Calibration

Calibration is the set of operations that establishes, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding accepted value of a reference calibrant. There is an expectation that instrumentation should be calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national standards; where no such standards exist, the basis for calibration or verification shall be recorded.[1] The work of the ICSC has been cited as a basis for calibration of analytical instrumentation, HPLC for example[2].

Qualification

Qualification is the collection of documented evidence that an instrument performs suitably for its intended purpose and that it is properly maintained and calibrated. Use of a qualified instrument in analysis contributes to confidence in the veracity of generated data.[3]

Validation

Validation relates to the 'fitness for purpose' of analytical methods and procedures as well as computerised systems. The majority of modern analytical instruments contain hardware, firmware and software in order to function. Many are fully computerised and automated systems. Computerised system validation is defined as 'Establishing documented evidence which provides a high degree of assurance that a specific computer-related system will consistently operate in accordance with pre-determined specifications'[4]. Furthermore, ISO Guide 17025 requires that equipment and its software used for testing, calibrating and sampling shall be capable of achieving the accuracy required and shall comply with specifications relevant to the tests and or calibrations concerned.[5]

Holistic approaches and 'Fitness for Purpose'

Most modern analytical systems are multi-modular. While individual modules may require individual qualification and/or calibration, such tests alone cannot guarantee the accuracy of analytical results [6]. When the software validation aspects are taken into account, it becomes necessary to adopt a 'holistic' or system suitability approach. These holistic tests are for the purpose of ensuring a satisfactory performance of the overall system. Procedures that fulfil this role include internal quality control, by using one or more control materials as surrogate test materials in every run of analysis. IQC ensures that statistical control is maintained after the initial validation of the system. Proficiency testing and, where appropriate, the analysis of certified reference materials act as a powerful, occasional, but external check on system accuracy.

When this hierarchical approach is linked to analytical data quality management tools, the quality of analytical data and derived information is assured.[7]

A framework for analytical data integrity

The foundations for the confidence in an analytical result, as discussed above, can be summarised in a hierarchical way, requiring the following [8];

- The instrumentation used has been qualified and calibrated.
- The method selected is based upon sound scientific principles and has been shown to be robust and reliable for the type of test material.
- The iri