Simplifying Mass Calibration

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Currently, mass calibration is a time-consuming and complicated process that involves a large amount of data handling, calculations, and administrative steps. Using new software packages, calibration labs worldwide are replacing limited legacy solutions with a previously unheard-of level of calibration efficiency. This is helping operators eliminate manual steps and ensure traceability while simultaneously enhancing fairness in cross-border trade.

Mass calibration is an elaborate, calculation-intensive process. Accuracy requires educated personnel working for long periods of time. In spite of its resource-intensive nature, it is a proposition that international companies must take seriously. Today's climate of ever-expanding cross-border trade requires accurate balance readings, which in turn require highly accurate mass calibration.

Calibration processes depend on a complex set of steps, including correct reference-weight class and comparator selection. Proper selection requires a complete uncertainty analysis: customer data is entered, certification numbers assigned, and weight set-related data recorded, perhaps into multiple, often-redundant worksheets or systems. Reference weights themselves must conform to regulations such as OILM R111, NIST HB44, or JJG 99-2006 [1, 2, 3] and be traceable to the international standards.

Correction of physical effects and observation of environmental fluctuations are also crucial to achieving precise measurements, while traceability provides surety and an ability to analyse results for any deviation on an ongoing basis. In short, all aspects of calibration must be conducted with extreme care to make sure reported values are true and accurate.

In-house Solutions Inherent Issues

Historically, software solutions that have been designed to automate weight selection and data-handling steps to increase reliability and save time have had limited applicability. As such, some national metrology institutes (NMIs) and private calibration laboratories have attempted to create custom software solutions, a costly effort that can be beyond the reach of smaller labs or cash-strapped government institutes.

Ongoing reliability for these custom systems may also be called into question for various reasons including low data security and the amount of training required for new personnel. Custom systems also typically lack an ability to interface with the comparator balances or other lab equipment. As such, the most significant source of error in any calibration process, manual data transcription, is not addressed or eliminated *(Figure 1)*. If data is only stored on paper, statistical analysis and historical reporting becomes difficult if not impossible.

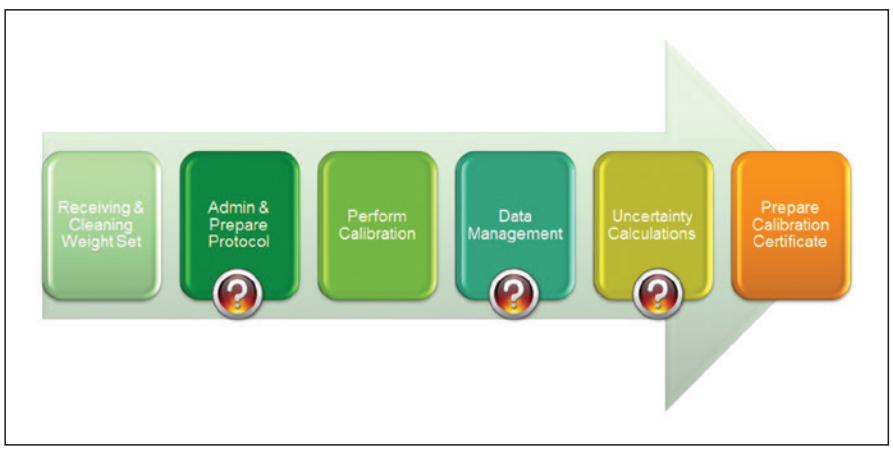

Figure 1. Manual process for weight calibration indicating steps with highest risk of error

Ensuring Traceability and Security

There are bright spots on the horizon as far as calibration software goes, however. Some newer solutions are able to securely interface with comparator balances, eliminate error potential, and significantly reduce the number of steps required to calibrate weights. For example, Mettler Toledo MC Link assists operators with everything from choosing the appropriate regulatory scheme to issuing calibration certificates.

Ideally, a chosen software solution should deliver:

- traceability
- security
- physical effects correction
- control of relevant environmental data
- environmental data analysis/correction

Security should be maintained through password-protected access. A manager should have the ability to create and monitor calibration protocols, including weighing scheme definition (i.e. ABA, ABBA, ABBsAs), number of repetitions, use of check standard and sensitivity weight, uncertainty definition, statistical testing, and target accuracy classes. Once customer details are defined in the system, weight sets can be assigned to that

customer by selecting from a list of templates that include all relevant data related to 'standard' weight sets.

Customer-specific data such as weight set ID and accuracy class should only need to be entered once. Afterwards, a comparator should be selected and the calibration started in just a few clicks. If multiple mass comparators are available, this should also be easily defined so operators can see which comparators are appropriate for a given method.

