**Date:** **NVLAP Lab Code:** Click or tap here to enter text.

**NIST HANDBOOK 150-2 CHECKLIST (ISO/IEC 17025:2017)**

**(Calibration)**

**Instructions to the Assessor:** This checklist addresses specific accreditation criteria prescribed in NIST Handbook 150-2, Calibration. Included also are instructions and comments sheets used for observing actual demonstrations of the performance of selected test methods. These criteria do not supersede the *Criteria for Accreditation* based on ISO/IEC 17025:2017, which are addressed in the NVLAP General Criteria Checklist.

Place an "X" beside each checklist item that represents a nonconformity. Place a "C" beside each item on which you are commenting for other reasons. Record the nonconformity explanation and/or comment in assessment report created in the assessor portal under the laboratory’s assessment record. Place "OK" beside all other items you observed or verified as compliant at the laboratory.

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| **Requirement** | **Compliance**  **(OK, X, or C)** | **Management System Reference** | **Objective Evidence** |

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| **Requirements from body of Handbook 150-2**  **(apply across all technical fields of calibration)** |

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| **3** | **Accreditation Process** |

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| **3.2** | **Management system review** |

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|  | **3.2.1** | If the management system of the laboratory uses different numbering than that of ISO/IEC 17025, the laboratory shall create a cross-reference document allowing the laboratory and a NVLAP assessor to verify that all requirements of clauses 4 through 8 of the international standard, as well as other applicable general NVLAP requirements, are met by the management system.  NOTE A subset of requirements may be fulfilled by some laboratories without either program, policy, procedure, or resulting records. When completing the cross-reference document, for clauses where no documentation is required, it is acceptable to simply note *met without documentation* for the relevant clause. These will be assessed through discussion during the onsite assessment. Of course, when a program, policy, procedure, or record is called for in the requirements, these must be contained within the laboratory’s quality system and its location must be noted in the cross-reference document. | Choose an item. |  |  |
|  | **3.2.2** | Additionally, if the laboratory uses different numbering than that of ISO/IEC 17025, the locations within the laboratory’s management system of the requirements given in this document, NIST Handbook 150-2, shall be provided in a cross-reference document. | Choose an item. |  |  |

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| **3.3** | **Assessment of field locations** |

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|  | **3.3.2.2** | When a laboratory has technical aspects of its accredited work being performed at a field location by staff not based at the laboratory’s main facility, the following requirements for NVLAP accreditation shall apply:  NOTE The additional requirements here in 3.3.2.2 do not apply to field service calibrations performed by staff based at the main laboratory. |  |  |  |
|  | **a)** | The laboratory shall demonstrate that all requirements of NIST Handbook 150 (other than the calibration) are being managed, performed, or otherwise controlled at the main facility. | Choose an item. |  |  |
|  | **b)** | The management system documentation shall clearly cover the processes for managing the field operations and identify the personnel specifically authorized to perform calibrations at the field locations. | Choose an item. |  |  |
|  | **c)** | For an initial accreditation of a calibration laboratory having one or more field locations, at least one field location will be assessed by NVLAP. | Choose an item. |  |  |
|  | **d)** | In addition, all field representatives shall be present at the initial assessment of the main facility. | Choose an item. |  |  |
|  | **e)** | The laboratory shall have field representatives (signatories and/or calibration technicians) available at the main facility for renewal assessments. In advance of the assessment, NVLAP will notify the laboratory which, or how many, of the field representatives are to be present. | Choose an item. |  |  |
|  | **f)** | As described in NIST Handbook 150, assessments are normally held biennially. During what would otherwise be a non-assessment year, an assessment of a field representative shall be done at his or her usual location if all field locations were not visited as part of the regular biennial assessment. | Choose an item. |  |  |
|  | **g)** | The laboratory shall demonstrate that field personnel are trained at the main facility, by staff from the main facility, or by field-based training staff specifically trained at the main facility. | Choose an item. |  |  |
|  | **h)** | The manner in which field personnel are trained shall be included in the training system documentation | Choose an item. |  |  |
|  | **i)** | Calibration reports shall be issued by the main facility, indicate the physical locations where the calibrations were performed, and be signed by approved signatories. | Choose an item. |  |  |
|  | **j)** | The laboratory shall have a defined interlaboratory comparison program between its headquarters and field locations. | Choose an item. |  |  |

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| **7** | **Process requirements** |

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|  | **7.6** | **Evaluation of measurement uncertainty** |

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|  | **7.6.1** | Calibration laboratories shall provide evidence that they can provide calibrations to customers so that measurement uncertainties equal those covered by the CMC. | Choose an item. |  |  |
|  | **7.6.2** | In the formulation of CMC, laboratories shall take notice of the performance of the “best existing device” that is available for a specific category of calibrations. | Choose an item. |  |  |
|  | **a)** | A reasonable amount of contribution to uncertainty from repeatability shall be included and contributions due to reproducibility should be included in the CMC uncertainty component, when available. The CMC quoted should include the contribution from a relatively ideal or best available device to be calibrated such that the CMC claimed is demonstrably realizable. | Choose an item. |  |  |
|  | **b)** | It is recognized that for some calibrations a “best existing device” does not exist and/or contributions to the uncertainty attributed to the device significantly affect the uncertainty. If such contributions to uncertainty from the device can be separated from other contributions, then the contributions from the device may be excluded from the CMC statement. For such a case, however, the scope of accreditation shall clearly identify that the contributions to the uncertainty from the device are not included.  NOTE The term “best existing device” is understood as a device to be calibrated that is commercially or otherwise available for customers, even if it has a special performance (stability) or has a long history of calibration. | Choose an item. |  |  |
|  | **7.7** | **Ensuring the validity of results** |  |  |  |

