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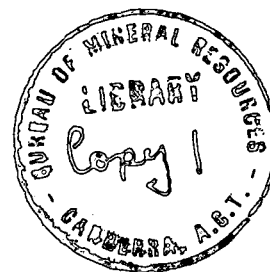
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RECORDS 1953 No. 14



MAGNETIC SURVEY
FOR TESTING SITE,
NAVAL TORPEDO FACTORY
NEUTRAL BAY, N.S.W.

by

F.W. WOOD

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Plate

1. Test circuit for torpedo unit.
 2. Method of testing effect of non-uniform field.
 3. Plan of survey on roof of administration building.
 4. Magnetic profile on roof of administration building.
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MAGNETIC SURVEY FOR "TESTING SITE" AT
THE NAVAL TORPEDO FACTORY, NEUTRAL BAY,
SYDNEY, NEW SOUTH WALES.

1. INTRODUCTION

A request was received in December, 1951, from the Director of Ordnance and Underwater Weapons of the Department of the Navy for assistance in selecting an area suitable for the electrical balance testing of the pistol-firing rod unit of the torpedo. It was desired that this site should be at the R.A.N. Torpedo Establishment at Neutral Bay, Sydney, New South Wales.

The only condition laid down in the relevant specification is that "the rod may be supported in a suitable wooden structure or in such other manner provided that the complete rod unit is not less than ten feet from any ferro-magnetic materials."

In order to arrive at a more specific definition of the requirements for the testing site, the problem was discussed with the Chief Superintendent and officers of the Torpedo Establishment. The appropriate test specifications were consulted, and a series of measurements were carried out to determine the actual requirements.

The magnetic investigations described in this report were carried out in August, 1952, and the overall results and conclusions were communicated verbally at that time to the officers concerned.

2. NATURE OF THE PROBLEM

The test area is required for the purpose of checking the adjustment of pistol-firing units fitted into torpedo heads. This, in turn, calls for a nearly uniform horizontal magnetic field over a length of about five feet in a plane passing through the centre of the unit under test. The test specification does not indicate the degree of uniformity required in the magnetic field but merely states that no mass of iron or other magnetic material should be allowed within ten feet of the unit under test.

For the purpose of the test, the pistol-firing unit is set up in the magnetic meridian and supported in a horizontal plane in such a way that it can be rotated quickly through an angle of 180° about a vertical axis through its centre. The unit consists essentially of a mu-metal rod fitted with two coils mounted near the ends of the rod. These coils are joined in series and in opposition and for the purpose of the test are connected to a ballistic galvanometer (see Plate 1). The unit is then swung through 180° in 1 second. If the adjustment of the unit is satisfactory, it will produce little or no electrical current and the deflection of the galvanometer will not exceed a prescribed amount. In that case the unit could safely be connected to the firing mechanism of the torpedo without risk of producing a premature explosion. A unit which produced too large a galvanometer deflection can be successively adjusted and re-tested until it falls within the requirements of the specification.

All this is a simple matter when carried out in a uniform horizontal magnetic field but no data are immediately available to indicate the effect of non-uniformity of the field.

in the test area. However, calculations based on the known constants and characteristics of the unit indicate that only a slight non-uniformity would be needed to produce a galvanometer deflection at least equal to the minimum permissible test deflection. It is difficult to determine an exact figure because much depends upon the gradient of the magnetic field between the ends of the rod, the rate at which the unit is rotated and the characteristics of the galvanometer. Nevertheless, it seems certain that a difference of as much as 100 gammas (i.e. 1 milligauss) in the magnetic field between the ends of the rod could not be tolerated. The upper limit is probably very much less than this figure.

The problem therefore assumed two separate aspects. One was to determine to what degree the magnetic field needs to be uniform and the other was to find a site with this required degree of uniformity within the Torpedo Establishment.

3. METHODS USED

Because of the difficulty, already mentioned, of making a satisfactory mathematical assessment of the effect of a non-uniform magnetic field, it was decided to make an experimental check. For this purpose, use was made of a unit that had been tested and balanced in England. Unfortunately, a galvanometer with the required characteristics was not available at the Torpedo Establishment but the National Standards Laboratory, Sydney, kindly made one available.

