

SURVEYING METRO

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In August 1976 the Metro Central Mapping Agency published a booklet on the establishment, application and use of their Precise Base Line. Copies are available from their office. The booklet lists six sources of error in EDM instruments and gives practical methods for checking the accuracy and calibration of these instruments. The six sources of error discussed are centering, tripod height, phase measurement, modulation frequency, meteorological data and instrument/reflector constant. Of general interest may be the following on the establishment and remeasurement of the base line:-

The need for a base line is quite apparent. With all the Electronic Distance Measurement (EDM) instruments in use throughout the survey industry, in particular in the Metropolitan area, the need for confidence in the day-to-day accuracy of the instrument is important. Although acceptable variations occur when an instrument is used to determine a number of distances in a survey, this only indicates the consistency of the instrument and not the accuracy of the distances. A precise base line can be used as a standard against which to measure the accuracy of EDM instruments, thus greatly reducing the variation of measurements in the survey industry.

It is anticipated that many municipal agencies requiring survey work will shortly include pre- and post-calibration of EDM instruments on a precise base line in their contracts.

Metropolitan Toronto first established a precise base line in 1968 and recently had it re-measured.

In 1965, the Municipality of Metropolitan Toronto commenced a program of densification of the Horizontal Control Network. We proceeded to establish a number of second order control markers by measuring all distances with Electronic Distance Measuring instruments. Shortly after commencing this densification program it became apparent that we needed a base line of very high accuracy. The goal was to provide a uniform base line on which all users of Electronic Distance Measuring (EDM) instruments could calibrate their instruments, prove the accuracy of their instruments, and to provide a convenient place for all users to check their instruments on a periodic basis, thus avoiding loss of time and money.

The site to be selected for this base had to satisfy the following criteria:-

- A. Centrally located, reasonably close to Surveyors' offices in Metropolitan Toronto.
- B. A clear line of sight for the total length.
- C. Free of high tension lines.
- D. No structure or object within 10 m of the line of sight.
- E. Reasonably level for 600 m.
- F. Favourable soil conditions.
- G. Protection from future construction.
- H. Pointing away from the sun during most of the working day.

The most suitable base line location was found to be in the Don Valley, near the junction of the Don Valley Parkway and Don Mills Road.

The base line construction was undertaken in 1968 with a total of 10 monuments. The monuments were set at intervals of between 30 m and 91 m, with the total length being approximately 579 m. The monuments were poured in place with re-inforcing rods added for additional strength, and were 0.3 m in diameter at the top and between 1.5 to 1.8 m deep. At the time of the pouring each monument had a centre punched brass cap inserted at the top and slightly recessed for protection. The tops of all monuments were poured flush with the ground or buried slightly.

The base line was measured by two independent survey firms (Marshall MacKlin Monaghan, O.L.S. and J. D. Barnes, O.L.S.). Both used metric invar tapes and chaining bucks. One firm used first order chaining equipment loaned to the Roads and Traffic Department by Ryerson Polytechnical Institute. All tapes used were standardized by the Federal Bureau of Weights and Measures with certificates issued for each tape.

A comparison of these two independent results arrived at by these firms showed a relative accuracy of 1 in 50,000 for the end to end measurements.

This base line has been used continually over the years by the survey industry in Metropolitan Toronto for checking and calibrating their EDM instruments and also for instructing their staff in the operation of new instruments. It has also been used in training their field staff in taping procedures and for calibrating their tapes.

In 1974 the base line was disturbed when a 0.76 m diameter gas pipeline was installed. Thereafter it was suspected that some monuments had been disturbed during the pipeline construction. After checking the base line it was decided that a remeasurement was needed.

There is now an EDM instrument capable of measuring the base line at a very high accuracy, manufactured by Kern Instruments. This instrument, Mekometer ME-3000, has been designed for precision measurements up to 3,000 m, and uses a xenon flashtube as a source of radiation to carry the measuring signals which produces a white light with a mixture of wavelengths between 0.4 to 0.9 m; hence it is called a "white light" EDM instrument. The high resolution coupled with the ease of operation assures accurate and convenient measurements. The accuracy of this instrument is + 0.3 mm + 1 ppm.

The Geodetic Survey of Canada acquired a Mekometer for base line work. Arrangements were made through the Surveyor General of Ontario with the Geodetic Survey of Canada to measure the base line. The work was performed in November of 1975.

A comparison between the original taped distances and those measured with the Mekometer produced the following results:-

FROM TO POINT TO POINT		CHANGE (m)
1	2	-0.001
2	3	+0.008
3	4	-0.003
4	5	+0.001
5	6	-0.003
6	7	-0.002
7	8	-0.001
8	9	-0.001
9	10	0.000
TOTAL, HOLDING		
No. 2		OVERALL CHANGE
FROM	TO	(m)
2	1	-0.001
2	3	+0.008
2	4	+0.005
2	5	+0.006
2	6	+0.003
2	7	+0.001
2	8	0.000
2	9	-0.001
2	10	-0.001
OVERALL	1-10	-0.002

As can be seen from the aforementioned table, markers 3, 4, 5 and 6 were moved 8, 5, 6 and 3 mm respectively by the construction of the gas pipeline. Markers 1, 2, 7, 8, 9 and 10 were not affected by the construction and all others agreed within 0.002 m.

With the favourable soil conditions in the Don Valley the base line should remain stable providing there is no additional heavy construction in its vicinity.

Any surveyor intending to use the base line should contact the Central Map-

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ping Agency's Geodetic Survey Section to reserve an appropriate date and time.

Anyone using the base line without a reservation must immediately leave if they are overlapping another's reserved time.

One duplicate copy of the EDM Instrument Record Sheet should be forwarded to the Central Mapping Agency within one week of using the base line.

Any EDM instruments used on contracts for survey work for the Municipality of Metropolitan Toronto shall consider it part of the contract to have an instrument/reflector constant test performed monthly on the base line. A copy of the results shall be returned with the job package upon completion of the contract.