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|  | **7.7.2** | Proficiency testing (PT) requirements |

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|  | **7.7.2.1** | A calibration laboratory shall meet the following requirements for frequency of PT: |  |  |  |
|  | **a)** | For those measurement parameters for which it is available, laboratories shall participate in appropriately rigorous PT (testing at the level of the laboratory’s accredited capabilities). | Choose an item. |  |  |
|  | **b)** | An applicant laboratory shall show satisfactory participation in at least one PT prior to initial accreditation. | Choose an item. |  |  |
|  | **c)** | At a minimum, an accredited laboratory shall participate in proficiency testing in each field of calibration published on their scope at least once every four years. For some fields of calibration, e.g. ionizing radiation, NVLAP supports industry sector requirements for increased proficiency testing frequency. When this is the case, additional information is given in the technical annex for that field. | Choose an item. |  |  |
|  | **d)** | A laboratory shall meet any additional PT requirements stated in the annexes in this handbook related to the parameter(s) for which it is accredited. | Choose an item. |  |  |
|  | **e)** | As established in section 3.4 of this handbook, laboratories seeking accreditation for calibrations with uncertainties deemed by NVLAP to be near those provided by an NMI, proficiency testing of rigor comparable to an NMI key or regional supplementary comparison will be required, and at a specified frequency that may exceed that in 7.7.2.1a. Such PT may be identified by NVLAP in consultation with NIST experts for parameters where laboratories are operating at or near NIST uncertainties. In this case, the laboratory shall participate in the identified PT. | Choose an item. |  |  |
|  | **7.7.2.2** | Acceptable PT Activities |  |  |  |
|  |  | A calibration laboratory shall use one or more of the following types of proficiency testing: | Choose an item. |  |  |
|  | **a)** | PT through a provider accredited to ISO/IEC 17043 for the parameter being tested at the uncertainty level of that test, where that the accreditation to ISO/IEC 17043 is issued by a body which is signatory to a mutual recognition arrangement (MRA) for proficiency testing accreditation in a regional body recognized by the International Laboratory Accreditation Cooperation (ILAC); or | Choose an item. |  |  |
|  | **b)** | a PT which is coordinated through the NIST Office of Weights and Measures (OWM) Regional Measurement Assurance Program (RMAP); or | Choose an item. |  |  |
|  | **c)** | a PT or Measurement Assurance Program (MAP) offered through a NIST technical division; or | Choose an item. |  |  |
|  | **d)** | an exception: it is possible that PT providers that are not accredited may be acceptable. In this case, the non-accredited PT provider shall meet the requirements of ISO/IEC 17043, where applicable. The acceptability of proficiency tests from such providers will be determined by NVLAP in consultation with the laboratory. | Choose an item. |  |  |
|  | **7.7.2.3** | Reporting of PT |  |  |  |
|  |  | A calibration laboratory shall meet the following requirements for reporting proficiency testing: |  |  |  |
|  | **a)** | PT results shall be available for review during on-site assessments. | Choose an item. |  |  |
|  | **b)** | The E-normal value (En) shall be reported for each measurement result, where applicable. | Choose an item. |  |  |
|  | **c)** | Laboratories are required to address unsatisfactory PT results. Records of corrective actions taken to address unsatisfactory results shall be available for review during assessments. | Choose an item. |  |  |
|  | **7.7.2.4** | Laboratory PT Plan |  |  |  |
|  |  | A calibration laboratory shall have a PT plan meeting the following requirements: | Choose an item. |  |  |
|  | **a)** | An applicant calibration laboratory shall develop a proficiency testing participation plan, describing how the laboratory will meet requirements for minimum participation in PT given above. | Choose an item. |  |  |
|  | **b)** | With each renewal of accreditation, an accredited calibration laboratory shall provide an updated PT participation schedule, including evidence that planned activities have been completed. NVLAP Program Managers review the schedule and work with the laboratory as necessary to ensure that it adequately covers the scope of accreditation. During the onsite assessment, the assessors review the results of proficiency testing. | Choose an item. |  |  |
|  | **c)** | The PT plan shall reflect the laboratory’s past year PT activities as well as planned activities for the next three years to provide continuing evidence that technical competence is being maintained. | Choose an item. |  |  |
|  | **d)** | The PT plan shall be regularly reviewed by the laboratory in response to changes in scope, staffing, methodology, instrumentation, etc.  NOTE Review of the PT plan by the laboratory may occur as part of the management review process. | Choose an item. |  |  |
|  | **7.8** | **Reporting of results** |  |  |  |

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|  | **7.8.1** | Calibration Measurement Results |