A large circular coil was set up in that Laboratory with its axis horizontal and lying in the magnetic meridian, and current was passed through it to produce a magnetic field superimposed upon the earth's magnetic field. By this means it was possible to produce different degrees of non-uniformity in the field at a distance of several feet along the axis of the circular coil where the torpedo unit was mounted (see Plate 2). The magnetic field intensity at points along this axis was measured with a special saturable-core magnetometer recently designed in the National Standards Laboratory. It is capable of rapid determinations of field strength at any point with an accuracy of ± 0.05 milligauss.

With differences of 10 and 5 milligauss between the ends of the torpedo unit, very large deflections were recorded as the unit was rotated through 180° . Unfortunately, it was not found possible to reduce the difference to as little as 1 milligauss, even with no current passing through the circular coil, because of other disturbing fields within the laboratory. Nevertheless, the experimental tests confirmed that the minimum permissible difference is less than 1 milligauss.

With this condition in mind a survey was made of some possible sites within the grounds of the Torpedo Establishment. For the measurement of the horizontal magnetic field a La Cour quartz horizontal magnetometer was chosen. This instrument has an accuracy of ± 0.05 milligauss but each measurement takes about fifteen minutes. Therefore, for preliminary testing a Watts vertical magnetic balance was used since with it a reading can be obtained in less than five minutes. In applying the results it is necessary only to remember that the vertical magnetic intensity in Sydney is about twice the horizontal intensity. The variations in the horizontal intensity will therefore be about half the amplitude of the variations observed in the

vertical intensity. The scale value of the Watts balance was 30 gammas (i.e. 0.3 milligauss) per division.

4. RESULTS

(a) Short-period fluctuations.

A start was made to determine the uniformity of the magnetic field in the machine shop on the third floor where a cleared space is available. It was immediately evident that the site is unsuitable because of large, rapid fluctuations taking place continuously. Changes of 0.3 milligauss per second were recorded and a total change of 0.9 milligauss was observed within a period of 15 seconds. Such changes would make the area quite unsuitable for testing purposes.

Three other possible sites were tested outside the buildings and away from the machine shop. These were (i) on the centre of the concrete apron of the pistol-firing platform, (ii) on the open space in front of the garage and carpenter's shop, and (iii) on the flat roof of the administration building. At all these places rapid and rather large fluctuations were observed in the vertical magnetic intensity. The existence of fluctuations at all these sites indicates that the whole area is disturbed by fields from direct currents presumably from the nearby electric railway and tram lines.

(b) Differences between sites.

The average values of the vertical field at the four sites tested were widely different. A summary of the values obtained at the four sites is given below. Since the field appeared to be least disturbed on the roof of the administration building, the average value recorded there is taken as the reference level and the average values at the other three sites are expressed as differences from it.

<u>Site</u>	<u>Fluctuations</u> <u>milligauss</u>	<u>Average Value</u> <u>milligauss</u>
A. On the flat roof of administration building	\pm 0.1 in 1 second \pm 0.3 in 5 seconds	0.0
B. On third floor of machine shop	\pm 0.3 in 1 second \pm 0.9 in 15 seconds	+ 31.3
C. On centre of pistol- firing platform	\pm 0.3 in 2 seconds \pm 1.1 in 1 minute	+ 65.0
D. In front of garage and carpenter's shop	\pm 0.3 in 1 second \pm 1.0 in 15 seconds	+ 33.9

The large differences between the average values at the sites shows that there are large magnetized bodies within the factory area possibly in the rocks, but more probably in the building structures, the machinery or the building foundations including reinforcing in concrete. The measured differences in some cases were more than one-eighth the value of the earth's magnetic field.

(c) Non-uniformity at a given site.

These results make it seem very unlikely that a reasonably undisturbed site can be found within the factory area. However, it was decided to test in some detail the site that showed the smallest fluctuations, namely, the flat roof of the administration building.

Nine points were marked out on the roof at intervals of five feet along a line extending from end to end of the roof. The positions of these points are shown in Plate 3 on which is also indicated the approximate positions of girders supporting the roof and the position of site A referred to in paragraph (b) above.

The values of the vertical intensity measured along this line are shown in the graph of Plate 4. The reference zero line on this graph is the average value obtained at site A. These results show that there is very considerable non-uniformity of magnetic field on the roof of the administration building due presumably to ferro-magnetic material in the structure of the building.

The measurements were made at a height of approximately 4'6" above the roof. The non-uniformity would possibly be less if measured at a height of 10 or 20 feet above the roof. Some of the worst effects of the non-uniformity could therefore be reduced by erecting a test room on a wooden structure above the roof but, even so, the short-period fluctuations would remain.

