



Measurement Traceability

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This Session

Aims to explain

- Traceability represents a process of comparison back to reference values
- Traceability is typically demonstrated through calibration activities
- Misconceptions around 'adjustments' and 'checks'

A process of comparison

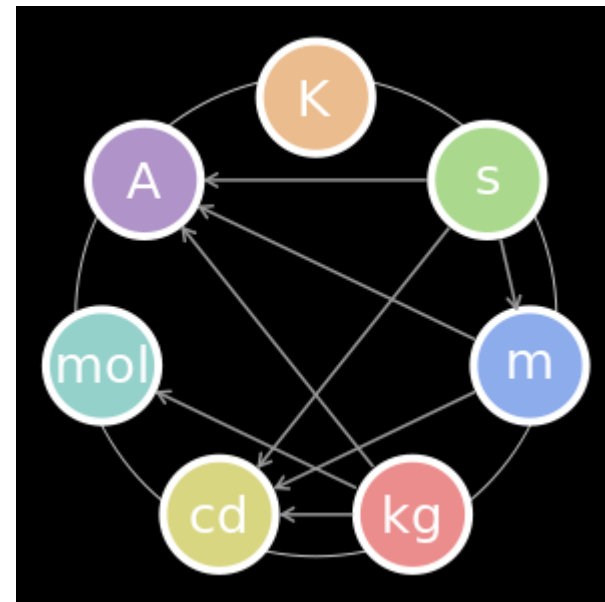
Metrological Traceability: property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.

(Refer to ISO/IEC Guide 99 (VIM), definition 2.39)

SI Units

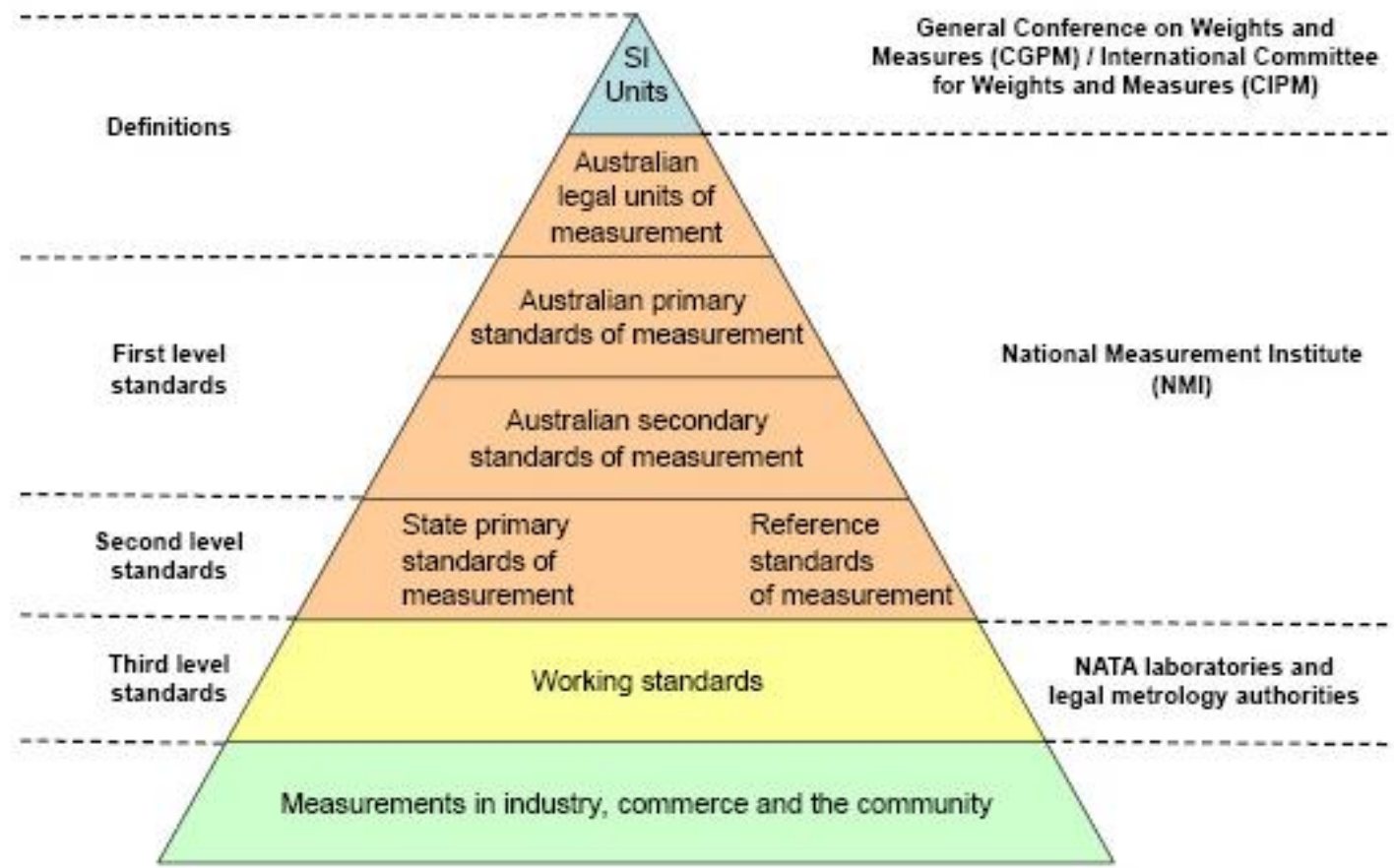
International Systems of Units has seven base units:

- the metre (m)
- the kilogram (kg)
- the second (s)
- the ampere (A)
- the kelvin (K)
- the candela (cd)
- the mole (mol)

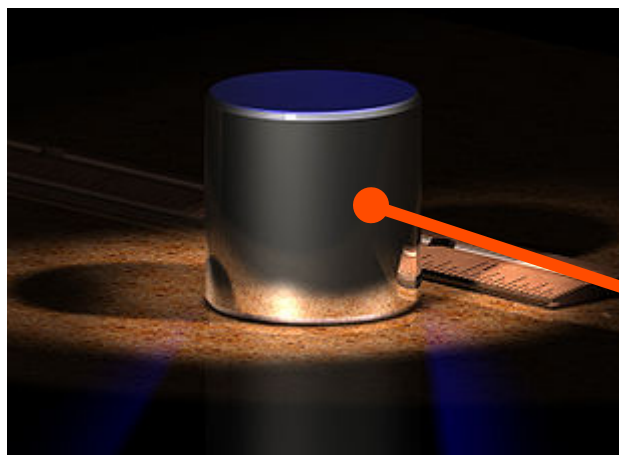




Standards Hierarchy

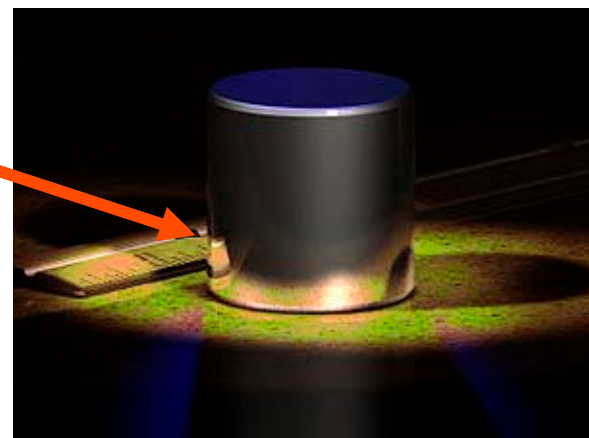


IPK and copies



The International Prototype Kilogram (IPK), kept at BIPM

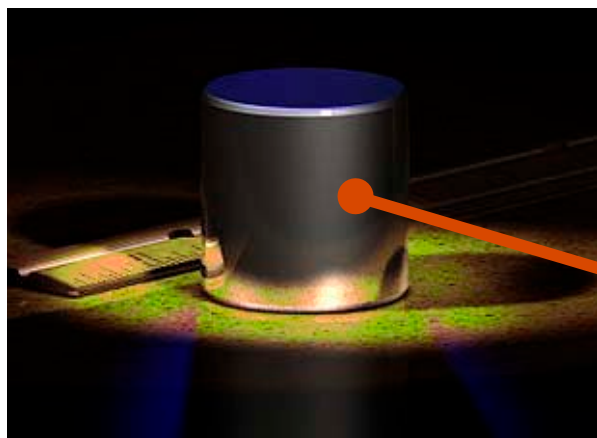
(International Bureau of Weights and Measures, des Poids et Mesures)



The National kilogram (NMI), a copy compared to IPK periodically

Working standards

Calibrated from the National kilogram



The National kilogram (NMI)