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|  | **a)** | The measurement result shall normally include the measured quantity value y and the associated expanded uncertainty U. In calibration certificates the measurement result should be reported as y ± U associated with the units of y and U. Tabular presentation of the measurement result may be used and the relative expanded uncertainty U / |y| may also be provided if appropriate. | Choose an item. |  |  |
|  | **b)** | The coverage factor and the coverage probability shall be stated on the calibration certificate. To this an explanatory note shall be added, which may have the following content:  “The reported expanded uncertainty of measurement (*U*) is stated as the standard uncertainty of measurement multiplied by the coverage factor *k* such that the coverage probability corresponds to approximately 95 %.”  NOTE For asymmetrical uncertainties other presentations than *y ± U* may be needed. This concerns also cases when uncertainty is determined by Monte Carlo simulations (propagation of distributions) or with logarithmic units. | Choose an item. |  |  |
|  | **c)** | The numerical value of the expanded uncertainty shall be given to, at most, two significant figures. | Choose an item. |  |  |
|  | **d)** | The numerical value of the measurement result shall in the final statement be rounded to the least significant figure in the value of the expanded uncertainty assigned to the measurement result. | Choose an item. |  |  |
|  | **e)** | Where displayed values have been rounded, that rounding shall be applied when all calculations have been completed; resultant values may then be rounded for presentation. | Choose an item. |  |  |
|  | **f)** | Contributions to the uncertainty stated on the calibration certificate shall include  relevant short-term contributions during calibration and contributions that can  reasonably be attributed to the customer’s device. | Choose an item. |  |  |
|  | **g)** | Where applicable, the uncertainty shall cover the same contributions to uncertainty that were included in evaluation of the CMC uncertainty component, except that uncertainty components evaluated for the best existing device shall be replaced with those of the customer’s device. Therefore, reported uncertainties tend to be larger than the uncertainty covered by the CMC. Random contributions that cannot be known by the laboratory, such as transport uncertainties, should normally be excluded in the uncertainty statement. If, however, a laboratory anticipates that such contributions will have significant impact on the uncertainties attributed by the laboratory, the customer should be notified according to the general clauses regarding tenders and reviews of contracts in ISO/IEC 17025. | Choose an item. |  |  |
|  | **h)** | As the definition of CMC implies, accredited calibration laboratories shall not report a smaller uncertainty of measurement than the uncertainty of the CMC for which the laboratory is accredited. | Choose an item. |  |  |

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| **Requirements from Annex A of Handbook 150-2**  Applicable only to those laboratories seeking accreditation/reaccreditation to ANSI/NCSL Z540-1-1994, Part 1  **Note to assessors:** leave all elements of this section blank if the laboratory is not being assessed for compliance with ANSI/NCSL Z540-1-1994, Part 1 |

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| **Annex A** |  | **ANSI/NCSL Z540-1-1994, Part 1** |

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|  | **A.2.1** | The quality manual and/or related documentation shall contain the laboratory's scope of calibrations and/or verifications | Choose an item. |  |  |
|  | **A.2.2** | The quality system adopted to satisfy the requirements of ANSI/NCSL Z540-1-1994 shall be reviewed at least once a year by the management to ensure its continuing suitability and effectiveness and to introduce any necessary changes or improvements. | Choose an item. |  |  |
|  | **A.3** | Calibration procedures shall contain the required range and tolerance or uncertainty of each item or unit parameter being calibrated or verified. In addition, the procedures shall contain the generic description of the measurement standards and equipment needed with the required parameter, range, tolerances or uncertainties, and specifications for performing the measurement of the calibration or verification, and/or representative types (manufacturer, model, option) that are capable of meeting the generic description for the measurement standards. The procedures shall be consistent with the accuracy required, and with any standard specifications relevant to the calibrations/verifications concerned. | Choose an item. |  |  |
|  | **A.4** | Tamper-resistant seals shall be affixed to operator accessible controls or adjustments on measurement standards or measuring and test equipment which, if moved, will invalidate the calibration. The laboratory's calibration system shall provide instructions for the use of such seals and for the disposition of equipment with damaged or broken seals. | Choose an item. |  |  |
|  | **A.5** | In addition to the list of required items in 7.8 of ISO/IEC 17025, each calibration report shall include a statement that the calibration report shall not be reproduced except in full, without the written approval of the laboratory. | Choose an item. |  |  |

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| **Requirements from Annex B of Handbook 150-2**  Applicable only to those laboratories seeking accreditation/reaccreditation for DIMENSIONAL calibrations.  **Note to assessors:** leave all elements of this section blank if the laboratory is not being assessed for compliance with the requirements for dimensional capabilities. |

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| **Annex B** |  | **Dimensional Measurements** |

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|  | **B.2** | Accommodation and environmental conditions |

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|  | **B.2.1** | Measurement results are generally reported as the length at 20 °C. If measurements are made at temperatures other than 20 °C, the uncertainties of the appropriate thermal corrections for the artifacts shall be included in the total uncertainty. For comparison measurements, the uncertainty component shall reflect the uncertainty in the thermal corrections of both the master and unknown artifacts, as well as the temperature difference between them, and the uncertainty of the temperature sensor used. | Choose an item. |  |  |
|  | **B.2.2** | The temperature stability of the environment shall be sufficient for the gage and measurement system to be in thermal equilibrium. If measurements are made in slowly changing environments, a suitable measurement model, which includes the effects of the drift, shall be used. Theoretical and experimental verification of the model should be available. | Choose an item. |  |  |
|  | **B.2.3** | For typical gages made of well-characterized materials (steel, carbide, or ceramic), ± 10 % shall be used as the standard uncertainty of the thermal expansion coefficient unless there is documentation of a lower value. | Choose an item. |  |  |
|  | **B.2.4** | The laboratory shall have a documented policy regarding responses to environmental conditions outside of specified range. | Choose an item. |  |  |
|  | **B.3** | Equipment |  |  |  |
|  | **B.3.1** | The laboratory shall have temperature-measuring capabilities suitable for the calibration procedure and the desired measurement uncertainty.  NOTE Calibrations involving direct comparisons of artifacts of similar size and materials will, in general, have modest requirements. Absolute calibrations or comparisons between artifacts of different sizes and/or materials will require more accurate temperature measurement or adjustment of the measurement uncertainty. | Choose an item. |  |  |
|  | **B.3.2** | A laboratory that makes mechanical comparisons of masters and test pieces of dissimilar materials shall have force measuring equipment to determine the force on the probe or probes. A correction for differential probe penetration should be applied as long as the probe has maintained its desired geometry. | Choose an item. |  |  |