5. CONCLUSION

The results indicate conclusively that a suitable testing site is not available within the torpedo factory area. It will therefore be necessary to seek a site in some other area which is under Naval supervision and on which a suitable building and the necessary equipment could be erected. It may well prove impossible to find a thoroughly satisfactory site within the Sydney Harbour area but a search should be made for one since it would, no doubt, be desirable to set up the testing site at not too great a distance from the Torpedo Establishment. A survey made in the vicinity of the de-gaussing station at Bradley Head (Richardson, 1944) indicated no marked magnetic effects. It is therefore possible that a suitable testing site may be found there. An extract from Richardson's report was left at the Torpedo Establishment.

6. RECOMMENDATIONS

(i) The following preliminary steps will have to be taken if satisfactory surveys are to be made for a suitable site :-

- (a) Enquiries should be made regarding the possibility of erecting a test building on the Bradley Head reserve.
- (b) A non-magnetic turntable should be constructed for rotating the units under test through 180° in the horizontal plane in 1 second.

(c) A ballistic galvanometer of the required specifications should be obtained.

(ii) Measurements could then be carried out to determine the permissible non-uniformity of magnetic field in the test area. These measurements could best be done at a proved site such as the Bureau's absolute magnetic station at Blacktown.

(iii) Following this, the search for a suitable "testing site" could proceed on a sound basis.

* (iv) There is a further point that should be investigated. An examination of the torpedo assembly suggests that the electrical balance of a unit may be affected by the presence of the steel walls of the compartment in which it is mounted in the torpedo head. This is because the walls are not symmetrically placed with respect to the two ends of the unit. It is therefore recommended that enquiries be made to determine if this factor has been investigated elsewhere.

* (v) Alternatively, a simple test could be carried out here. A unit, known to be in electrical balance, could be mounted in its compartment and the whole assembly swung in the earth's magnetic field to determine the effect, if any, of the steel compartment. It is recommended that the non-magnetic swinging platform be designed to enable this test to be carried out.

7. REFERENCES

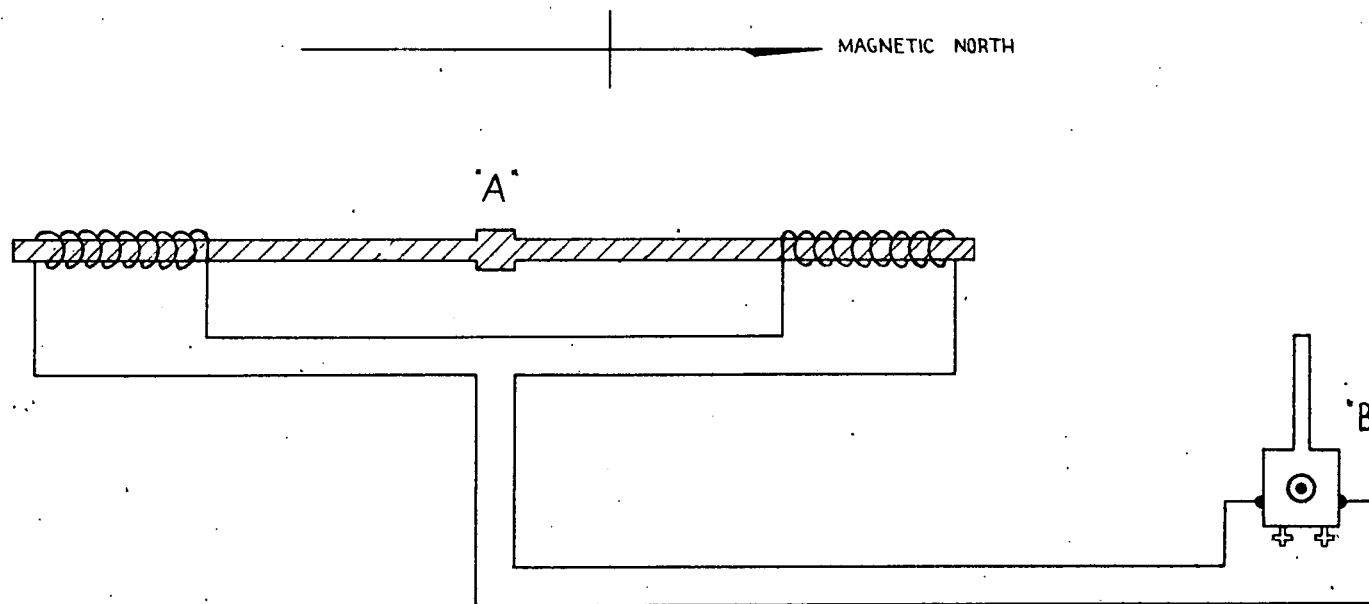
Richardson (1944) :

