PIER DIFFERENCES AT OTTAWA MAGNETIC OBSERVATORY

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INTRODUCTION

In late 1987, new marble piers were installed in Ottawa absolute Building No 4 to replace piers B, C, D, and E which were made of concrete. After the installation of the piers, the GSM-18 proton magnetometer was used to determine differences in total intensity between piers. Differences in the D and I components between pier A and pier B were also determined.

This information on pier differences, which has never before been documented properly, also permits a proper review of the practice of correcting F values to an historical site in Building 5.

TOTAL INTENSITY PIER DIFFERENCES

The GSM-18 proton magnetometer was used, in conjunction with the Elsec vector ppm, to establish pier differences in Building 4. Before determining these differences the GSM-18 had been placed beside the Elsec ppm sensor and a series of 50 comparative observations made. These confirmed that there was no systematic difference between the Elsec and the GSM-18. The average of the 50 GSM-18 readings was 57393.78 nT; the average of the Elsec readings was 57393.87 nT.

In Building 4, the GSM-18 was used as a roving instrument, its sensor being placed over or beside piers A to E in turn. The GMS-18 sensor was also placed besde the absolute ppm sensor, and on top of the AMOS ppm sensor (in Building 2). The field was sampled every 30 seconds, and the observations were stored in the instrument's internal memory. The length of each data set ranged from several hours to a couple days. The difference between each GSM-18 observation and the corresponding Elsec observation was computed, and the mean difference over the entire recording interval was established. Individual differences which differed by more than approximately 15 nT from the mean were rejected as being spikes. The mean differences are given in Table 1. All data were gathered between December, 1987 and March 1988.

It was not possible to place the ppm sensor at the exact height of the D&I fluxgate sensor on each pier. It appears that the polarizing current passing through the ppm coil induces currents in the aluminum base mounted on each pier which are in turn picked up by the ppm sensor as noise. Instead, the sensor was placed both at a higher and a lower position above Pier A and at a lower position beside it so that the vertical gradient could be computed. (The higher position was one ppm staff segment, 48 cm, above the top of the pier; the lower position was one staff segment above the floor immediately adjacent to the pier.) Thus a correction could be applied to differences obtained at any height. From Table 1 it can be seen that F decreases by 0.9 nT over 130 cm. Thus the vertical gradient is -0.69 nT/m. Comparable measurements at Pier B give a gradient of 0.92 nT/m, which is not significantly different that the gradient at Pier A. The vertical gradient was not determined at other places in the building but is assumed to be comparable.

TABLE 1

Site	F(site)-F(vppm)		No. data	No. rej.
Pier A (178 cm)	-10.2	0.4 nT	2993	9
Pier A (48 cm)	-9.3	0.2	1653	0
Pier B (178 cm)	-14.3	0.4	5030	5
Pier B (48 cm)	-13.1	0.3	2679	0
Pier C (48 cm)	-24.6	0.2	2376	1
Pier D (178 cm)	-16.8	0.2	2679	0
Pier E (48 cm)	-9.3	0.4	760	0
F abs pier	-8.1	0.3	684	0
F amos	-26.7	0.4	1419	0

Since all differences in Table 1 are given with respect to the vector ppm, the difference between any two piers can easily be calculated. In the following table these differences are expressed as a correction to be added to reduce the F value observed at a pier or site to the value which would be observed on Pier A, which is the Ottawa standard pier. Thus the Pier A correction is, by definition, zero. All values for piers A to E have been corrected for vertical gradient to the mean fluxgate sensor height of 159 cm. For Piers C, D and E a vertical gradient of -0.8 nT/m has been assumed.

The difference between the present site of the ppm and the previous site in building 5 is assumed to be 10 nT. This value has not been confirmed since the old location in Building 5 is not know exactly.

TABLE 2

Position	Correction
Pier A	0.0 nT
Pier B	+4.0
Pier C	+13.6
Pier D	+6.5
Pier E	0.0
Abs PPM	-2.0
Amos PPM	+16.6
Elsec	-10.1
Old ppm site	-12.0

These values are also shown in Figure 1 which also shows the relationship of the piers.

D AND I PIER DIFFERENCES

Between Jan 21 and Feb 25, 1988, a series of comparative declination and inclination observations were made on Pier A and Pier B. All observations were made with Jena 020 #1222 on Pier A, and the Jena 010B on Pier B. The results are summarized in Table 3.