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| **Requirements from Annex C of Handbook 150-2**  Applicable only to those laboratories seeking accreditation/reaccreditation for Time and Frequency calibration.  **Note to assessors:** leave all elements of this section blank if the laboratory is not being assessed for compliance with the requirements for time and frequency. |

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| **Annex C** |  | **Time and frequency measurements** |

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|  | **C.2.1** | Because a waveform is a set of ordered pairs (i.e., time, voltage), traceability of both the time and voltage shall be in place.  NOTE This is normally demonstrated by calibration of a high-speed oscilloscope or calibration of a fast-rise generator by an external source meeting the requirements in NIST Handbook 150, Annex B. | Choose an item. |  |  |
|  | **C.2.2** | Laboratories that utilize a Global Positioning System Disciplined Oscillator (GPSDO) to establish traceability shall: | Choose an item. |  |  |
|  | **a)** | have procedures in place to ensure GPS is locked and working properly; | Choose an item. |  |  |
|  | **b)** | consider the internal oscillator’s short-term stability and measurement time in the laboratory’s reported uncertainty. | Choose an item. |  |  |

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| **Requirements from Annex D of Handbook 150-2**  Applicable only to those laboratories seeking accreditation/reaccreditation for MECHANICAL calibrations.  **Note to assessors:** There are multiple subsections under the MECHANICAL heading, including FORCE, MASS, and VOLUME. For any of these subsections where the laboratory is not being assessed, leave all elements of that subsection blank. Only complete those subsections for which the laboratory’s capabilities are being assessed. |

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| **Annex D** |  | **Mechanical measurements** |

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| **D.1** |  | **Force Calibration** |

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|  | **D.1.2** | All measurement procedures, accommodation and environmental conditions, instruments and equipment used, and the reporting of results when conducting a force related calibration, shall comply with one or both of the following referenced standards documents, except in special circumstances (see below): | Choose an item. |  |  |
|  | **a)** | ASTM E74, *Standard Practices of Calibration and Verification of Force-Measuring Instruments* | Choose an item. |  |  |
|  | **b)** | *ISO 376: Metallic materials- Calibration of force-proving instruments used for the verification of uniaxial testing machines* | Choose an item. |  |  |

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|  | **D.1.3** | Accommodation and environmental conditions |

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|  | **D.1.3.1** | All instruments shall be allowed sufficient time to reach room temperature prior to calibration. | Choose an item. |  |  |
|  | **D.1.3.2** | The recommended calibration temperature is 23 °C (73.4 °F), however, calibrations shall be conducted within the temperature ranges specified by the procedural method used. | Choose an item. |  |  |
|  | **D.1.3.3** | During calibration, the temperature shall be monitored at a location that reflects the temperature of the instrument. | Choose an item. |  |  |
|  | **D.1.3.4** | Temperature stability shall be maintained in accordance with the procedural method used. | Choose an item. |  |  |
|  | **D.1.3.5** | If the temperature variations exceed ± 0.2 °C during the calibrations of non-temperature compensated instruments such as proving rings, the calibration data shall be corrected in accordance with the applicable force calibration standard. | Choose an item. |  |  |
|  | **D.1.4** | Equipment |  |  |  |
|  | **D.1.4.1** | Primary Force Standards (ASTM E74) |  |  |  |
|  | **D.1.4.1.1** | A laboratory that performs primary force standards calibrations shall directly apply a deadweight force without intervening mechanisms such as levers, hydraulic multipliers, or the like, whose mass has been determined by comparison with mass reference standards traceable to the International System of Units (SI). | Choose an item. |  |  |
|  | **D.1.4.1.2** | Primary force standard deadweight machines shall not have any mechanism for amplifying the force such as levers, hydraulic multipliers or the like, or any mechanism that counterbalances the frame (or tare). | Choose an item. |  |  |
|  | **D.1.4.1.3** | Weights used as primary standards in deadweight machines shall be made of rolled, forged, or cast metal. | Choose an item. |  |  |
|  | **D.1.4.1.4** | The surface roughness of the weights shall meet the requirements of the applicable force calibration standard. | Choose an item. |  |  |
|  | **D.1.4.1.5** | If the weights are plated or coated, the finish shall be of a proven design and of a material such as cadmium or nickel-chromium. | Choose an item. |  |  |
|  | **D.1.4.1.6** | The forces developed by the weights shall be determined using formula 1, | Choose an item. |  |  |
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|  |  | where *F* = force (N),  *m* = mass (kg),  *g* = local acceleration due to gravity (m/s2),  *ρ*a = density of air, and  *ρ*w = density of the weight (same units as *ρ*a). |  |  |  |
|  | **D.1.4.1.7** | This requires that the laboratory shall have knowledge of the local gravity, its uncertainty, and the local air buoyancy correction. | Choose an item. |  |  |
|  | **D.1.4.1.8** | The masses of the weights shall be known to within 0.005 % of their nominal values by comparison to reference standards traceable to the International System of Units (SI). The local value of the acceleration due to gravity, calculated within 0.0001 m/s2 (10 mGal), may be obtained from the National Geodetic Information Center, National Oceanic and Atmospheric Administration. | Choose an item. |  |  |
|  | **D.1.4.1.9** | The laboratory shall keep records of the calibration of all weights used as standards. | Choose an item. |  |  |
|  | **D.1.4.1.10** | The uncertainty of the vertical component of force applied by the weights shall also be stated in the laboratory records and in reports of calibration. | Choose an item. |  |  |
|  | **D.1.4.1.11** | The masses of the weights shall be determined initially, and the determination repeated if damage or disassembly of the machine occurs. | Choose an item. |  |  |
|  | **D.1.4.1.12** | Verification of force realization shall be demonstrated through an intercomparison program as outlined by the laboratory’s quality system. | Choose an item. |  |  |