In MC Link, potential for error is further limited by ensuring that elements of a calibration process that do not fulfil accuracy requirements are not available for selection by the operator performing the calibration.

Fast, Secure Set-up and Selection

Throughout calibration, an appropriate software solution reduces human influence, leading to high data security and efficiency. Using MC Link, a calibration job with predefined values such as weight sets templates, reference weights data, and processes allows a complete calibration method to be generated with all required definitions in less than 10 seconds. An operator can read the weight set and weights to be calibrated with a bar code reader. The comparator, test weight, reference standard and calibration method are then automatically selected and transferred to a laboratory client running on a tablet for execution.

The right software solution will offer even greater time-savings during recalibration. The weight set ID is simply read with the reader and the right method is started automatically using the settings of prior calibrations. The operator is led through the process with clear instructions on a GUI. The client interface also provides live feedback on calibration status as process readings are taken and verified for tolerances and statistical testing. Any potential performance influences are detected immediately allowing corrective action. Once a full weight set is processed and all weights are within required tolerances, a calibration certificate can then be generated and ready for printing *(Figure 2)*.

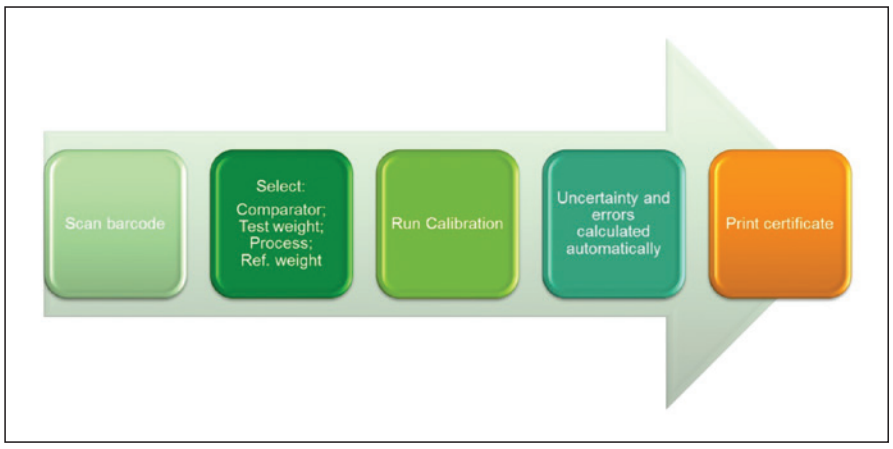

Figure 2. Process for running a calibration with MC Link software

Integrated Process Control

Process control on an ongoing basis should also either be incorporated into the actual calibration process itself or performed prior to calibration to ensure the system is satisfying accuracy requirements. In MC Link, all calculations are performed online and the visual control graph allows live analysis during calibration. Single readings as well as results are displayed with limits for visual observation in air-buoyancy-corrected conventional mass. With multiple quality control tools, warnings are displayed on-screen when limits are exceeded or statistical tests failed. This allows an operator to take immediate corrective action to ensure calibration results are accurate *(Figure 3)*.

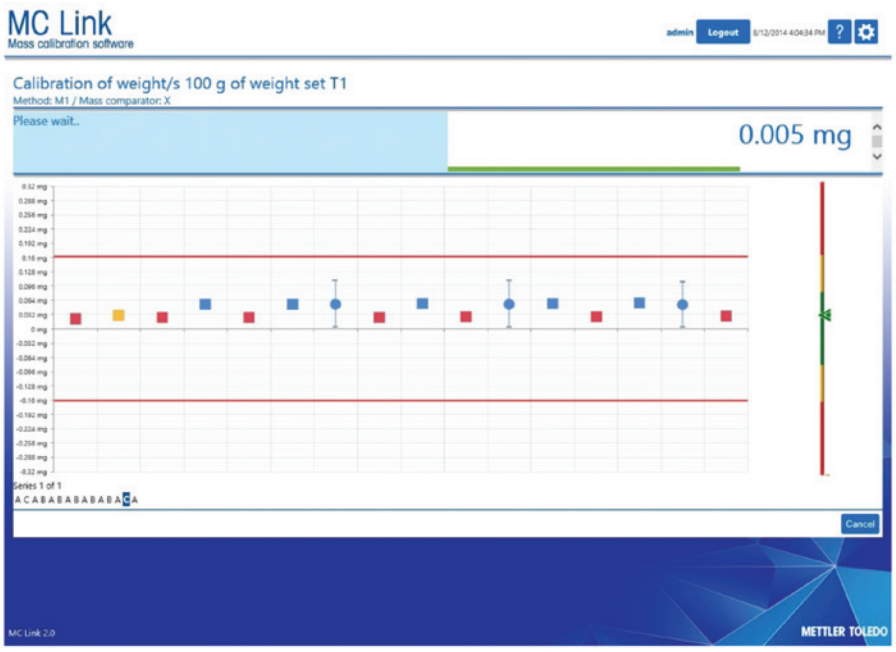

Figure 3. In-Process Control: a graphical view makes it easier to determine whether values are in or out of tolerance

Comparators are also tested on a time-controlled basis for repeatability and blocked if they fail defined limits. Eccentricity testing allows real-time definition of comparators' specific uncertainty parameters. Possible sensitivity drifts are corrected to ensure full compliance with system requirements.