TABLE 3

	D			I		
Date	Pier A	Pier B	Dif	Pier A	Pier B	Dif
Jan 21	36.694	36.901	-0.207	50.308	50.192	0.116
Jan 26	36.897	36.775	0.122	50.330	50.194	0.136
Feb 02	37.021	36.890	0.131	50.317	50.221	0.096
Feb 03	36.576	36.793	-0.217	50.301	50.200	0.101
Feb 16	36.639	36.430	0.209	50.316	50.166	0.150
Feb 17	36.605	36.530	0.075	50.303	50.202	0.101
Feb 24	36.473	36.531	-0.058	50.285	50.198	0.087
Feb 25	36.443	36.712	-0.269	50.288	50.199	0.089

The mean differences between the two piers are:

Pier A - Pier B

D $-0.027' \pm 0.186'$

I $+0.110' \pm 0.023'$

The scatter in the I differences is quite small so that the mean difference is significant. The scatter in the D differences, however, is so large that the mean difference can not be considered significantly different from zero.

It is beyond the scope of this report to examine in detail the reasons for the large scatter in the D differences, but it is worthwhile to state that the probable single most important cause of the scatter is the inablility of an observer to sight the azimuth mark accurately due to atmospheric turbulence. This arises because the mark is located at a distance of almost 500 m from Building 4. The sighting error caused by turbulence can easily reach 0.2' or 0.3' on days when thermal upwelling is large. This problem should be remedied by constructing a new azimuth pier closer (100 m to 150 m) to Building 4.

In summary, the D and I corrections to be added to the values observed on Pier B are:

D:	0.00
I:	+0.11' = 6.6"

THE HISTORICAL F CORRECTION

Prior to some indeterminate date in 1976 or 1977 absolute observations were carried out in Building 5. After observations were started in Building 4 the F observations were corrected to the Building 5 site by adding a correction of 10 nT. This avoided introducing a shift in the annual mean values, but it is not good practice. The F observations are made at a different location than the D and

I observations, and are then reduced to a site even further away. Since Pier A in Building 4 is the standard pier (ie: Pier A is Ottawa observatory), all absolute observations should be made on or reduced to this pier. This simplifies matters should the proton magnetometer be moved again. A new pier difference would be established at that time and it would not be necessary to keep track of, and accumulate, all past differences.

It is therefore recommended that the historical correction no longer be added to the F values. Instead, a correction of -2.0 nT should be added to reduce the F values to Pier A. This will introduce discontinuities in the baselines and in the minute values of approximately -11.5 nT for Z, -3.5 nT for X and +0.9 nT for Y at that time.

It is currently practice to reduce all observatory data to conform to the 1975 annual means to preserve continuity. I am not suggesting that this practice change. However, this type of adjustment is made for the sole purpose of making life easy for the user of the data and should not be considered as an essential correction to the absolute observations. Adjustments of this type should be made at some other point in the data reduction procedure, not at the time of observation in the guise of an instrument or pier correction. Perhaps this, and all other, historical corrections can be added automatically when running ADBASLIN.