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|  | **D.1.4.2** | Secondary force standards (ASTM E74) |

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|  | **D.1.4.2.1** | Secondary force standards shall have been calibrated against primary force standards, with the exception that secondary force standards having capacities exceeding 1 000 000 lbf (4.4 MN) may be calibrated against a combination of several lower-capacity secondary force standards loaded in parallel. | Choose an item. |  |  |
|  | **D.1.4.2.2** | If several secondary force standards are combined and loaded in parallel to meet special needs for high capacities exceeding 1 000 000 lbf (4.4 MN): |  |  |  |
|  | **a)** | those secondary force standards shall have equal compliance, and | Choose an item. |  |  |
|  | **b)** | forces shall be applied equally to each of those secondary force standards. | Choose an item. |  |  |
|  | **D.1.4.2.3** | Secondary force standards used shall have a suitable force calibration frame or mechanism to ensure an axial force application to the unit under test. The secondary system should exhibit no parasitic, frictional or mechanical losses during use. | Choose an item. |  |  |
|  | **D.1.4.2.4** | Any perturbations shall have been characterized. | Choose an item. |  |  |
|  | **D.1.4.3** | The uncertainty of the applied forces generated shall be determined using appropriate methods, such as recommended in ASTM E74 and ISO 376. | Choose an item. |  |  |

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|  | **D.1.4.4** | Overload or repaired instruments |

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|  | **D.1.4.4.1** | Any force standard or multiplying system that is repaired or modified in a way that may result in changes in the calibration curve shall be recalibrated prior to use. | Choose an item. |  |  |
|  | **D.1.4.4.2** | Any instrument that sustains an overload that produces a change in the zero-force output of 1 % or more shall be recalibrated prior to use. | Choose an item. |  |  |
|  | **D.1.4.5** | All calibration hardware that is subject to calibration forces such as coupling nuts, pull-rods, adapters, etc., shall be clearly labelled with the maximum allowable force they can sustain. | Choose an item. |  |  |
|  | **D.1.4.6** | The electrical instrumentation used to calibrate force-measuring instrumentation shall comply with the requirements specified by the procedural method used. | Choose an item. |  |  |
|  | **D.1.5** | Calibration |  |  |  |
|  | **D.1.5.1** | The calibration forces shall be distributed over the full range of the force-measuring instrument as specified by the procedural method used. Note that the requirements of ASTM E74 and ISO 376 differ. | Choose an item. |  |  |
|  | **D.1.5.2** | Randomization of force application conditions is of primary importance. The instrument undergoing calibration shall be rotated in the calibration machine and subjected to other randomizations in accordance with the procedural method used. | Choose an item. |  |  |
|  | **D.1.6** | Records: All measurements shall be appropriately recorded and maintained in accordance with the procedural method used where those requirements exceed those of ISO/IEC 17025. | Choose an item. |  |  |
|  | **D.1.7** | Reporting the results |  |  |  |
|  | **D.1.7.1** | In addition to the report requirements of ISO/IEC 17025, the laboratory shall provide calibration reports that conform to the requirements of ASTM E74, ISO 376 or both. | Choose an item. |  |  |
|  | **D.1.7.2** | The calibration report shall state which documentary standard(s) was (were) followed. | Choose an item. |  |  |
|  | **D.1.7.3** | In cases where other procedural standards are followed, the calibration report shall, at a minimum, contain the following information: |  |  |  |
|  | **a)** | manufacturer and serial number of the instrument calibrated; | Choose an item. |  |  |
|  | **b)** | type of reference standard used (i.e., primary standard, secondary standard), including the uncertainty in the applied force; | Choose an item. |  |  |
|  | **c)** | if critical to transducer performance, identification of the force application fittings used; | Choose an item. |  |  |
|  | **d)** | temperature at which the calibration was performed, including limits of temperatures variations during the calibrations; | Choose an item. |  |  |
|  | **e)** | listing of the calibration forces applied and deflections observed; | Choose an item. |  |  |
|  | **f)** | the calibration curve, including the method of analysis used to obtain the curve, and the deviations of the experimental data for the fitted curve; | Choose an item. |  |  |
|  | **g)** | the uncertainty associated with the calibration results and limits of assigned force ranges if such limits are required. | Choose an item. |  |  |
| **D.2** |  | **Mass Calibration** |  |  |  |
|  |  | NOTE Echelon classifications referenced below are further defined in NIST Handbook 143, Table 4. |  |  |  |
|  | **D.2.2.1** | 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. | Choose an item. |  |  |
|  | **D.2.2.2** | The environmental conditions shall be within the specifications of the weighing instruments where applicable. | Choose an item. |  |  |
|  | **D.2.2.3** | 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. | Choose an item. |  |  |
|  | **D.2.2.4** | 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. | Choose an item. |  |  |
|  | **D.2.2.5** | Vibration shall not diminish the performance of precision analytical balances and mass comparators. | Choose an item. |  |  |
|  | **D.2.2.6** | 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. | Choose an item. |  |  |
|  | **D.2.2.7** | Laboratories shall evaluate the level of significance for buoyancy corrections for all mass calibrations. | Choose an item. |  |  |

