GMP 12

Good Measurement Practice

for

Standard Operating Procedure Selection

Good laboratory practices, use of proper standards and equipment, and selection of standard operating procedures are essential for providing calibration results with accurate and traceable values with appropriate and suitable uncertainties. The following matrix recommends SOPs based on the parameter, type of calibration items, and level of uncertainty needed.

# **Table 1. Procedure Selection Table.**

| **Parameter or Documentary Standard[[1]](#footnote-1)** | **Calibration Item** | **Recommended SOP** |
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| **Mass** (NISTIR 6969 and NISTIR 5672) | | |
|  | Railroad test cars | SOP 27, Railroad Test Cars using a Master Track Scale |
| HB 105-8 | Weight carts | SOP 33, Calibration of Weight Carts (References SOP 4 and SOP 7) |
| HB 105-1, Class F  ASTM, OIML | Class F  Class 5, 6, 7  Class M1, M2, M3  e.g., 10 kg to 250 kg (≥500 lb) cast iron  1 mg to 5 kg  (1 μlb to 10 lb) stainless steel | SOP 8, Modified Substitution - may be used if expanded uncertainty is less than 1/3 of the tolerance  SOP 7, Single Substitution - to be used, as a minimum, if conditions given for SOP 8 cannot be met  NOTE: Balances and standards must be selected properly for these conditions to be met. |
| ASTM, OIML | Class 3, 4 (P)  Class F1, F2  e.g., 1 kg kit, 100 g kit | SOP 7, Single Substitution - may be used if expanded uncertainty is less than 1/3 of the tolerance. If uncertainty is greater than 1/3 of the tolerance, then use SOP 4.  SOP 4, Double Substitution - to be used for buoyancy corrections and if expanded uncertainty is less than 1/3 of the tolerance  NOTE: Balances and standards must be selected properly for these conditions to be met. |
| ASTM, OIML | Class 1, 2 (S, S-1)  Class E2  When used for balance calibration | SOP 5, 3-1 Weighing Design (preferred)  SOP 4, Double Substitution - to be used for buoyancy corrections and if expanded uncertainty is less than 1/3 of the tolerance |
| ASTM, OIML | Class 000, 00, 0, 1 (S)  Class E1  When used as laboratory standards | Weighing Designs per NIST Technical Note (TN) 952, TN 844, NISTIR 5672, SOP 28, with appropriate check standards;  SOP 5, 3-1 Weighing Design (optional) |

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| **Volume** (NISTIR 7383) | | |
| HB 105-2 | Glass flasks | SOP 14, Gravimetric Calibration of Volumetric Standards Using an Electronic Balance  SOP 16, Calibration of Measuring Flasks  Volume Transfer Method (acceptable) |
| HB 105-3 | 20 L test measures  (5 gal or 10 gal) | Preferred: SOP 19, Calibration of Graduated Neck-Type Metal Provers (Volume Transfer Method) is preferred. When temperature instability is observed during the calibration process, SOP 19 must be used.  SOP 31, Scale Plate Calibration for Volumetric Field Standards  SOP 18, Calibration of Graduated Neck-Type Metal Volumetric Field Standards Using a Slicker-Plate Type Standard, may be used if temperature stability and limits are acceptable (single delivery from slicker plate type standard; for glass standards use SOP 19. |
| HB 105-3 | Large graduated neck type provers - used for meter verification | SOP 19, Calibration of Graduated Neck-Type Metal Provers (Volume Transfer Method)  SOP 31, Scale Plate Calibration for Volumetric Field Standards |
| HB 105-4 | LPG provers | SOP 21, Calibration of LPG Provers  SOP 31, Scale Plate Calibration for Volumetric Field Standards |
| HB 105-7 | Compact Displacement Prover (Small Volume Provers) | SOP 26, Gravimetric Calibration of Dynamic Volumetric Systems used as Standards |
|  | Laboratory standards  Glassware: burets, pipettes, flasks | SOP 14, Gravimetric Calibration of Volumetric Standards Using an Electronic Balance |
|  | Laboratory standards  Laboratory slicker plate standards | SOP 14, Gravimetric Calibration of Volumetric Standards Using an Electronic Balance |
|  | Micropipettes | SOP 14, Gravimetric Calibration of Volumetric Standards Using an Electronic Balance |
| HB 105-3 | Large graduated neck type provers - used as laboratory standards | SOP 19, Calibration of Graduated Neck-Type Metal Provers (Volume Transfer Method) OR  SOP 14, Gravimetric Calibration of Volumetric Standards Using an Electronic Balance  SOP 31, Scale Plate Calibration for Volumetric Field Standards |

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| **Length** (NISTIR 8028) | | | | |
|  | Tapes | | SOP 11, Bench Method (lower uncertainties) OR  SOP 12, Tape to Tape | |
|  | Rigid Rules | | SOP 10, Rigid Rule | |
|  | Pi Tapes | | SOP 23, Pi Tape Calibration | |
| **Liquid-in-Glass Thermometers** | | | | |
| HB 105-6 | Field standards for weights and measures | | SOP 25 (unpublished) | |
| **Timing Devices** | | | | |
| HB 105-5 | Field standards for weights and measures | | SOP 24 (unpublished) | |
| **Traffic Speed Gun Tuning Forks** | | | | |
|  | For enforcement official use | | SOP 22 (unpublished) | |
| **Measurement Assurance** | | | | |
| All Process Measurement Assurance | | SOP 30 | | Use of process measurement assurance programs |
| Mass | | SOP 5, 28 | | Use of check standards in procedure  TN 952, TN 844, NISTIR 5672 |
| Mass | | SOP 4, 6, 7, 8 | | SOP 9 |
| Length | | SOP 10, 11, 12, 23 | | Redundancy built into procedures with replicate measurements |
| Volume | | SOP 13, 14, 15, 16, 18, 19, 21, 26 | | SOP 17, laboratory check standards OR  SOP 20, standard deviation charts and range charts |
| Temperature | | SOP 25 | | Use of check standards in procedure (SOP 30, SOP 17) |
| **Uncertainty** | | | | |
| All parameters | | All SOPs | | SOP 29, Calculation of Uncertainty  Note: Each SOP for calibration procedures includes a detailed uncertainty budget table template identifying common components to be included. |

# **Table 2. Documentary Standard References.**

| **Documentary Standard Number** | **Title** | **Latest Revision Date** |
| --- | --- | --- |
| 105-1 | Specifications and Tolerances for Field Standard Weights (NIST Class F) | 2019 |
| 105-2 | Specifications and Tolerances for Field Standard Measuring Flasks | 1996 |
| 105-3 | Specifications and Tolerances for Graduated Neck Type Volumetric Field Standards | 2010 |
| 105-4 | Specifications and Tolerances for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid Volumetric Provers | 2016 |
| 105-5 | Specifications and Tolerances for Field Standard Stopwatches | 1997 |
| 105-6 | Specifications and Tolerances for Thermometers | 1997 |
| 105-7 | Specifications and Tolerances for Dynamic Small Volume Provers | 1997 |
| 105-8 | Specifications and Tolerances for Field Standard Weight Carts | 2019 |
| ASTM E617 | Standard Specification for Laboratory Weights and Precision Mass Standards | 2018 |
| OIML R111 | Weights of classes E1, E2, F1, F2, M1, M1–2, M2, M2–3 and M3  Part 1: Metrological and technical requirements | 2004 |

1. See Table 2 for complete Titles for the Documentary Standard references used in Table 1. [↑](#footnote-ref-1)