An NMI secondary standard

Working standards

Calibrated from the National kilogram



The NMI secondary standard



Laboratory primary calibration standard

Working standards

Calibrated from the National kilogram



Laboratory primary calibration standard



Laboratory secondary standards

Working standards

Calibrated from the National kilogram



Laboratory secondary standards



Precision balances

Working mass sets



Working standards

Calibrated from the National kilogram



Working mass sets

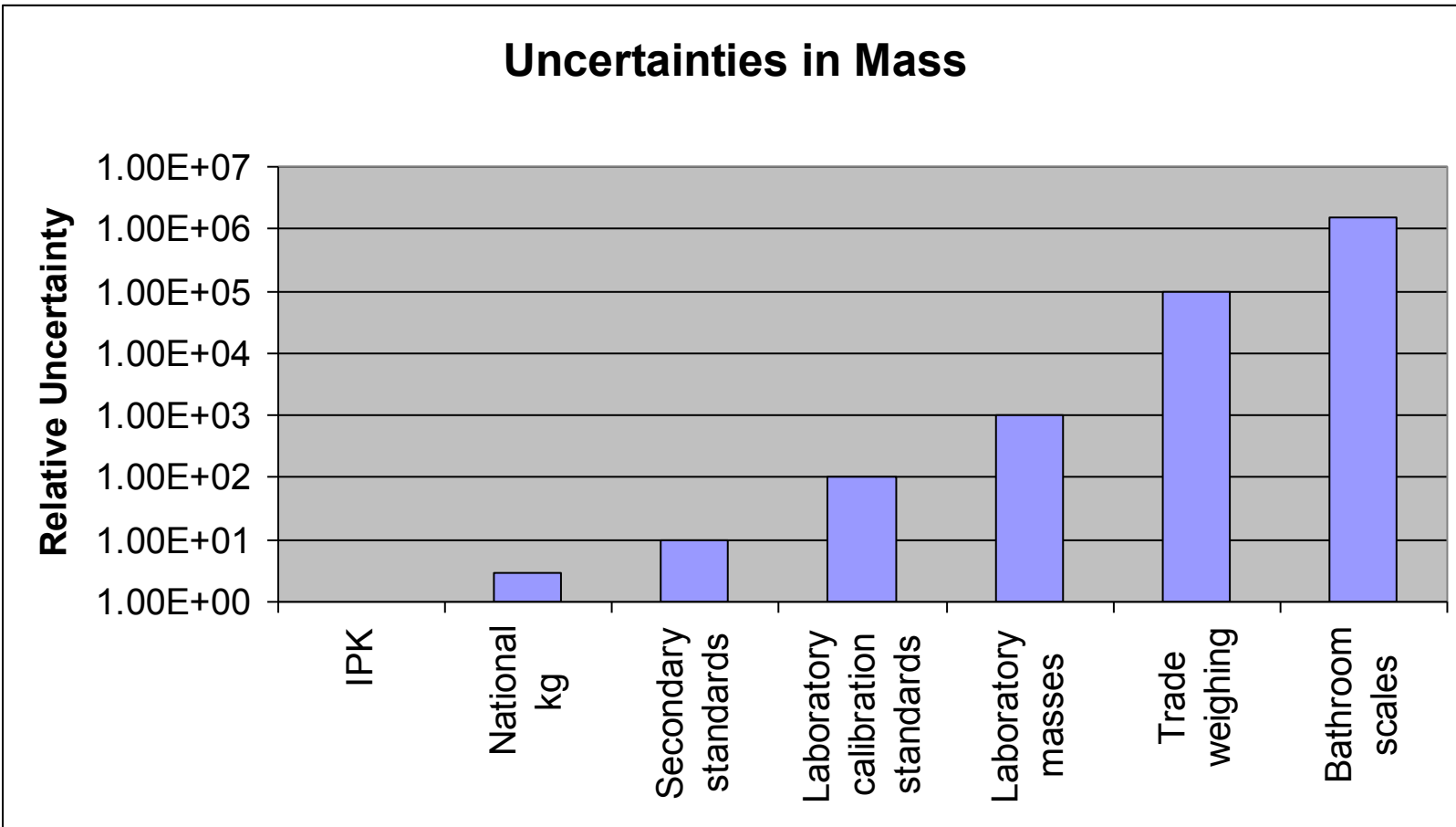


Trade and Industry weighing systems





Increasing Uncertainty



Traceability Network

