed.

1987 - Absolute hut replaced.

Magnetic observatory

Aug 1950 - Watts horizontal intensity variometer no. 61911 was installed. Scale value was 3.5 nT/mm.

1951 - Watts H-variometer returned to Australia. 3-component normal La Cour magnetograph installed. Scale values: H, 12 nT/mm; D, 0.9 '/mm; Z, 13 nT/mm.

Apr 1960 - 3-component insensitive La Cour magnetograph installed to supplement the existing sensitive magnetograph. Scale values: H, 63 nT/mm; D, 2.25 '/mm; Z, 59 nT/mm.

Dec 1962 - Normal La Cour magnetograph was replaced by a La Cour rapid-run magnetograph (180 mm/hr). The insensitive La Cour magnetograph was modified to increase the sensitivity of the H and Z variometers by changing the H fibre and replacing the Z magnet. Scale values were:

	Before Normal	After Rapid-run	Before Insensitive	After Normal
H (nT/mm)	12.6	5.4	63	24.6
D ('/mm)	0.92	1.03	2.35	2.35
Z (nT/mm)	14.2	5.3	59	20.6

26 Feb 1968 - On 26 Feb the D fibre was replaced in an attempt to reduce erratic drift. On 9 Mar the H fibre was replaced - scatter and drift continued. The H scale value was reduced to 23.7 nT/mm.

1 Feb 1970 - H variometer fibre was replaced in the normal magnetograph. This reduced the H scale value to 19.3 nT/mm, and eliminated steep drift.

1978 - Recording ceased on the rapid-run magnetograph.

Feb 1982 - Rapid-run magnetometers returned to Australia.

Jan 1984 - Digital and analogue recording from X and Y photo-electronic magnetometers (PEMs) commenced.

Oct 1984 - Digital and analogue recording from MNS2 proton precession magnetometer commenced.
- Recording ceased on La Cour normal-run magnetograph.
- Digital and analogue recording from Z PEM commenced.
- Daily operation of magnetic observatory handed over to Antarctic Division staff.
- La Cour normal-run magnetograph and remains of rapid-run magnetograph returned to Australia.

Mar 1986 - X recorded on channel 2, Y recorded on channel 1 of Edas2 and W+W from 0050 UT, 24.10.1984 to 0000 UT, 01.03.1986.

Dec 1986 - X recorded as -X up, Y recorded as -Y up, and Z recorded as |Z| on Edas2 and W+W from 0050 UT, 24.10.1984 to 2100 UT, 06.12.1986; thence recorded as +X up, +Y up and +Z up.

TABLE 1: Station data for Macquarie Island magnetic absolute hut

Geographic	latitude	54° 30.0' S
	longitude	158° 57.0' E
Geomagnetic	latitude	-60.6°
	longitude	244.6°
Elevation		8 metres
Foundation		basalt

The geomagnetic coordinates are based on the 1980.0 DGRF model of the geomagnetic field.

TABLE 2: Magnetograph parameters, 1985/6

Component	Scale Value	Standard Deviation	Temperature Coefficient	Nominal Calibration Current	Coil Constant
01.12.1985 00 U.T. to 07.12.1986 05 U.T.					
X	0.1996,	0.0006 nT/ct	6.4 nT/°C	40 mA	8.03 nT/mA
Y	0.1998,	0.0006 nT/ct	3.4 nT/°C	40 mA	8.03 nT/mA
Z	-0.2012,	0.0004 nT/ct	-14.4 nT/°C	40 mA	8.03 nT/mA
F(0-990)	0.4012,	0.0004 nT/ct	-	990 nT	
F(0-99)	0.04006,	0.00007 nT/ct	-	99 nT	
T	0.00185	°C/ct	-	-	-

TABLE 3: MCC-1 scale value currents, 07.12.1986

Current Setting	Current measured (mA) +	0	-	Total (mA)
4	4.00	0.00	4.00	8.00
8	7.95	0.00	7.95	15.90
20	19.85	0.00	19.80	39.65
40	39.5	0.00	39.4	78.9
80	79.1	0.00	78.0	157.1