"Report on Magnetic Investigations in the vicinity of Sydney Harbour Open Magnetic Proving Range," No.1944/16, Mineral Resources Survey Branch, Department of Supply, Canberra.

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January, 1953.

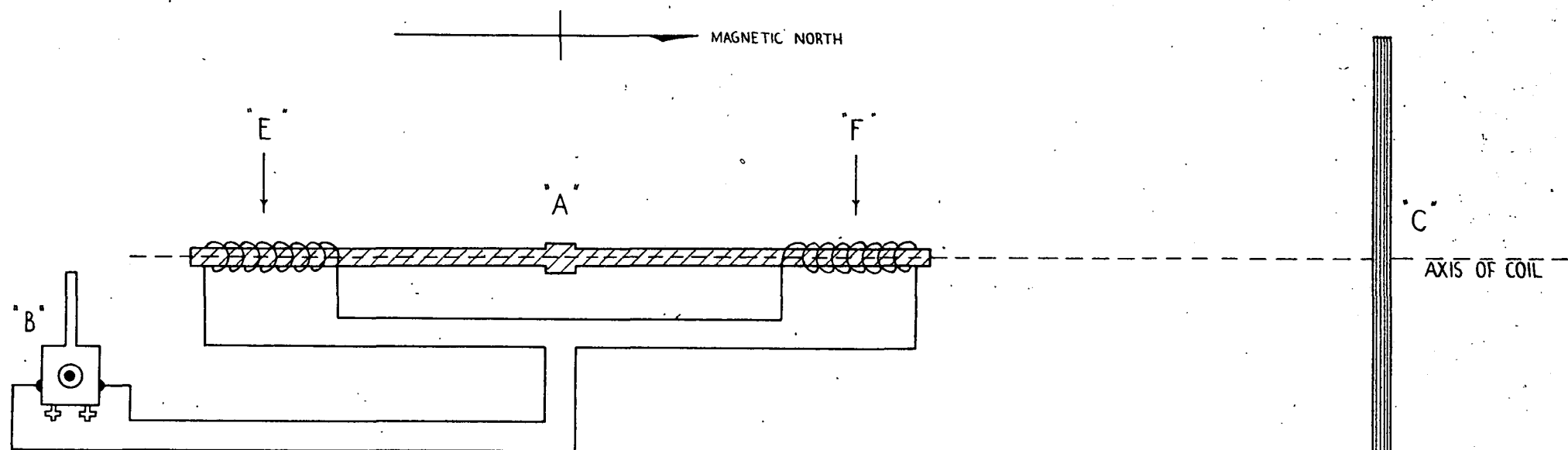


LEGEND

- 'A' UNIT UNDER TEST
- 'B' BALLISTIC GALVANOMETER

INVESTIGATION OF "TESTING SITE" AT R.A.N. TORPEDO FACTORY NEUTRAL BAY, N.S.W.