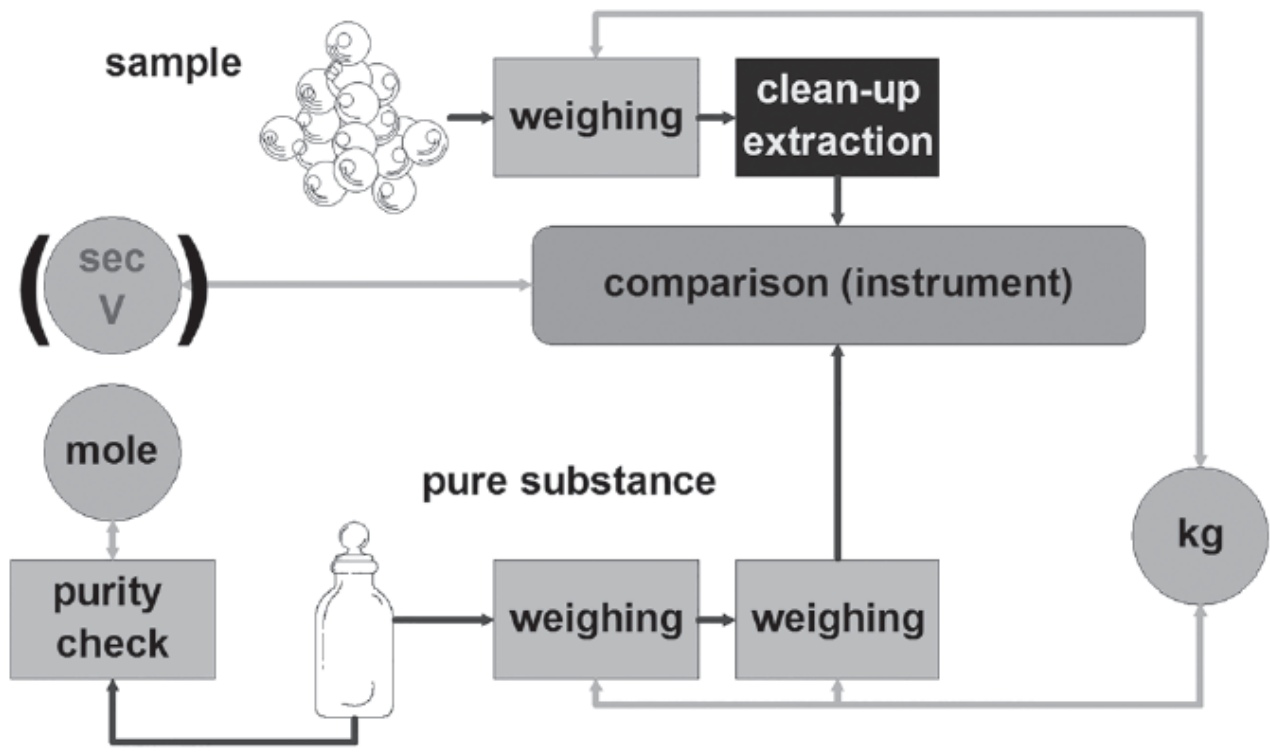


Figure 1 — “Horizontal” traceability network relating the measured quantities in a measurement procedure model to a set of SI units

Refer to ISO/TR 16476:2016

Metrological Traceability

Metrological traceability always consists of two parts:

- A clear definition of the measurand that defines what is supposed to be traceable;
- The traceability of the property values themselves to the appropriate stated references.

Traceability of measurement results is assured through proper **calibration** of all relevant input quantities against appropriate standards, and in most cases can only be established in a networked approach.