TABLE 4: Observed baseline values, 1985/6

Date	U.T. hr min	Baseline Value	Standard Deviation	Remarks
X, True north intensity		(nT)		
01 Dec 1985	00 00	11291	4	
25 Jan 1986	00 00	11283	3	drift
12 Jun 1986	04 31	11295	12	power failure
09 Aug 1986	03 55	11278	4	power failure
07 Dec 1986	05 00			
Y, True east intensity		(nT)		
01 Dec 1985	00 00	6144	2	
18 Dec 1985	21 46	6136	3	mains power transient
27 Apr 1986	00 00	6130	4	drift
09 Oct 1986	00 00	6133	2	drift
07 Dec 1986	05 00			
Z, Vertical intensity		(nT)		
01 Dec 1985	00 00	-63480	8	
11 Jun 1986	22 05	-63467	12	power failure
29 Oct 1986	00 07	-63458	11	power failure
07 Dec 1986	05 00			
F(0-990), Total field		(nT)		
01 Dec 1985	00 00	64011	3	
07 Dec 1986	05 00			
F(0-99), Total field		(nT)		
01 Dec 1985	00 00	64805	2	
07 Dec 1986	05 00			
T, Temperature		(°C)		
01 Dec 1985	00 00	-3.35	0.05	
30 Jun 1986	00 00	-3.90	0.08	
07 Dec 1986	05 00			

X, Y, Z, F(0-990) and F(0-99) baseline datums are 5000 counts; T baseline datum is 0 counts.

TABLE 5: Preliminary monthly mean geomagnetic values, 1985/6

Month	X (nT)	Y (nT)	Z (nT)	F (nT)	D (° 'E)
1985					
Dec	11 017	6156	-63 592	64 832	29 11.8
1986					
Jan	11 014	6154	-63 584	64 823	29 11.6
Feb	10 996	6157	-63 587	64 823	29 14.7
Mar	10 991	6154	-63 596	64 831	29 14.7
Apr	10 990	6159	-63 596	64 832	29 16.0
May	10 996	6158	-63 603	64 839	29 15.0
Jun	11 004	6162	-63 589	64 825	29 14.8
Jul	11 006	6162	-63 580	64 819	29 14.7
Aug	10 979	6160	-63 576	64 810	29 17.8
Sep	10 988	6166	-63 580	64 816	29 18.0
Oct	10 987	6167	-63 559	64 795	29 18.3
Nov	10 986	6171	-63 557	64 794	29 19.5

TABLE 6: Preliminary geomagnetic annual mean values, 1975 - 1985

Year	D (° 'E)	I (° ')	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)
1975	27 43.2	-78 38.2	12847	11373	5976	-63926	65204
1976	27 51.6	-78 39.1	12822	11336	5992	-63891	65165
1977	27 59.8	-78 39.9	12802	11304	6010	-63861	65132
1978	28 11.3	-78 41.1	12773	11258	6034	-63838	65103
1979	28 19.6	-78 42.3	12745	11219	6047	-63807	65067
1980	28 28.9	-78 43.3	12717	11178	6064	-63770	65026
1981	28 36.1	-78 44.2	12691	11142	6075	-63726	64977
1982	28 47.7	-78 45.4	12664	11098	6100	-63703	64950
1983	28 55.0	-78 46.1	12644	11068	6114	-63670	64913
1984	29 03.3	-78 46.6	12628	11039	6133	-63645	64886
1985	29 09.5	-78 46.9	12616	11017	6147	-63608	64847
Mean annual changes							
1975-1985	8.6	-0.9	-23	-36	17	32	-36
1975-1980	9.1	-1.0	-26	-39	18	31	-36
1980-1985	8.1	-0.7	-20	-32	17	32	-36

TABLE 7: Reference mark azimuths and round of angle observations

Mark Code	Description	Azimuth	Angular Difference	Angular difference from round of angle observations
Pier E to:				
AR	Anchor Rock	353° 41.27'		
			2.95'	1.83'
NMI	Rock formation near western shoreline	353° 44.22'		
				52° 52.77'
GOW	Centre of large geophysics office window		183° 15.66'	
				130° 23.84'
SM	The Nuggets rock formation	176° 59.88'		
			176° 41.39'	176° 41.52'
AR	Anchor Rock			
Pier X to:				
	Anchor Rock			
				44° 12.58'
CAM	Camera stand (NM/X/I)	39° 01.75'		
				19° 14.17'
	Centre of large geophysics office window			
				128° 16.82'
	Near beacon (♈)			
				168° 16.38'
	Anchor Rock			