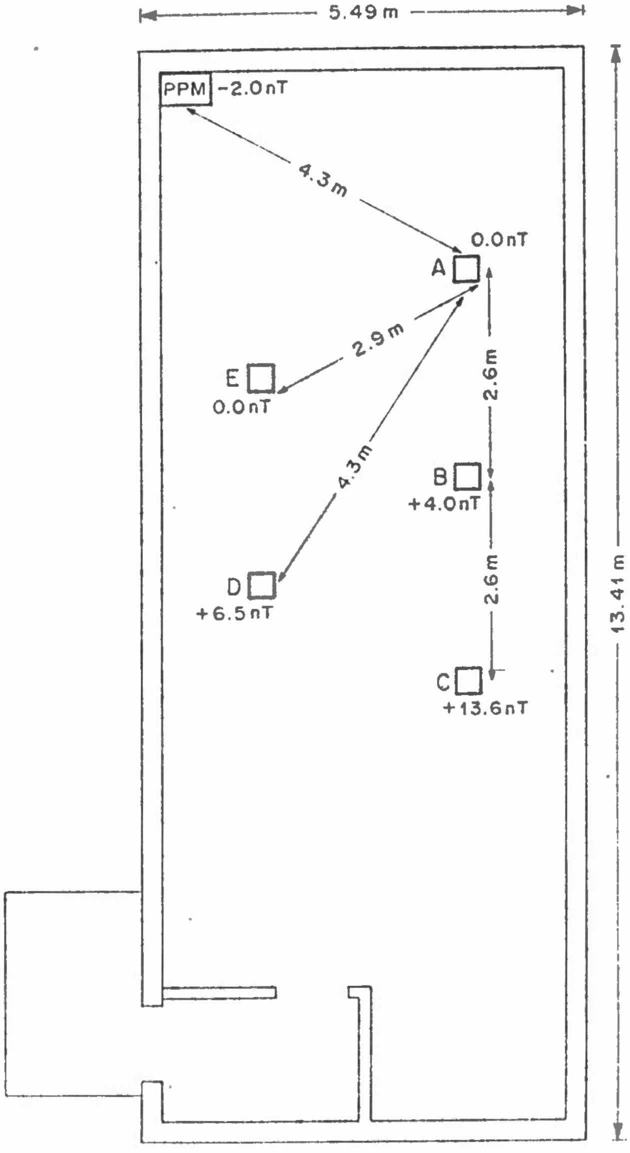
SUMMARY AND RECOMMENDATIONS

1)The practice of adding an historical correction directly to the F observations should be discontinued as soon as it is opereationally convenient. (Historical corrections should be added at some other point in the data reduction procedure.)

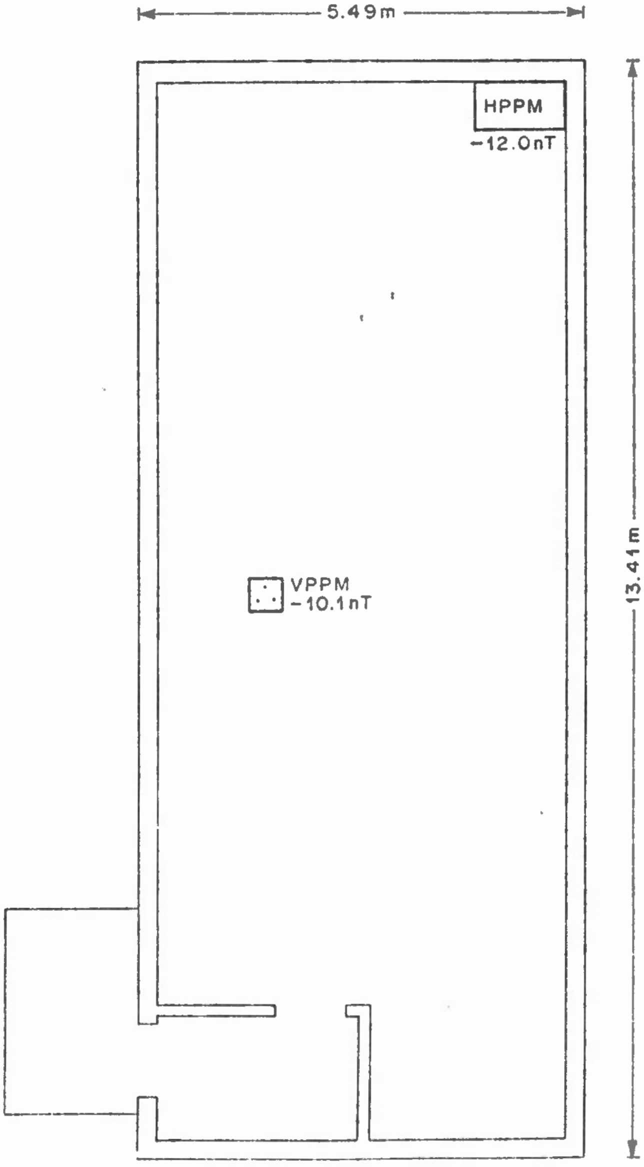
2)The correction which should be added to the F values observed at the present ppm site to reduce them to Pier A is -2.0 nT. At present, this correction should be applied directly on the observation sheet. However, looking ahead, the introduction of CANMOS will probably necessitate changes in procedures since there may no longer be a separate absolute ppm in Building 4. Perhaps the pier difference between the CANMOS ppm and Pier A can be added automatically by DIFTRE.

3)The D and I corrections to be added to observations made on Pier B are: 0.00' for D and 0.11' for I.

4)A new pier for the azimuth mark should be installed 100 m to 150 m north of Building 4 to reduce the errors in D caused by atmospheric turbulence when sighting the mark.


5.49 m
PPM -2.0nT
4.3m
0.0nT
A
2.9m
2.6m
E
0.0nT
4.3m
B
+4.0nT
D
+6.5nT
2.6m
C
+13.6nT
13.41 m

Bldg. 4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HPPM
-12.0nT
VPPM
-10.1nT
13.41 m

Bldg. 5