Calibration

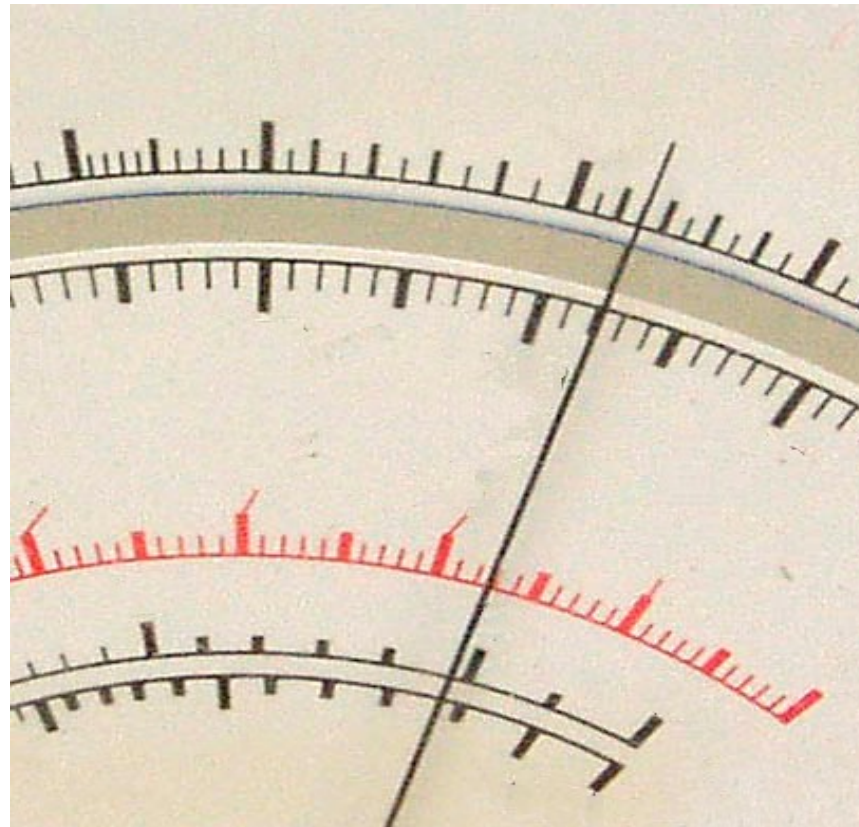
- Is a series of measures made against known reference/s
- Across a predetermined range (*extrapolation is not allowed*)
- With a measurement uncertainty estimated for each measurement

Calibrations may be performed on measuring instruments, reference materials, artefacts and ancillary equipment items.

Calibration Reports and Reference Material Certificates are examples of evidence of measurement traceability.

Calibration of equipment

A measurement made using uncalibrated equipment is not reliable.



Calibration of equipment

NATA Policy Circular 11 – Policy on Metrological Traceability

- If the result of a calibration for an item of equipment contributes significantly to the overall uncertainty and validity of the result, traceability must be formally demonstrated for that equipment.
- If the result of a calibration is not considered to be a dominant factor in the result, evidence to support this claim is required.

Calibration of equipment

Evidence of traceability

- A National Measurement Institute which is a member of the CIPM MRA with applicable calibration services listed on the BIPM Key Comparison Data Base is considered to represent valid traceability.
- A calibration laboratory whose service is accredited by an ILAC MRA partner (in calibration) and with the applicable calibration range and uncertainty listed in their scope of accreditation is considered to represent valid traceability.
- Other?

Calibration of equipment

Whilst not all equipment requires formal calibration, some performance aspects may still require verification in order to establish suitability for use.

- Such verifications might include assessing compliance to a specified precision, resolution, linearity or a dimensional tolerance.
- Technical competency for such verification activity needs to be demonstrated
- Reference equipment used shall be appropriately calibrated
- Uncertainty of measurement of the verification activity shall be taken into consideration

Calibration of reference materials

Useful insights are provided in ISO Guide 33 *Reference materials – Good practice in using reference materials*

- **Level** the reference material should have properties at the level at which the measurement process is intended.
- **Matrix** as close to the matrix of the test sample as practicable.
- **Form** should be in the same form as the sample - solid, gas, etc.
- **Quantity** should be sufficient of quantity.
- **Stability** have stable properties throughout the experiment.
- **Acceptable uncertainty** be compatible with the precision and trueness requirements.

Calibration of reference materials

Evidence of traceability for Reference Materials

- Values assigned to reference materials produced by National Measurement Institutes and included in the BIPM Key Comparison Data Base are considered to have valid traceability.
- Values assigned to reference materials produced by an accredited Reference Materials Provider under its accredited scope of accreditation to ISO Guide 34:2009 are considered to have valid traceability.
- Other?

Where do 'adjustments' fit in?

An *adjustment* is to change the sensitivity of the test equipment against a known reference.

It is not part of the formal definition of calibration.

- An adjustment is often seen to be equivalent to a repair
- For many instruments, after an adjustment is made, a calibration must be repeated (pressure gauge)
- While other instruments are designed to perform an adjustment before measurement (balances) or before use (sound level meters)

What about 'checks'?

A *check* is a measure (or inspection) used to determine continuing stability of an item (i.e. that it has not deviated significantly from its original calibrated value).

- Does not necessarily require traceability
- No measurement uncertainty is necessarily calculated
- Suitability of the check method must be evaluated
- Documented history of the check is preferable

A check provides no evidence of traceability



Technical Note 13



Questions?