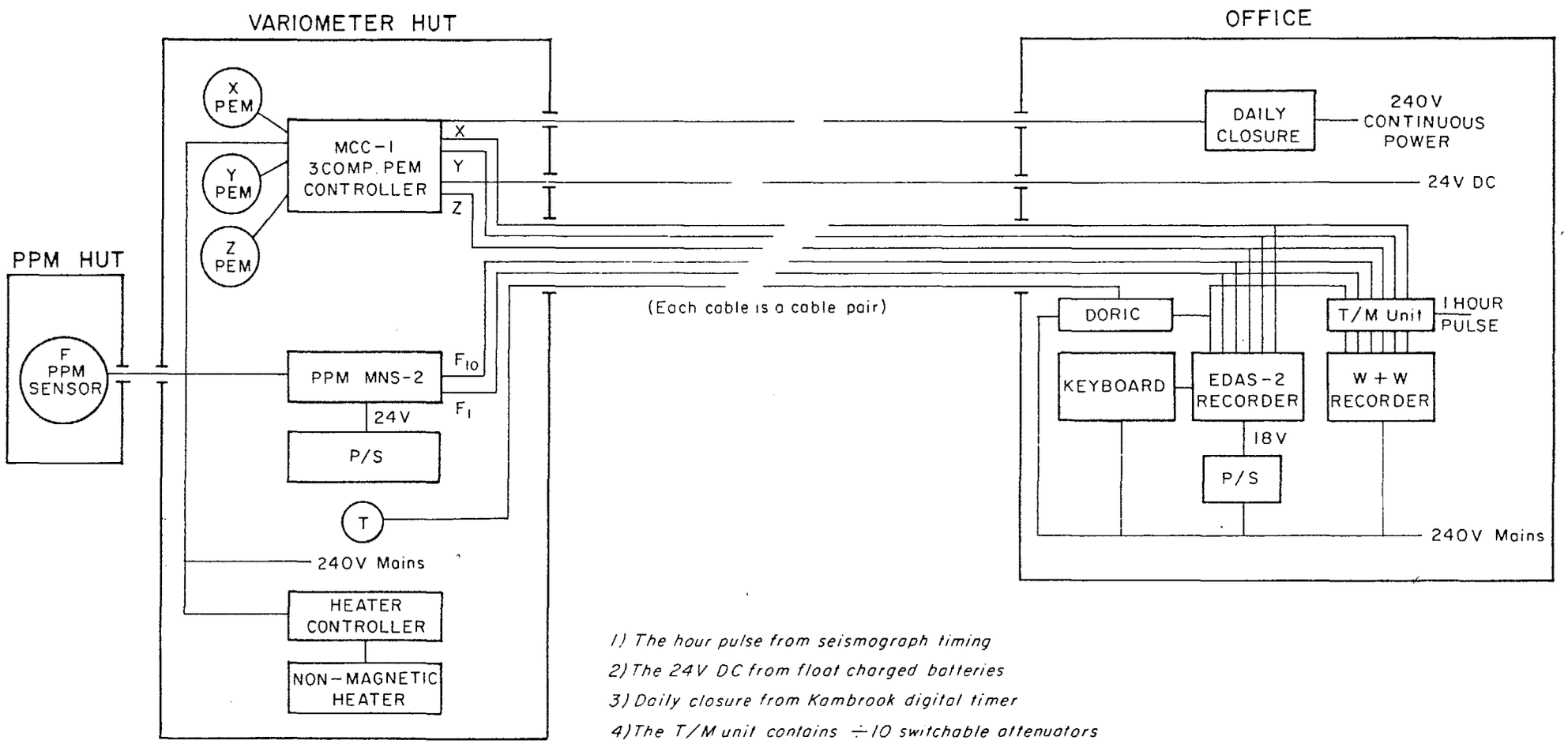
TABLE 8: Magnetometer comparisons

Place	Date	Instrument A	Instrument B	Difference (A-B) nT (H at 23700 nT)	Observers
CNB	01 Aug 1986	MNS2.3	G816/1024	+2.3	WDW
CNB	06 Nov 1986	MNS2.3	G816/1024	+2.3	APH
MCQ	07 Dec 1986	G816/1024	Aust 525	+2.4	WDW
CNB	06 Jan 1987	MNS2.3	Aust 524	+1.7	WDW
CNB	26 Mar 1987	QHM 460	QHM 179	+6.9 (0.00029H)	WDW/RH
CNB	26 Mar 1987	QHM 461	QHM 179	+8.0 (0.00034H)	WDW/RH
CNB	26 Mar 1987	QHM 462	QHM 179	+7.6 (0.00032H)	WDW/RH

