

# Leica Geosystems Halcrow Group: TCA1800 Calibration



**With over 220 staff worldwide, Halcrow Groups' Geomatics division is a leading consultancy specialising in a wide range of activities from topographical mapping and inshore hydrography, to Geographical Information Systems (GIS) analysis and software support. Cutting-edge engineering technology is at the heart of Halcrow's business from sub-millimeter precision total stations and terrestrial laser scanners to geotechnical tools such as tilt and verticality sensors.**

One recent project to carry out deformation survey work at the Thames Barrier and associated gates required the highest accuracy, which is why Halcrow demanded full calibration certificates to verify the measurement precision and sub millimeter accuracy of the instruments.

The overall demand for certificates confirming the measurement quality of new or used surveying equipment is growing, as an increasing number of surveying companies and contractors are applying for ISO 9001:2000 certification, as well as the growing number 'public interest' projects that require certification (e.g. public health, public safety, sports events, and legal procedures).

"The TCA1800 is a very rugged total station, yet versatile enough to be able to carry out both setting out work and precision monitoring all in one day. Several of our framework clients insist on UKAS-traceable accreditation for the calibration, and this includes the need for a full baseline EDM calibration. This is especially important when observing long baselines over water (as at the Thames Barrier) and gives us the confidence in the repeatability and accuracy of the baselines we are measuring"

**Chris Hall MRICS, Project Manager, Halcrow Group**



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# Certificates for Surveying Products

Certification of equipment requires calibration in a national/international accredited EDM baseline laboratory. Leica Geosystems AG in Switzerland is an international accredited calibration laboratory for the dimensions angle and distance. A number of certificates are available for new equipment at the initial purchase or for used equipment at Leica Geosystems authorised service centres including total stations, digital levels and GPS sensors.

Leica Geosystems offers a wide variety of certificates; at the highest level Calibration Certificates are available, at the next level Producer Inspection Certificates M and Producer Certificates O and at the lowest level Service Certificates.

## Leica Geosystems Certification

- To issue the highest Certificate, the Calibration Certificate (Fig 1.), a national accreditation of the calibration laboratory in accordance with ILAC (International Laboratory Accreditation Cooperation) and ISO/IEC17025 regulations is required. This means that the certificate is internationally acknowledged and the test results are directly traceable to national standards.
- Producer Inspection Certificate M is based on the manufacturer's defined standards and complies with the ISO 9001:2000 requirements of 'control and monitoring of measuring devices'. The reported test results are traceable to national standards or recognised procedures.
- Producer Certificate O is based on the manufacturer's defined procedures and confirm that the individual product was inspected and published specifications were met at the time of inspection.
- Service Certificate is issued at Leica Geosystems authorised service centres in combination with repair or maintenance to confirm that the individual product was checked and the published specifications were met.



Fig.1 Leica Geosystems Calibration Certificate



Fig.2 Halcrow TCA1800 on test with the Leica TPM-2 Theodolite checking machine

## Calibration Certificates

Calibration Certificates confirm that the product was inspected and explicitly state the traceability to national standards, the uncertainty of measurement for each measurand (measured value) and compliance of the measurement values with the published product specifications at the time of inspection. Calibration Certificates are not supplemented by detailed measurement reports, they are internationally acknowledged certificates that can only be issued by calibration laboratories with a national accreditation indicated by the registered accreditation mark and number on the certificate document.



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# Halcrow Instrument Calibration

To fully certify the TCA1800 instrument, Halcrow had to return it as well as all ancillary equipment (prisms and tribrachs) to Leica Geosystems UK head office in Milton Keynes. The instrument was then booked into the service centre and prepared for shipping to Switzerland. On arrival at the calibration laboratory in Switzerland the TCA1800 underwent an initial check in preparation for the calibration process.

The TCA1800 was then subjected to the following calibration tests:

1. Measurement determination of the linearity and the zero point correction of a distance measurement.
2. An EDM baseline test for the determination of the standard deviation of a distance measurement and for verification of the zero point correction.
3. A frequency measurement laboratory to determine the measuring frequency of the EDM at various temperatures.
4. An angle measurement laboratory for the determination of the standard deviation of an angle measurement (vertical and horizontal).



Fig.3 Halcrow TCA1800 on the Leica Geosystems nationally accredited EDM baseline.

## The EDM Baseline

The EDM baseline pillars are located on the dam bed of the river Rhein, which is made out of stone and rock. The pillar foundations are fixed with concrete into the dam, with the remaining concrete section above the ground being insulated by a plastic tube in order to protect it against temperature heating caused by direct sunshine. Although the baseline has a long distance range of up to 3000m, the typical calibration range is 500m, with a combination of 21 distance measurements. Longer range calibrations at 1000, 2000 and 3000m intervals can be made on request.

## Cyclic Errors

When the baseline was originally built, care was taken for the correct distribution of the distance intervals over the wavelengths of the EDM, in order to detect possible cyclic errors. This was needed for earlier EDM models, however the later EDM's, such as the TCA1800, cyclic errors can be taken care of either by hardware and/or software (at least for Leica Geosystems instruments).

## Scale Error

Any scale error on the TCA1800 was assured by frequency calibration. In order to gain a picture of the long-term behavior of the baseline distances, we measure so called "nominal" distances using a mekometer unit as well as a Leica TC2003. The precision of the results and the results itself of the two instruments are equal. The reason for this is that the mekometer has a longer measuring time within which

the atmosphere can change, unlike the TC2003 which has a short measuring time, minimising any atmosphere deviation, therefore the resulting distance on the TC2003 is less affected by the atmosphere than the mekometer.

## Atmospheric Corrections

A critical procedure to the calibration process is to apply atmospheric corrections to the measurements of the TCA1800. These parameters were measured at the instrument station and along the baseline for each measurement, and the atmospheric corrections applied to each distance.

## Angular Accuracy Determination

Determining the accuracy of angle measurement for a total station is not a trivial task, especially when the results should be free from atmospheric conditions and human skill. To overcome the deficiencies of manual methods of angular accuracy determination, Leica Geosystems invented the unique TPM machine, now in its second generation (Fig 2.). The TPM-2 has a  $1\sigma$  accuracy 0.058" for horizontal angles and 0.091" for vertical angles. Only with such accuracy is it possible to provide Calibration Certificates for total stations with accuracies as low as 0.5" and 1" (e.g. TCA2003 and TCA1800). Currently Leica Geosystems AG is the only manufacturer worldwide with an accredited Calibration Laboratory for both distance and angles.

## Summary

Following completion of the calibration process the TCA1800 was found to be operating to the required tolerance of 1" angle accuracy and 1mm distance accuracy and a full Calibration Certificate was issued.

The certified instrument was then returned directly to Halcrow and was subsequently used in confidence on Halcrow's precise monitoring and engineering projects, including the Thames Barrier. ■

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