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|  | **D.2.3** | Procedures and method validation |

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|  | **D.2.3.1** | 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. | Choose an item. |  |  |
|  | **D.2.3.2** | 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. | Choose an item. |  |  |
|  | **D.2.4** | Equipment |  |  |  |
|  | **D.2.4.1** | 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: | Choose an item. |  |  |
|  | **a)** | they shall be reevaluated to ascertain the current level of precision prior to use, and | Choose an item. |  |  |
|  | **b)** | the uncertainty estimate shall reflect the post-repair performance. | Choose an item. |  |  |
|  | **D.2.4.2** | 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. | Choose an item. |  |  |
|  | **D.2.4.3** | For an application where external standards are used for comparison, appropriate control charts shall be maintained to evaluate the process standard deviation. | Choose an item. |  |  |
|  | **D.2.4.4** | Balances |  |  |  |
|  | **D.2.4.4.1** | Balances used as a direct comparison to the mass unit shall be calibrated prior to use. | Choose an item. |  |  |
|  | **D.2.4.4.2** | For an application requiring balance accuracy, the laboratory shall choose appropriate and correct calibration procedures and calculations. | Choose an item. |  |  |
|  | **D.2.4.4.3** | 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. | Choose an item. |  |  |
|  | **D.2.4.4.4** | 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. | Choose an item. |  |  |
|  | **D.2.4.5** | Environmental sensors |  |  |  |
|  | **D.2.4.5.1** | 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). | Choose an item. |  |  |
|  | **D.2.4.5.2** | These instruments shall be recalibrated periodically unless intrinsic (defining) standards are employed. | Choose an item. |  |  |
|  | **D.2.4.5.3** | Calibration and intercomparison periods shall be documented by the laboratory. | Choose an item. |  |  |
|  | **D.2.4.5.4** | For intrinsic standards, data from intercomparison with standards of known measurement values shall be available. | Choose an item. |  |  |
|  | **D.2.4.5.5** | Means shall be provided to measure barometric air pressure, air temperature, and relative humidity of the laboratory environment adequate to the method used. | Choose an item. |  |  |
|  | **D.2.4.5.6** | Documentation of the uncertainty and traceability of these environmental measurement results shall be maintained. | Choose an item. |  |  |
|  | **D.2.5** | Standards |  |  |  |
|  | **D.2.5.1** | Suitable reference standards shall be available at each echelon and range for which the laboratory is accredited. | Choose an item. |  |  |
|  | **D.2.5.2** | Sufficient historical data and uncertainty analysis shall be available to support the standards used at each level of a traceability hierarchy. | Choose an item. |  |  |
|  | **D.2.5.3** | Suitable calibration intervals shall be documented and ensured. | Choose an item. |  |  |
|  | **D.2.5.4** | 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. | Choose an item. |  |  |
|  | **D.2.5.5** | 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). | Choose an item. |  |  |
|  | **D.2.5.6** | 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. | Choose an item. |  |  |

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|  | **D.2.6** | Handling of test and calibration items |

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|  | **D.2.6.1** | The laboratory shall have documented procedures to ensure adequate chain-of-custody of calibration items if required by law. | Choose an item. |  |  |
|  | **D.2.6.2** | 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. | Choose an item. |  |  |
|  | **D.2.6.3** | The laboratory shall allow adequate stabilization time for mass standards to ensure environmental and thermal stability prior to calibration. | Choose an item. |  |  |
|  | **D.2.6.4** | 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. | Choose an item. |  |  |

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|  | **D.2.7** | Assuring the quality of test and calibration results |