Observers:
APH A. Hitchman
RH R. Hutchinson
WDW W. Welsh

Figure 1 MACQUARIE ISLAND

PHOTOELECTRIC MAGNETOGRAPH SYSTEM



1) The hour pulse from seismograph timing

2) The 24V DC from float charged batteries

3) Daily closure from Kambrook digital timer

4) The T/M unit contains ÷10 switchable attenuators

24/09/354

Figure 2 MAGNETIC OBSERVATIONS MACQUARIE ISLAND

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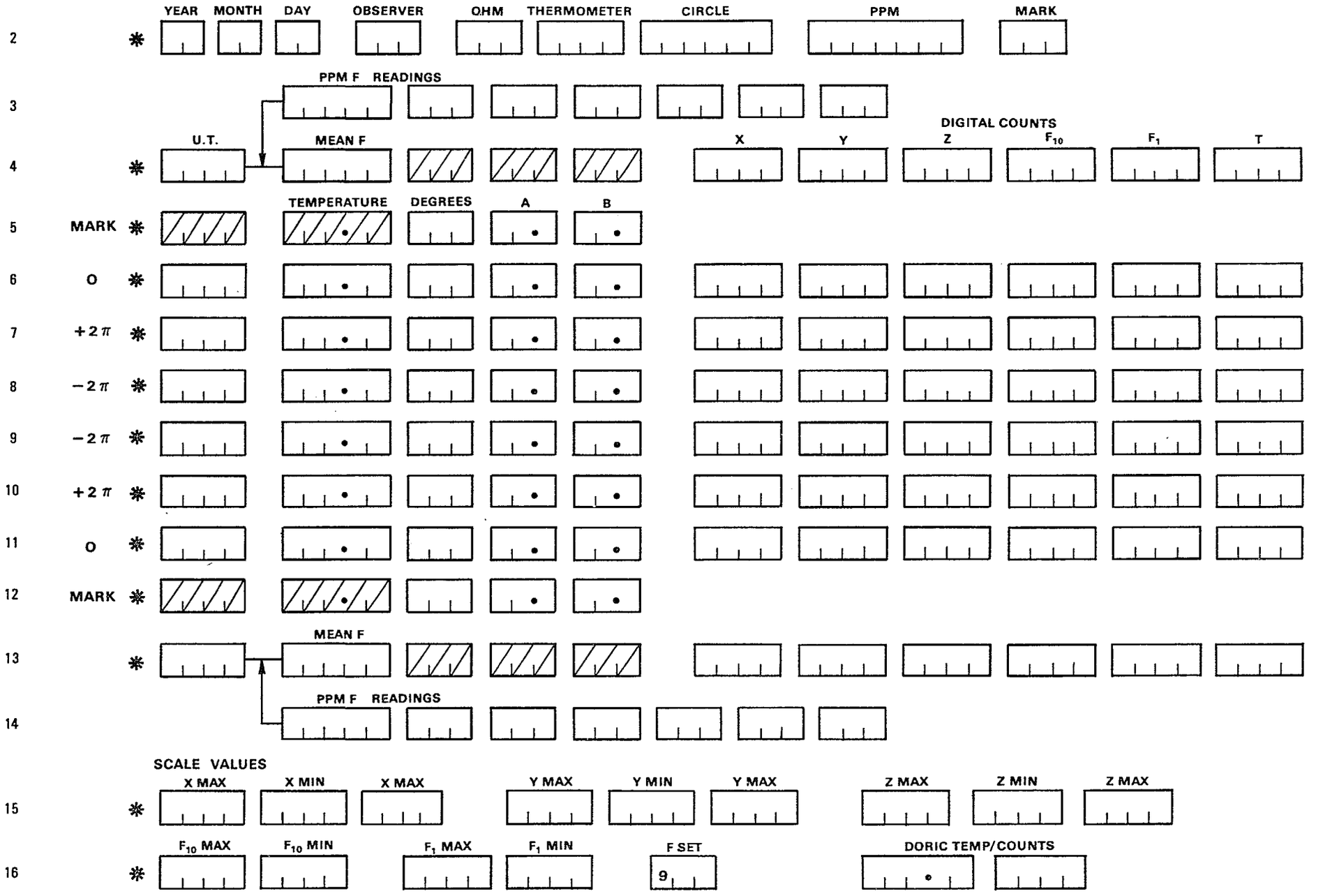

* *LINES TO BE TELEXED TO B.M.R., CANBERRA: ONE SPACE ONLY BETWEEN BLOCKS.*