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# BRIEFING NOTE ON INSTRUMENT CALIBRATION

TSA briefing notes are intended to provide information and explanations to members on specific topics of relevance to the profession. Briefing notes are not intended to recommend or advise on professional procedures. All content is based on information available at the time of issue.

## 1. Introduction

It is important that high precision measurement tools are regularly serviced, their calibration status checked and if required, subsequently adjusted.

We as survey professionals place faith in the tools that we invest in and utilise. Maintenance, both to extend the life of the investments, and to ensure the quality of the results produced is sound practice.

Furthermore, it is the duty of every survey professional to ensure that the data provided is accurate and is to the clients' specified requirements. Regular calibration ensures that instrument error, as a possible source of inaccuracy, is avoided.



## 2. Definition of 'calibration?'

Calibration is the systematic comparison of measurements. Measurements are taken and then compared back to the reference data. The magnitude of any deviation will dictate whether the system is within tolerance, i.e. within the manufacturer's specified calibration limits or whether adjustments are required to return it to conformity.

The formal definition of calibration is as follows:

*'Operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties (of the calibrated instrument or secondary standard) and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication'.*

– Reference: JCGM 200:2008 International Vocabulary of Metrology – basic and general concepts and associated terms (VIM).

The instrument adjustment process is the technique of calibration. It is the adjustment of the instrument so that the result agrees with value of the applied standard to within a specified accuracy. It is fair to say that the adjustment process will bring the instrument to within a specified tolerance rather than to an exact match with the comparison standard.



## 3. Why do we need to calibrate survey instruments?

Surveying companies and /or their contractors need to show conformity to a strict certification system. The primary certification is ISO 9001, a quality assurance system demonstrating consistent performance as a defined regulatory standard. The standard is currently being revised with an update due at the end of 2015. The revision aims to improve performance, process and outcomes and demonstrate continual improvement.

Compliance is generally dictated by national regulations to ensure the safety of both the operator and those affected by the data. Inadequate calibration and verification of survey instruments can introduce a significant level of risk, particularly on engineering and construction projects. There may also be legal involvement affecting compliance requirements, e.g. forensic applications.

## 4. What equipment is calibrated?

The majority of all survey equipment is calibrated. This includes, but is not limited to, the following:

- Total Stations
- Digital Levels
- GPS/GNSS Sensors
- Terrestrial LiDAR Systems
- Electromagnetic location tools used in utility mapping (Receivers and Generators)
- Geophysical Instrumentation, e.g. ground penetrating radar
- Photographic & LiDAR equipment used in photogrammetry & aerial surveys.





## 5. Why do instruments go out of calibration?

There are many factors which can influence the calibration status and indicate if calibration is required. The list below provides some examples:

- A newly manufactured instrument
- After a repair or modification
- When a specified operating time has elapsed
- When a specified usage (operating hours) has elapsed
- Before and/or after a critical measurement
- After an adverse event, e.g. after an instrument has been exposed to shock, vibration, or changes in temperature
- Whenever observations indicate a substandard performance
- As specified by a requirement, e.g. customer specification or instrument manufacturers' recommendation.

## 6. Manufacturers' certification

There are many manufacturers of survey equipment and each have their own certification structure. It is generally a requirement for companies to adhere to the manufacturers' stated time intervals for calibration to ensure conformity with Quality Management System (QMS) requirements.

Clients and contracting companies will often request calibration certificates, relevant to the instruments being used by surveyors on site, to ensure compliance with health and safety plans drawn up under current Construction, Design and Management (CDM) regulations.

## 7. Calibration procedures for total stations

RICS has produced a detailed guidance note on best practice for calibration of Total Stations (EDMs).

"High accuracy work", whilst not specifically defined, will generally include most applications where total stations are used, e.g. Topographical Surveys, Setting Out, Measured Building Surveys and Monitoring.

Verification checks of survey instruments should be undertaken on a regular basis, particularly after shocks or exposure to adverse conditions, or if measurements and observations give cause for concern. Most modern total stations now have internal check and adjust software that can be run to ascertain if the instrument is performing within the correct tolerances.

If a verification or calibration check indicates that the instrument is not providing measurements within the manufacturer's specified tolerances, and these are beyond the range of the instrument's standard adjustment mechanisms to correct, then the instrument should be sent to a manufacturer-approved centre for servicing, checking and adjustment. It should be noted that this kind of procedure can apply to most types of survey equipment and is not limited to total stations.



## 8. Summary

It is a surveyor's professional duty to ensure that the instruments they use are capable of providing accurate results, when used correctly, in order to minimize the risk arising from inadequate reporting. It is recommended that there should be a scheduled calibration and verification procedure employed for all relevant survey instruments and adherence to this programme should be monitored and recorded. In addition, regular in-house checks should also be performed to ensure the continued good performance of relevant instruments. Recently calibrated instruments, of any kind, can be used as a benchmark to check the performance of equipment that is between calibrations. This allows survey companies to demonstrate their commitment to good practice and compliance with any quality management system in use, such as ISO 9001. Furthermore, the ability to demonstrate adherence to any such programme is often required to meet the CDM obligations of clients involved in larger projects.

### Further information

JCGM 200:2008 International Vocabulary of Metrology – basic and general concepts and associated terms (VIM)

[http://www.bipm.org/utis/common/documents/jcgm/JCGM\\_200\\_2008.pdf](http://www.bipm.org/utis/common/documents/jcgm/JCGM_200_2008.pdf)

RICS 2007 EDM Calibration 2nd Edition, Royal Institution of Chartered Surveyors, UK

<http://www.rics.org/uk/shop/EDM-Calibration-16993.aspx>

### The Survey Association

Formed in 1979 as The UK Land and Hydrographic Association, TSA is now established as the representative organisation for UK private surveying firms. The Associations aims are:

- To provide a vehicle for members to act effectively together on agreed courses of action
- To promote the interests of the profession to all those who determine the economic and social conditions in which the industry operates and
- To identify and represent the views of the industry.

### Using a TSA member

By using a TSA member you can be assured that your project will get off to the best possible start. Whatever the size of project, you can be certain that TSA member companies are expert in the provision and management of spatially related data on which to base your concept, design and construction.

Professional attention from a TSA surveyor will reduce risk, repetition, possibly save you money and will ensure that your project receives the best possible attention.

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## Document Revision History

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