

D2 Mass calibrations

D2.1 General

The purpose of this annex is to specify the criteria needed to assess the competence of a calibration laboratory that performs mass calibrations. Note that the **ECHELON** classifications referenced below are further defined in **NIST Handbook 143, Table 4**.

D2.2 Accommodation and environmental conditions

D2.2.1 To be deemed capable of making adequate measurements, calibration laboratories shall provide an environment with adequate environmental controls appropriate for the level of measurements to be made, according to ECHELON classes.

D2.2.2 The environmental conditions shall be within the specifications of the weighing instruments where applicable.

D2.2.3 Instruments measuring environmental conditions shall be used in close proximity to the balance being used. For ECHELON I, temperature may be measured inside the weighing chamber when there is a difference between the air temperature in the balance chamber and the surrounding area.

D2.2.4 The laboratory shall maintain limited access to the calibration area and minimize contamination (maintain a clean surface) for locations where calibration items are being tested.

D2.2.5 Vibration shall not diminish the performance of precision analytical balances and mass comparators.

D2.2.6 Undesirable effects due to static electricity shall be controlled, if needed, with methods such as humidity, anti-static, deionizing radiation devices, the grounding of balances or operators, or with the use of special conductive flooring, and selection of proper clothing for staff.

D2.2.7 Laboratories shall evaluate the level of significance for buoyancy corrections for all mass calibrations.

D2.3 Procedures and method validation

D2.3.1 The procedures and formula chosen for the mass measurement, the reference standard(s) to be used, and the equipment to be used for a calibration shall provide acceptable levels of uncertainty for that calibration.

D2.3.2 A documented procedure, compliant with the requirements of OIML or ASTM documentary standards for mass, shall be available in the laboratory to determine the correct algorithm to be used for the specific calibration.

D2.4 Equipment

D2.4.1 Due to comparison methods and calculations used in mass calibration, the uncertainty of measurement results from auxiliary instruments for ECHELONS I and II, (e.g., scale, analytical balance, mass comparator) is less important than the precision of the instrument. However, if such equipment used for comparison are repaired or serviced:

- a) they shall be reevaluated to ascertain the current level of precision prior to use, and

b) the uncertainty estimate shall reflect the post-repair performance.

D2.4.2 The precision of the scale, analytical balance, or mass comparator, as determined through appropriate process control charts, shall be suitable to the ECHELON class for which it is used.

D2.4.3 For an application where external standards are used for comparison, appropriate control charts shall be maintained to evaluate the process standard deviation.

D2.4.4 Balances

D2.4.4.1 Balances used as a direct comparison to the mass unit shall be calibrated prior to use.

D2.4.4.2 For an application requiring balance accuracy, the laboratory shall choose appropriate and correct calibration procedures and calculations.

D2.4.4.3 Balances used as dividers and multipliers of the mass unit shall be capable of providing the appropriate uncertainty and linearity requirements of the ECHELON class for which they are used.

D2.4.4.4 Calibration of built-in standards shall be performed periodically and shall be verified prior to use. History from measurement control programs (surveillance testing) may be used to determine calibration intervals.

D2.4.5 Environmental sensors

D2.4.5.1 Measurement results data from instruments used to monitor environmental conditions in the laboratory shall be traceable to the International System of Units (SI) through a suitable national laboratory (directly or by way of an accredited laboratory).

D2.4.5.2 These instruments shall be recalibrated periodically unless intrinsic (defining) standards are employed.

D2.4.5.3 Calibration and intercomparison periods shall be documented by the laboratory.

D2.4.5.4 For intrinsic standards, data from intercomparison with standards of known measurement values shall be available.

D2.4.5.5 Means shall be provided to measure barometric air pressure, air temperature, and relative humidity of the laboratory environment adequate to the method used.

D2.4.5.6 Documentation of the uncertainty and traceability of these environmental measurement results shall be maintained.

D2.5 Standards

D2.5.1 Suitable reference standards shall be available at each ECHELON and range for which the laboratory is accredited.

D2.5.2 Sufficient historical data and uncertainty analysis shall be available to support the standards used at each level of a traceability hierarchy.

D2.5.3 Suitable calibration intervals shall be documented and ensured.