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|  | **D.2.7.1** | 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. | Choose an item. |  |  |
|  | **D.2.7.2** | 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. | Choose an item. |  |  |
|  | **D.2.7.3** | 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. | Choose an item. |  |  |
|  | **b)** | those data shall be available for review. | Choose an item. |  |  |
|  | **D.2.8** | Reporting the results |  |  |  |
|  | **D.2.8.1** | Calibration reports shall describe the mass standards mentioned in the report with sufficient detail to avoid any ambiguity. | Choose an item. |  |  |
|  | **D.2.8.2** | 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; | Choose an item. |  |  |
|  | **b)** | conventional (apparent) mass values versus appropriate reference density; | Choose an item. |  |  |
|  | **c)** | reference density; | Choose an item. |  |  |
|  | **d)** | uncertainties; | Choose an item. |  |  |
|  | **e)** | material; | Choose an item. |  |  |
|  | **f)** | thermal coefficient of expansion (if used in calculations); | Choose an item. |  |  |
|  | **g)** | construction; | Choose an item. |  |  |
|  | **h)** | density (assumed or measured, along with the measurement method); | Choose an item. |  |  |
|  | **i)** | any identifying markings; | Choose an item. |  |  |
|  | **j)** | tolerances, if appropriate; | Choose an item. |  |  |
|  | **k)** | magnetic susceptibility of mass standards, if evaluated, along with method of evaluation. | Choose an item. |  |  |
|  | **D.2.10.2** | 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. | Choose an item. |  |  |
|  | **D.2.10.3** | Information regarding cleaning methods, where applicable, shall be provided on the calibration reports. | Choose an item. |  |  |
|  | **D.2.10.4** | 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; | Choose an item. |  |  |
|  | **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. | Choose an item. |  |  |
|  | **D.2.10.5** | 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. | Choose an item. |  |  |
|  | **D.2.10.6** | Any out-of-tolerance conditions of the mass standards under test identified through the calibration process shall be noted on the calibration report. | Choose an item. |  |  |

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| **D.3** |  | **Volume calibrations** |

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|  | **D.3.2** | Accommodations and environmental conditions |

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|  | **D.3.2.1** | Vibration, air currents, rapid temperature fluctuations, and other environmental variations shall be kept to levels such that they do not diminish the validity of the measurement whether by volume transfer methods or the performance of precision balances or scales when gravimetric methods are used. | Choose an item. |  |  |
|  | **D.3.2.2** | Relative humidity shall be monitored more closely when evaporation or condensation may be a concern. | Choose an item. |  |  |

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|  | **D.3.3** | Calibration methods and method validation |

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|  | **D.3.3.1** | The algorithm chosen for the measurement, the reference standard to be used, and the equipment to be used for a calibration shall be correct for that calibration. | Choose an item. |  |  |
|  | **D.3.3.2** | A documented procedure shall be available in the laboratory. | Choose an item. |  |  |

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|  | **D.3.4** | Equipment, standards and reference materials |

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|  | **D.3.4.1.1** | Mass standards used as reference standards shall be traceable to the International System of Units (SI) through standards maintained by a national laboratory (such as NIST) and be available at each class and range for which the laboratory is accredited. | Choose an item. |  |  |
|  | **D.3.4.1.2** | When water is used as the medium for gravimetric methods, it shall be deionized or distilled, and its density shall be verified. | Choose an item. |  |  |
|  | **D.3.4.1.3** | For gravimetric procedures the density shall be calculated/measured to 0.000001 g/cm3. | Choose an item. |  |  |
|  | **D.3.4.1.4** | The quality of water used as a calibration medium shall be of adequate purity (potable) and cleanliness and free from excess air entrapment. | Choose an item. |  |  |
|  | **D.3.4.1.5** | Gravimetric methods shall be performed using weighing equipment with adequate accuracy and precision for the uncertainty of the measurement procedure. | Choose an item. |  |  |
|  | **D.3.4.1.6** | Appropriate control charts or range charts shall be maintained to verify the volume measurement process. | Choose an item. |  |  |
|  | **D.3.4.1.7** | Mass calibration variability shall not be used to estimate variability for gravimetric volume calibrations. | Choose an item. |  |  |
|  | **D.3.4.1.8** | Gravimetric methods require the means to adequately measure barometric air pressure, air temperature, water temperature, and relative humidity of the laboratory environment to perform proper buoyancy corrections and calculate or look up accurate water density. Environmental measuring equipment shall be appropriate to support the volume calibration method used. | Choose an item. |  |  |
|  | **D.3.4.2.1** | Volume standards used as reference standards in the laboratory shall be traceable to the SI through standards maintained by a national metrology institute such as NIST. | Choose an item. |  |  |
|  | **D.3.4.2.2** | The laboratory shall have appropriate programs and procedures in place for verification and recalibration of its volume standards. | Choose an item. |  |  |
|  | **D.3.4.2.3** | Volumetric methods require accurate temperature measurements. Environmental measuring equipment shall be appropriate to support the volume calibration method used. | Choose an item. |  |  |
|  | **D.3.4.2.4** | Extreme care shall be used to measure water temperatures. The accuracy of water density calculations is severely degraded by inaccurate water temperature measurements and the presence of thermal gradients. | Choose an item. |  |  |
|  | **D.3.5** | Handling of calibration items |  |  |  |
|  | **D.3.5.1** | The volume standard being calibrated shall be free of any sign of abuse or damage, such as dents, chips, improper draining due to lack of cleanliness, and dirty sight gages. | Choose an item. |  |  |
|  | **D.3.5.2** | The laboratory shall have documented procedures to ensure adequate chain-of-custody of calibration items if required by law. | Choose an item. |  |  |
|  | **D.3.5.3** | Procedures shall be documented to ensure adequate tracking glass or metal volumetric standards. | Choose an item. |  |  |

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|  | **D.3.6** | Assuring the quality of calibration results |