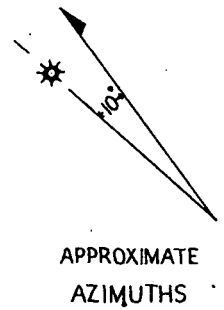
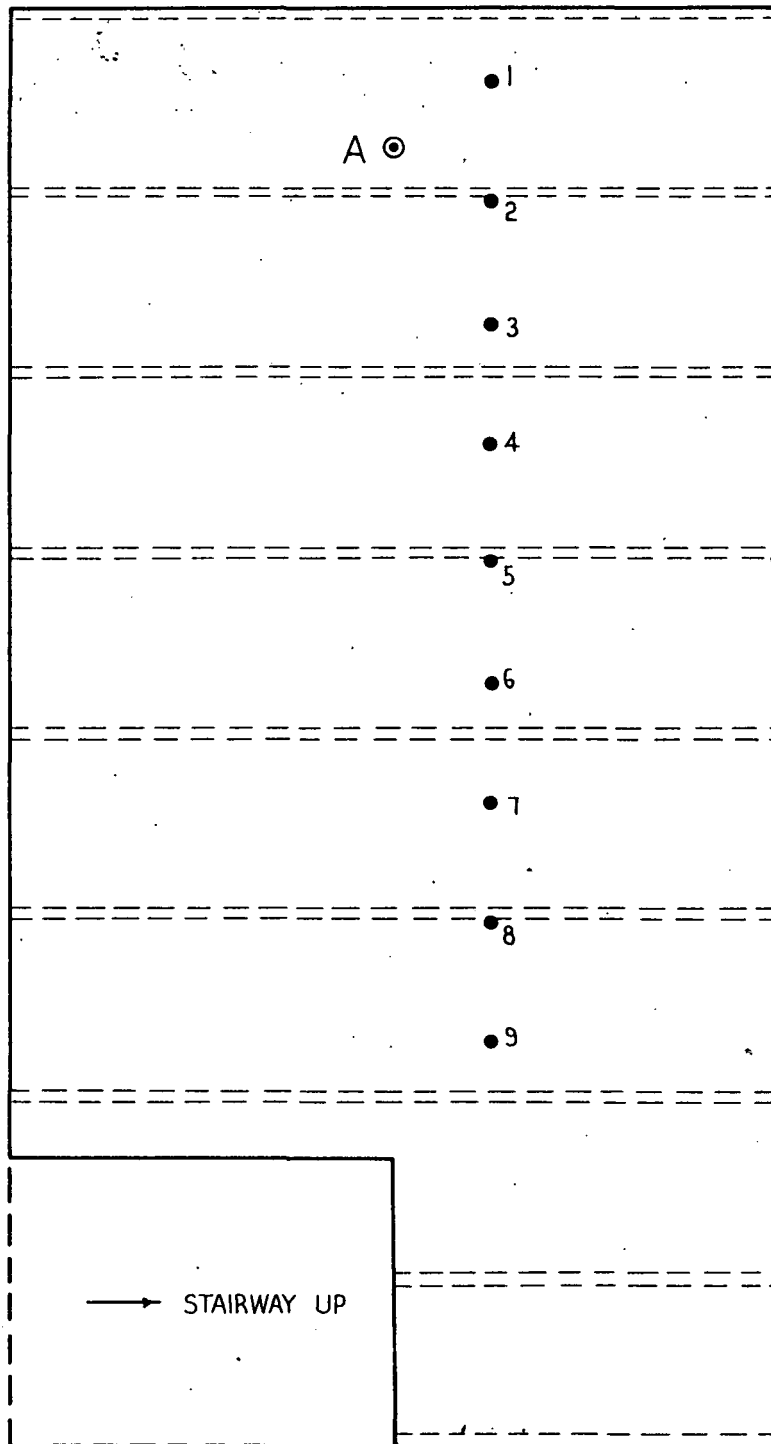
TEST CIRCUIT FOR TORPEDO UNIT



LEGEND

- A TORPEDO UNIT
- B BALLISTIC GALVINOMETER
- C COIL PRODUCING E.M. FIELD
- D SOURCE OF VARIABLE CURRENT
- E } MAGNETIC FIELD MEASURED
- F } AT THESE DISTANCES ALONG AXIS

INVESTIGATION OF "TESTING SITE" AT R.A.N. TORPEDO FACTORY, NEUTRAL BAY N.S.W. METHOD OF TESTING EFFECT OF NON-UNIFORM MAGNETIC FIELD