The actual performance capability of the comparator is verified to ensure correct readings and generate historical data for statistical testing. Only accepted tests are used for statistical analysis. This information can be used later to guide processes where no check standards have been implemented.

Efficiency and Data Traceability

In conclusion, a robust software suite will offer users an ability to bring their mass calibration processes to a new level of ease and reliability. The benefits of such a software product include:

1. Simplifying/automating process tasks. Mass calibration is performed with high efficiency due to reduced labour/administrative tasks, fewer working steps, and lower process complexity. Ongoing statistical testing supports quality control. Officers can concentrate on weight placement and handling, rather than calculations or data analysis.

2. Simplifying recalibration efforts. In most labs, a high proportion of workload is periodic recalibration of the same client weight sets. The ability to enter a weight set ID and retrieve previous calibration settings accelerates repeat calibration processes for additional time savings and heightened lab productivity.

3. Secure data handling. An effective software package that eliminates manual data entry during calibration and certificate printing creates data that has a high degree of integrity. In fact, in an ideal situation, the only writing required is a signature on the calibration certificate. Error potential is significantly reduced.

4. Fully traceable results. Measuring instruments such as climate sensors and comparators can be connected directly to the systems, allowing fast and reliable communication among instruments. Ongoing analysis detects potential error sources. Data can be validated and quality assured.

5. Integrated process control. Incorporating process control into calibration on an ongoing basis helps to ensure results remain within accepted tolerance limits so results can be trusted over time.

Feature	Advantage	Benefit
Barcode reading of weight ID	• System quickly reads and displays the content of the weights set. • Avoids human error in manually writing or typing multi-digit weight ID's.	• Simple calibration • Efficient workflow Data security • Traceability
Only compatible options can be selected	• Options incompatible with test weight requirements are unavailable for selection. • Eliminates risk of choosing incorrect comparator, method or reference weights (according to uncertainty analysis).	• Error-free selection • Reliable results • Data security
Predefined methods	• Minimizes risk to set up smaller labs with less experience. • Ensures compliance with regulations.	• Low risk for fast set up of a regulatory compliant mass laboratory
Tablet user interface	• Lower investment cost than laptop. • High flexibility in the laboratory. • Lower heat dissipation, reduces temperature variations in lab, which in turn improves overall performance of comparators and reference weights. • Less space required at calibration workstation.	• Cost saving • Improved performance
On screen guidance	• Step-by-step instructions avoid mistakes in which weight is placed. • Enables less experienced personnel to execute high quality mass calibration activities. • Allows easy judgment of the quality of results at a glance.	• Simple calibration • High quality results • Cost efficiency • Data security
Background control	• Operator is notified of any problems. • If results are out-of-tolerance, process can be stopped immediately, to avoid delays.	• Reliable results • Efficient workflow • Simple calibration
Automated data recording	• Ensures prompt and error-free data import for subsequent calculations. • Prevents reading / writing errors. • Mass calibration process is faster and more secure.	• Worry-free weighing • Reliable results
Automatic correction of physical effects	• Ensures full reproducibility of calibrations and correctness of certified values. • Reliable certificates supplied to customers ensure confidence and long term reputation of the laboratory	• Certificate correctness • Data reliability

Figure 4. Features, advantages and benefits of MC Link mass calibration software [Mettler Toledo]

Implementation of such a software solution will help enhance an individual calibration lab's adherence to SOPs, assure regulatory compliance, and increase calibration capacity. Additionally, an evolution towards broad-scale use of this kind of software will help stabilise mass calibration across industries, generate more reliable certificates, and ensure greater fairness in cross-border trade.

References

1. OIML R111 – TC 9/SC 3 (2004)

2. NIST Handbook 44, 'Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices,' 2014 edition

3. JJG 99-2006, "Verification Regulation of Weights," China Institute of Metrology (2007)

For more information, see: http://us.mt.com/us/en/home/supportive_content/White_Papers/productorganizations/labtec/07_Mass_Comparators/WP_MC_Link_Request.html