D2.5.4 For ECHELON I, the laboratory shall state the presence of a possible systematic error in the combined uncertainty associated with the use of an assumed or reported density in the primary or reference standards (additional type B component) or the laboratory shall have appropriate means to measure the density of mass standards.

D2.5.5 Each mass standard used as a reference standard by the laboratory shall be calibrated by a National Metrology Institute or by an accredited laboratory with capability adequate to sustain the uncertainty required and maintain traceability to International System of Units (SI).

D2.5.6 The laboratory shall provide evidence, such as periodic surveillance, that the mass standards are, in principle, stable and acceptable for providing calibration services at each ECHELON for which they are used.

D2.6 Handling of test and calibration items

D2.6.1 The laboratory shall have documented procedures to ensure adequate chain-of-custody of calibration items if required by law.

D2.6.2 The laboratory shall document appropriate procedures to ensure that cleaning or adjustments, if performed, ensures the integrity of the standards, and to provide for thermal and other environmental conditioning, where appropriate.

D2.6.3 The laboratory shall allow adequate stabilization time for mass standards to ensure environmental and thermal stability prior to calibration.

D2.6.4 Documented procedures to ensure adequate tracking of calibration items shall be appropriate to the class of mass standard. Strings, tags, or labels fastened to the standard are inappropriate for all types of mass standards.

D2.7 Assuring the quality of test and calibration results

D2.7.1 Appropriate measurement control programs shall be in place and available for review for each ECHELON and nominal mass range for which calibration data is provided. Appropriate data include balance standard deviations that represent measurement process variation using well-characterized check standard values.

D2.7.2 Measurement control techniques shall exhibit results consistent with the procedures used to perform calibrations and be integrated into the measurement procedures to accurately reflect the measurement process.

D2.7.3 For those situations in which statistical information is not inherent to the process, i.e., simple measurements without built-in redundancy checks:

- a) additional measurements shall be made to provide experimental characterization of the measurement sufficient for an adequate estimation of the process uncertainty;
- b) those data shall be available for review.

D2.8 Reporting the results

D2.8.1 Calibration reports shall describe the mass standards mentioned in the report with sufficient detail to avoid any ambiguity.

D2.8.2 In addition to the general report requirements of ISO/IEC 17025, for ECHELON I and II calibration, additional items to be included on a test report, are:

- a) mass (true mass) values;
- b) conventional (apparent) mass values versus appropriate reference density;
- c) reference density;
- d) uncertainties;
- e) material;
- f) thermal coefficient of expansion (if used in calculations);
- g) construction;
- h) density (assumed or measured, along with measurement method);
- i) any identifying markings;
- j) tolerances, if appropriate;
- k) magnetic susceptibility of mass standards, if evaluated, along with method of evaluation.

D2.10.2 Environmental parameters measured during the test shall be provided on calibration reports for ECHELONS I and II. Typical ranges are acceptable for ECHELON III. These include: laboratory temperature, barometric pressure, and relative humidity.

D2.10.3 Information regarding cleaning methods, where applicable, shall be provided on the calibration reports.

D2.10.4 Calibration reports may include reference to OIML or ASTM classification schemes and tolerances. It is the responsibility of the requestor of the calibration, not the laboratory, to select classifications acceptable for their needs. If conformity is being assessed:

- a) items being calibrated shall meet appropriate specifications for evaluation as well as tolerances or state which items are and/or are not evaluated;
- b) in instances where magnetism, surface finish, density, or other requirements of the specifications are not evaluated for ECHELON I and II, a statement to that effect shall be included on the calibration report.

D2.10.5 The external surface of a mass standard should be free of any sign of abuse or damage. Signs of abuse or misuse include the placement of labels, tags, wires or other material on mass standards. In addition, visible dirt and fingerprints are a sign of misuse for ECHELONS I and II. It is recommended that the calibration laboratory establish appropriate means for notifying customers regarding any unusual factors, such as signs of abuse regarding the mass standard being tested. Any of these indicators of abuse or damage shall be described in the calibration report.

D2.10.6 Any out-of-tolerance conditions of the mass standards under test identified through the calibration process shall be noted on the calibration report.