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|  | **D.3.6.1** | Measurement control programs shall be in place and available for review for each measurement type (based upon procedures) and nominal volume range for which calibration data is provided. | Choose an item. |  |  |
|  | **D.3.6.2** | Measurement control techniques shall be implemented, with the resulting data available for review. | Choose an item. |  |  |
|  | **D.3.6.3** | For those situations in which statistical information is not inherent to the process, i.e., simple measurements without built-in redundancy checks, additional measurements shall be made to provide experimental characterization of the measurement that is sufficient for an adequate estimation of the measurement uncertainty. | Choose an item. |  |  |
|  | **D.3.7** | Reporting the results |  |  |  |
|  | **D.3.7.1** | As required by ISO/IEC 17025, calibration reports shall describe the volume standards with sufficient detail to avoid any ambiguity. In addition to those items required by ISO/IEC 17025, calibration reports shall contain the following items: | Choose an item. |  |  |
|  | **a)** | volume; | Choose an item. |  |  |
|  | **b)** | uncertainty; | Choose an item. |  |  |
|  | **c)** | reference temperature; | Choose an item. |  |  |
|  | **d)** | material of the standard submitted for calibration; | Choose an item. |  |  |
|  | **e)** | thermal coefficient of expansion (assumed, measured, or provided by the manufacturer) used; | Choose an item. |  |  |
|  | **f)** | construction of the item being calibrated; | Choose an item. |  |  |
|  | **g)** | any identifying markings; | Choose an item. |  |  |
|  | **h)** | any tolerances if appropriate (see section regarding conformity statements). | Choose an item. |  |  |
|  | **D.3.7.2** | Environmental parameters measured during the calibration shall be provided on the calibration report as appropriate. These measurements include laboratory air temperature, volume standard temperature, temperature of the medium, barometric pressure, and relative humidity. | Choose an item. |  |  |
|  | **D.3.7.3** | Conformity assessment to a classification scheme is often required for customers using volume standards. If a statement of conformity is being made: |  |  |  |
|  | **a)** | the volume standards being calibrated shall meet the appropriate classifications such as NIST, ASTM, API, or OIML; | Choose an item. |  |  |
|  | **b)** | the calibration reports shall clearly identify the classification scheme with revision date to which the conformity assessment was made; | Choose an item. |  |  |
|  | **c)** | conformity statements shall clearly specify to which results they apply and which specifications and tolerances, or parts thereof, are met or not met; | Choose an item. |  |  |
|  | **d)** | out-of-tolerance conditions shall be reported. | Choose an item. |  |  |

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| **Requirements from Annex E of Handbook 150-2**  Applicable only to those laboratories seeking accreditation/reaccreditation for Legal Metrology  These additional requirements apply to legal metrology laboratories that are both NVLAP accredited and NIST Office of Weights and Measures (OWM) recognized.  While NVLAP-accredited laboratories that are *not* State weights and measures laboratories may choose to follow the requirements in this annex, they will not be assessed to them by NVLAP.  **Note to assessors:** leave all elements of this section blank if the laboratory is not being assessed for compliance with the requirements for legal metrology. |

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| **Annex E** |  | **Legal Metrology** |  |  |  |
|  | **E.2** | **Training requirements** |  |  |  |
|  |  | Training requirements for State weights and measures laboratories are published in NIST Handbook 143, *State Weights and Measures Laboratories Program Handbook*, which is available on the NIST OWM website, accessible from [www.nist.gov](http://www.nist.gov). These requirements are summarized in Table E.1 and shall be met by personnel in State weights and measures laboratories who hold approved signatory status for calibration certificates.  Note: Training requirements will be verified for each signatory by reviewing the training records of the laboratory staff. | Choose an item. |  |  |
|  | **E.3** | **Regional Measurement Assurance Program (RMAP) Requirements** |  |  |  |
|  |  | Laboratory personnel involved in calibrations covered by their accreditation shall attend the annual OWM Regional Metrology Assurance Program training events as required for ongoing NIST Office of Weights and Measures recognition. | Choose an item. |  |  |
|  | **E.4** | **Proficiency testing (PT) requirements** |  |  |  |
|  | E.4.1 | NVLAP-accredited State weights and measures laboratories shall participate in all RMAP PTs for capabilities listed on their NVLAP scope of accreditation and for those capabilities they desire to add to their scope of accreditation. | Choose an item. |  |  |
|  | E.4.2 | RMAP proficiency tests are accepted by NVLAP, and State weights and measures laboratories shall include them in the Proficiency Testing Schedule required for submission with each application to NVLAP for accreditation or renewal of accreditation. | Choose an item. |  |  |
|  | E.4.3 | Results of RMAP PTs shall be available for review during the NVLAP assessment process. | Choose an item. |  |  |
|  | E.4.4 | State weights and measures laboratories having capabilities on their NVLAP scopes of accreditation for which RMAP PT is not available shall ensure that proficiency testing is done by other means.  NOTE Laboratories may, under the guidance of OWM and following the documented procedures, coordinate “Mini-MAPs” with other laboratories to cover these capabilities. | Choose an item. |  |  |
|  | E.5.1 | State weights and measures laboratories commonly have additional regulatory requirements resulting from the adoption into State law or regulation of requirements from documentary standards. When this is the case, State weights and measures laboratories shall meet these additional requirements, when applicable including, but not limited to: | Choose an item. |  |  |
|  | a) | assessment of submitted standards for full conformity to specified documentary standards referenced in State law or regulation, except where exemptions to full conformity are noted according to ISO/IEC 17025 or the documentary standards themselves; | Choose an item. |  |  |
|  | b) | inclusion on calibration certificates of statements of conformity as assessed in E.5.1a; | Choose an item. |  |  |
|  | c) | inclusion on calibration certificates of calibration intervals when such intervals are defined and/or required by State laws or regulations. | Choose an item. |  |  |