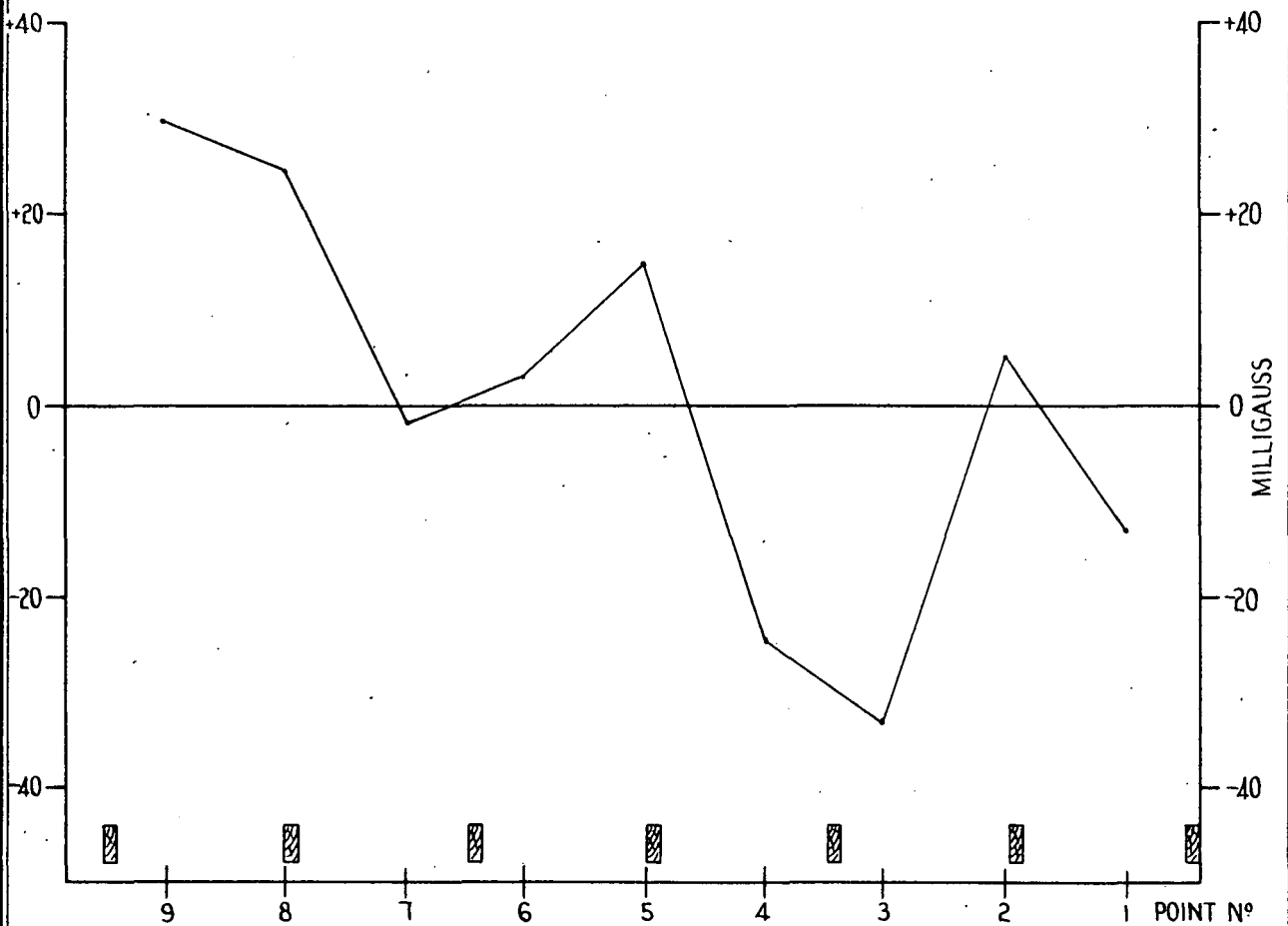
LEGEND

- ⊙ TEST STATION 'A' (SEE TEXT)
- POSITION OF SURVEY STATIONS
- ===== APPROXIMATE POSITION OF ROOF GIRDER

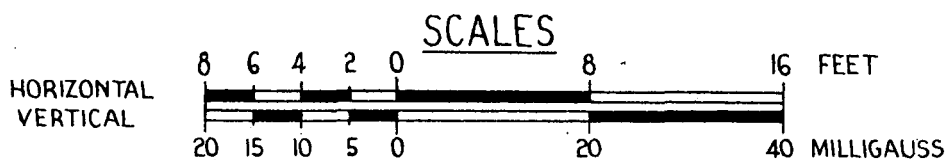
SCALE



INVESTIGATION OF "TESTING SITE" AT R.A.N. TORPEDO FACTORY, NEUTRAL BAY N.S.W. PLAN OF SURVEY ON ROOF OF ADMINISTRATION BUILDING



▨ . APPROXIMATE POSITION OF GIRDER



J.W. Wood GEOPHYSICIST

INVESTIGATION OF "TESTING SITE" AT
R.A.N. TORPEDO FACTORY, NEUTRAL BAY N.S.W.
MAGNETIC PROFILE ON
ROOF OF ADMINISTRATION BUILDING